FLUID INCLUSION RESEARCH

Proceedings of COFFI

Edwin Roedder, *Editor*
Andrzej Kozlowski, *Associate Editor*

Volume 10

1977

To Harvey, with my thanks for all your
help in getting this together

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Fluid Inclusion Research

Volume 10

Camera-ready copy for this volume
has been provided by the editor

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Volunteers Needed

The editors would appreciate any help that can be offered by the readers in issuing future volumes of Fluid Inclusion Research - Proceedings of COFFI. Help is particularly needed in translation and in preparing abstracts on a regular basis from various segments of the literature. These jobs can be partitioned into as small units as desired; please contact either editor at the above addresses. On an informal basis, it would be most helpful if readers could send to the editors reprints or even just reference citations of pertinent literature. Such help is particularly useful to avoid missing obscure publications, such as theses, or ones in which the presence of inclusion data may not be obvious from title or abstract. If important papers have been missed in previous volumes, they also should be noted.

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Preface

In 1968 the publication of Fluid Inclusion Research - Proceedings of COFFI was started as an offshoot of the Commission on Ore-Forming Fluids in Inclusions (COFFI) of the International Association on the Genesis of Ore Deposits (IAGOD). Although closely connected with COFFI and IAGOD, the publication of these volumes is independently arranged and separately financed, solely by subscriptions, on a nonprofit basis. It was started with a loan, now mostly repaid, from the International Union of Geological Sciences.

The purpose of the publication is to provide entree to the literature with English abstracts or annotated bibliographic citations of all items from the world literature published during the volume year that either contain fluid inclusion data or are pertinent to some aspect of fluid inclusion work. This covers all types of fluid inclusions (aqueous, organic, silicate melt, sulfide melt, gas, etc.), causes and mechanisms of trapping (including various types of immiscibility), physical, chemical, and isotopic data, and data on experimental studies of systems pertinent to the interpretation of all types of phase changes occurring in inclusions, as well as to the sources of such volatiles or fluids and their interactions with rocks. These data are generally given without editorial value judgements except in the case of obviously contradictory or obscure statements. Extent of coverage varies in part as an inverse function of the availability of the original text to the average Western reader and in part as a direct function of the usefulness of the data. In addition to abstracts and citations, we publish English translations of inclusion papers from foreign languages, where available and not otherwise published in English, and notices of meetings and symposia. A reviewer of one of the previous volumes had asked that the abstracts in future issues be split into a number of subject categories rather than be presented in a single, alphabetical sequence. This was not done, because such grouping would not be beneficial to some users, and would add considerably to the editorial chores.

Most of the 551 items from Russian sources in this volume are by the associate editor. Included among these are the 198 abstracts remaining from the papers presented at the Fifth All-Union Conference on Thermobarometry held at Ufa (in the Urals), September 20-27, 1976, (the balance were in Volume 9), and 94 from the Abstracts of the All-Union Meeting, Novosibirsk, 1977. There are 51 items from other foreign language sources and 389 items from the English language literature for a total of 991 abstracts, citations, or annotated citations, plus subject and locality indices. (As all 7 items in the Translations section are also listed in the Abstract section, no author index is needed.)

Although each abstract is duly credited, the editors wish to acknowledge, in particular, the help of Dr. M. Fleischer, of the U.S. Geological Survey, who provided translations of several items and helped with many citations. Chemical Abstracts, of Columbus, Ohio, has most graciously permitted the use of a limited number of their copyrighted abstracts, as indicated in the abstract citations. Help has been received from Drs. H.A. Stalder (Bern, Switz.); Maurice Pagel (Nancy, France); Arthur Barabas (Lancaster, PA); Chris Eastoe (Hobart, Tasmania); P. Lattanzi (Firenze, Italy); and A.P. Berzina (Novosibirsk, USSR). Many other individuals, too numerous to list, have helped by sending the editors books, reprints, references, and copies of abstracts. We particularly are indebted to Professor Ermakov, Chairman Emeritus of COFFI, for copies of Russian books; and to H.E. Belkin for library searches.

Since this volume marks the tenth anniversary of Fluid Inclusion Research--Proceedings of COFFI, it might be appropriate to note some striking trends in fluid inclusion research that are readily apparent on comparison of the indices of this volume with the previous ones. In addition to the normal increase in the number of items published (65% over vol. 9), as characterizes most fields of science these days, there have been dramatic increases in the research recorded in this volume involving certain techniques such as gas chromatography and mass spectrometry, and in the determinations of minor and trace constituents in inclusions by a variety of methods. Major increases are also noted in studies of carbonatites, tin and tungsten in skarns ang greisens, and porphyry copper-molybdenum deposits. The largest increase is in studies of gold deposits, mainly in the USSR. One additional upward trend worth noting is the great increase in the study of intermediate types of inclusions between normal silicate melt and high-temperature aqueous solutions--the "solutions-melts" of the Soviet inclusioneers.

To authors of pertinent articles that have been omitted or are misquoted here through haste, or through language difficulties, we extend our apologies and our request to have these things called to our attention; to authors whose original abstracts have been drastically shortened, edited, or revised, we offer a reminder that the following "abstracts" are not intended to be abstracts of the whole paper, but only that part most pertinent to inclusion workers. The obvious inconsistencies in citation, transliteration, abstracting, and indexing are strictly a result of lack of editorial time. A series of unfortunate circumstances have seriously delayed publication of this volume; we hope to make future volumes much more current than this one. The editors will be glad to furnish free photocopies of the original Russian text of articles or abstracts that have not been translated, in exchange for partial or full translations for use in future issues. Otherwise, photocopies of the originals can be provided at twenty-five cents a page.

Sept. 20, 1980

Edwin Roedder, Editor
Andrzej Kozlowski, Associate Editor

Contents

Notices of Meetings and Symposia

PAST

Editor Kozlowski reports that the Sixth All-Union Conference on Thermobarochemistry, was held 15-18 September, 1978, in Vladivostok, USSR, with excursions starting 19 September. There were 410 registered members. Two volumes of abstracts were printed: I - Thermobarogeochemistry in geology, and II - Thermobarogeochemistry and Ore Genesis. Melt inclusions were not especially discussed. Vladivostok TV carried a story on the conference. A workshop on techniques and an exhibit of equipment was also held. The next (Seventh) All-Union meeting is planned for Kiev in 1982, but an intermediate meeting will be held, possibly Novosibirsk, in May 1981.

The Eleventh General Meeting of the International Mineralogical Association was held in Novosibirsk, USSR, on Sept. 4-10, 1978, and the Sixth All-Union Conference on Thermobarogeochemistry was held on Sept. 19-22, 1978 in Vladivostok. Papers from these meetings will also be abstracted in the next volume.

The Sixth International COFFI Symposium on Fluid Inclusion Research was held in conjunction with the Fifth Quadrennial IAGOD Symposium, at Snowbird, Utah in Aug., 1978, with 489 attendees, from 35 countries. Twenty-six abstracts were submitted for the COFFI symposium and will be published in the next volume.

A group of papers on inclusions were presented at a symposium in Durham, England (see Fluid Inclusion Research -- Proceedings of COFFI, v. 9, p. ix). Abstracts of some of these papers were in the Program of the meeting and hence were printed in the previous volume. The balance were printed in v. 86 of Sect. B of the Proceedings, Inst. Min. and Met. (1977) and are given here. Those that were printed in both places show some slight differences, but are only cited in this volume.

A User School on Fluid Inclusion Equipment and Methods was held March 30-April 1, 1978, at Imperial College, London, under the auspices of the Applied Mineralogical Society. It was organized by Dr. A.H. Rankin, Dept. Geology, Imperial College, London SW72 BP.

A Workshop on Fluid Inclusions, under the aegis of the Specialist Group in Economic Geology of the Geological Society of Australia, was held Feb. 26-28, 1979 at the Dept. of Geology at La Trobe University, Victoria, Australia, with 50 people in attendance. It was organized by T.A.P. Kwak.

A short course on Theory, methods and application of fluid inclusion research was held 1979 at Memorial Univ., St. John's Newfoundland. It was organized by N.C. Higgins and sponsored by the Newfoundland Section of the Geological Assoc. of Canada.

The 12th General Meeting of the International Mineralogical Association (IMA) was held in Orleans, France, 4-6 July, 1980, and the 26th International Geological Congress (IGC) was held in Paris, France, 7-17 July, 1980. Three open meetings of COFFI, held in conjunction with the IGC, resulted in considerable discussion of research and of plans for the future. Abstracts of the formal inclusion papers given at the IMA and IGC were published in Abstracts volumes and will be included in the appropriate (1980) COFFI volume.

FUTURE

The next general meeting of the International Mineralogical Association is scheduled to be held in Bulgaria in Sept. 1982. The next Quadrennial meeting of IAGOD will be held in conjunction with the International Geological Congress in Moscow in 1984. At this meeting fluid inclusion papers will be handled as regular IGC papers, according to Acad. V.S. Sobolev. The Seventh All-Union Conference on Thermobarogeochemistry is scheduled to be held in L'vov, 1982.

The next meeting of IAGOD will be in Tbilisi, Georgian SSR, Aug. 30-Sept. 17, 1982. Dr. A.V. Tvalchrelidze, 85 Paliashvili St., Cancasian Inst. of Mineral Raw Materials, 380062 Tbilisi, USSR, is organizer and General Secretary. Field trips are planned for Aug. 30-Sept. 5 and Sept. 12-17, to visit various deposits in the Great Caucasus, Transcarpathians, Crimea (Fe+Mn), Uzbek (Pb-Zn+Cu-Mo) and Turkmenia (Hg-Sb). The tentative deadline for abstracts is May, 1981, and the first circular is due to be issued Nov. 1980. The best papers are scheduled to be published in both Russian and English in Dec. 1983.

A Short Course on Petrologic Applications of Fluid Inclusions is to be held at the Univ. of Calgary, Alberta, Canada, on May 7-10, 1981, under the auspices of the Mineralogical Association of Canada. Profs. E.D. Ghent (Alberta), M.L. Crawford (Bryn Mawr), and L.S. Hollister (Princeton) are the organizers.

Organization of COFFI

The Bureau of COFFI consists of six officers as follows: Chairman Emeritus - N.P. Ermakov, U.S.S.R.; Chairman - E. Roedder, U.S.A.; First Vice-Chairman - S. Takenouchi, Japan; Second Vice-Chairman - F.P. Mel'nikov, U.S.S.R.; Third Vice-Chairman - M. Solomon, Australia; and Secretary - G. Deicha, France. The following series of Regional Representatives have also been established to provide foci for coordination and exchange of information on COFFI activities, and to help assure complete coverage of the world literature by forwarding reprints or citations to the editors.

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Abbreviations

The Cyrillic sequence, *а,б,в,г,д,е* are converted to abcdef. Most of the numerous abbreviations used in earlier volumes have not been used here. Other than the normal scientific and reference abbreviations, we use only the following:

dm.	daughter mineral	T	temperature (°C)
dxl.	daughter crystal	T_D	temperature of decrepitation*
G	gas	T_F	temperature of formation (i.e., trapping)*
L	liquid		
V	vapor	T_{Frz}	temperature of freezing*
P	primary	T_H	temperature of homogenization*
PS	pseudo secondary	T_M	temperature of melting*
S	secondary	(...)	part of author's abstract omitted.

*These abbreviations are used in this volume, but please see the following item.

Suggested terminology and abbreviations for future inclusion work.

The literature on fluid inclusion is expanding rapidly, and currently many different terms and abbreviations are in use for the temperatures at which various specific events occur within inclusions. The terminology, and hence also the abbreviations, in use in languages other than English obviously must differ, but the time has come for English-speaking inclusion workers to come to a consensus on terminology. After consultation with numerous inclusion laboratories, a consensus was reached on the following terminology, and it is suggested that if this terminology is used consistently in future papers, considerable ambiguity will be avoided. The overlap between the temperature ranges involved, and the similarities of the phase changes noted in gas-rich inclusions at very low temperatures, in "ordinary" aqueous inclusions below and above zero, in highly saline multiphase inclusions at ~300-600°C, and in melt inclusions at ~600-1200°C make it desirable to have the terminology and abbreviations compatible throughout. No terminology can cover all situations, but the recommended terms should be adequate to cover normal usage.

The lowest temperature normally recorded for aqueous inclusions is the temperature at which an inclusion first freezes on dropping the temperature.

This usually occurs only after considerable (metastable) supercooling, and hence the temperature represents not a stable phase change but only the fortuitous event of nucleation of ice and salts. It will vary with inclusion size and with the time-temperature procedure used, but has some significance as a measure of either the freedom of the system from foreign nuclei (for heterogeneous nucleation) or the ease of homogeneous nucleation, without spurious nuclei. When used, it has been called, quite logically, the freezing temperature (i.e., "Tf"). This is the same term that I introduced in 1962 for a different temperature, that of stable, reversible ice-solution equilibria, in allusion to the temperature at which ice (or other phases) should form on cooling, under stable equilibrium (and subsequently abbreviated T_f, T_F, or T_{Frz}). My usage was not well chosen, however, and I believe it should be dropped, and the term temperature of nucleation (Tn) used. This covers any nucleation event, and can be further identified as Tn ice, etc.

The next higher temperature is normally that at which some liquid is first seen to be present on warming a formerly all-crystalline inclusion. I have used the term first melting temperature here, but for simplicity and consistency, I suggest changing to "Te" for eutectic temperature, since that is, in effect, what is being determined.

On further warming, specific solid phases may melt (i.e., dissolve) at recognizable temperatures. Several papers have used "Tm" as the general term for such melting temperatures, with a designation appended to indicate which phase melted (when identifiable), such as "Tm NaCl" or "Tm CO_2". I suggest we follow this usage, as it is descriptive and hence effective. (I realize that "melting" is not necessarily always a good descriptor, but the other term that has been used here, "solution" (i.e., Ts) is equally invalid in other cases, e.g., for the disappearance of pure solid CO_2 at its triple point of -56°C). My original usage of "freezing temperature" thus becomes "Tm ice", or where there is no chance of ambiguity, "Tm". Temperatures for unidentified daughter minerals would then become "Tm dms".

The usage of "homogenization temperature" has also been the source of considerable ambiguity, in that sometimes it is used to refer only to liquid and vapor phases, and other times to total homogenization. I thus suggest that whenever ambiguity may exist, the usage be clarified by adding the designation of which phases homogenize. Thus in low-temperature phase equilibria one could use "Th CH_4 L-V" or "Th CO_2 L-V", and for inclusions with a daughter mineral, "Th L-V" would refer to the homogenization of these two fluids without reference to the behavior of the daughter mineral, the behavior of which is independent, of course. "Th" without other designation should be reserved for actual homogenization, i.e., complete homogenization. As such it would follow most current usage.

The temperature at which an inclusion was trapped is sometimes abbreviated "T_F", for temperature of formation. This causes confusion with the temperature of freezing, so I suggest "Tt" be used, for temperature of trapping. Thus inclusions were formed at Tt and Pt.

The temperature of decrepitation has usually been abbreviated Td, and this seems adequate. Specific details on how such a temperature is determined, e.g., the start of decrepitation, the most rapid rise of decrepitation rate, or the maximum number of impulses per unit increase in temperature, will vary with the technique used and will have to be specified in each paper.

Tentative summary of recommended designations (for ease of typewriting and typesetting, I suggest not using subscripts.)

Th - temperature of total homogenization. The phase into which homogenization occurs should also be stated as well (e.g., Th L or Th V).

Th L-V, Th CO_2 L-V, etc. - temperature of homogenization of the stated pair of phases only. The phase into which homogenization occurs should also be stated as well (e.g., Th CO_2 L-V (V), or Th CO_2-H_2O (CO_2)).

Tt - temperature of trapping.

Td - temperature of decrepitation.

Tm - temperature of melting (or dissolving).

Tm NaCl, Tm dms, Tm ice, etc. - temperature of melting (pure phase) or of solution (mixed system) of specific phases indicated.

Te - temperature of eutectic, i.e., first recognized formation of liquid on warming a completely crystalline inclusion; this is only an approximate or "practical" value at best, as traces of other components will always result in traces of melting at lower temperatures.

Tn - temperature of nucleation in fluid, generally on cooling (i.e., in a normally supercooled, metastable fluid). Thus Tn for an aqueous inclusion "freezing temperature" would be Tn ice; the heterogenization of a previously homogenized inclusion would be Tn V, Tn NaCl, Tn CO_2 V, etc.

E. Roedder, Editor

Abstracts, Translated Abstracts, or Annotated Citations to World Literature, 1977

Note - This section also includes some earlier items that were missed or were not available in time for inclusion in the previous volume.

ACADEMY OF SCIENCES OF THE USSR, KOMI DIVISION, INSTITUTE OF GEOLOGY and ALL-UNION MINERALOGICAL SOCIETY, 1976, Problems of genetic information in mineralogy (Proceedings of the All-Union Mineralogical Seminar), 175 pp. Syktyvkar (in Russian).

The book (printed in 500 copies and obtained through the courtesy of Dr. V.A. Kalyuzhnyi) consists of the abstracts of the 103 papers presented in the All-Union seminar held in Syktyvkar June 1-4, 1976. Several papers devoted to fluid inclusion studies are abstracted under the authors' names in this volume. (A.K.)

ADDY, S.K. and YPMA, P.J.M., 1977, Origin of massive sulfide deposits at Ducktown, Tennessee: An oxygen, carbon, and hydrogen isotope study: Econ. Geol., v. 72, p. 1245-1268.

Rocks in the alteration zone are depleted in their $\delta^{18}O$ values by approximately 2 per mil compared to the unaltered country rocks. The minerals in the alteration zone and the country rocks show identical δD values. The striking similarity of the $\delta^{13}C$ and δD values among the country rocks, the alteration zone, and the orebody suggests that the meteoric water recycled and maintained isotopic equilibrium with the metasediments and thus became metamorphogenic. (From the authors' abstract)

ADRIANOVA, S.I. and BARKHUDARYAN, N.B., 1977, Physico-chemical characteristics of the gold ore deposit of the black-shale formation (Lena Region) (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. II, p. 5-6 (in Russian;

translation by A. Kozlowski). Authors at the Central Sci.-Research Geol.-Prospecting Inst. of Geol. Ministry, Moscow.

The deposit formed at T 440-60°C under elevated P (0.7-1.0 kbar) from pneumatolytic-hydrothermal S-HCO_3-Ca solutions of 30% salt concentration. G consists of CO_2 (50-70 vol.%), $H_2S+SO_2+HCl+HF+NH_3$ (>25 vol.%), by analysis of individual inclusions. Over ∿30% of all inclusions bear L CO_2 (12-99.7 vol.%). Water and CO_2 in inclusions were also identified by IR absorption method. (From the authors' abst.)

AGAR, R.A., 1977, Preliminary investigation into the relationship of copper mineralization to a suite of monzonitic rocks in the Peruvian Coastal Batholith (abst.): Inst. Mining and Met., Trans., Sect. B, v. 86, p. B161-162.

Copper mineralization in the Peruvian Coastal Batholith is associated with a suite of monzonites known as the Linga Super unit, though the ore is located principally in the volcanic envelope and rarely in the monzonites themselves. Grades are generally low (<2% Cu), but locally are enhanced to 15% Cu where upward-migrating ore fluids were trapped beneath an impermeable gabbro sill. Fluid inclusion studies in late magmatic quartz indicate that the residual fluids that emanated from the monzonites were highly saline and enriched in metals. These fluids transported copper away from the monzonites and into the envelope, where the copper was deposited in structurally favourable sites. (Author's abstract)

AGEEV, A.N., 1976, On origin of basalt flows (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 103-104 (in Russian; translation by A. Kozlowski).

Inclusions of mineral-forming media in basalt flows were studied in a deposit of Iceland spar:

Basalt flow				Glass content, %	Phenocrysts	Inclusions	T_H, °C
Zone of flow	Texture	Fractures	Thickness of zone m				
Upper with amygdules	vitrophyric intersertal	depend on position of the zone, thickness up to 100 cm (sic.)	2-6	70-90	olivine plagioclase I plagioclase II	- glass + G glass gas glass	- 1150-1100 - - -
Massive	poikilophitic intersertal, tholeiitic	thermal tension fractures up to 1 cm thick	5-15	10-20	olivine plagioclase I plagioclase II pyroxene	- glass + G glass glass glass + G	- 1160-1070 - - 1200-1080
Bottom with amygdules	Intersertal	various orientations, thickness up to 10 cm	0.5	50-70	olivine plagioclase I plagioclase II	- glass + G glass	- - -

(Author's abst.)

AGEEV, A.N., 1977, On nature of the anomalous gas-liquid inclusions in Iceland spar. from the Siberian platform: Vestnik Moskovsk. Univ., Geologiya, no. 2, p. 117-120 (in Russian). Author at Moscow State Univ.

G/L inclusions in Iceland spar of 0.5-50 mm in size commonly reveal traces of leakage via several or numerous fractures. The surface

of the fractures exceeds by 2-10 times the surface of largest section of the inclusion; the volume containing the fractures is 5-10 times larger than volume of inclusion. Fractures are healed only in the distant edge with formation of small S inclusions, whereas the part adjacent to the inclusion has no evidence of healing. G occupies 15 to 50-80 vol. % of inclusion. Such inclusions were found in calcite occurring in a zone where winter is -50 to -60°C at the Earth's surface, and increases only to -20°C at a depth of 3 m. Calculated pressure caused by frozen inclusion filling should range from 125 to 1250 kg/cm^2, whereas calcite in direction parallel to the cleavage rhombohedron is resistant for breaking up to P 30-35 kg/cm^2. Rare inclusions with big G bubble and completely healed fractures being actually an aureole of S inclusions, were probably superheated under natural conditions. Morphology of fractures caused by freezing is different than those formed on superheating: the former have numerous "steps", the latter are smooth. (Abst. by A.K.)

AKIMTSEV, V.A., BAULIN, K.M., BAZAROV, L.Sh. and MIRONOVA, N. Yu., 1976, Temperatures of crystallization of certain minerals in rare-metal pegmatite (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 116 (in Russian; translation by A. Kozlowski).

1. P inclusions were studied from tantalite-columbite from quartz-cleavelandite and quartz-cleavelandite-spodumene zones, in beryl from block zone and in tourmaline. Phase composition: G $\leq$ 30, $LCO_2 \leq 35$, L $\leq$ 85, silicate dms $\leq$ 50, density of filling 1.4 g/cm^3. PS inclusions are similar.

2. LCO_2 dissolves in LH_2O at 350-230°C (tantalite-columbite), 360-320°C (beryl), and 470-290°C (tourmaline). T_H 580-400°C (tantalite-columbite); inclusions in beryl and tourmaline decrepitate at 500°C before homogenization.

3. P at 580°C is close to 2800 ± 500 atm.

4. Photoelastic effect around crystal inclusions disappears in tantalite-columbite at 560-440°C, and in schorl at 550-510°C, partly reappearing again on cooling.

5. S inclusions in tourmaline homogenize at 340-190°C. (Authors' abst.)

ALEKSANDROVA, E.S., IGNAT'YEVA, I.B. and PASHKOV, Yu.N., 1976, Problems of the methods of study of the composition of G/L inclusions in minerals (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 169 (in Russian; translation by A. Kozlowski).

Chromatographic data from studies of G/L inclusions opened by heat and by two mechanical methods (microdegasator-? and vibration mortar) were compared. Analysis was performed both in air and under inert gas. Opening by heat was performed in thermostatic apparatus of the chromatograph Vyrukhrom, and the extracted phase was transferred into the chromatographic columns. (...) Other samples were ground in water. O_2, N_2, CH_4, H_2, CO_2, and H_2O were found. Thermal opening gave good reproducibility of percent values in the T intervals chosen from the decrepitation curves, (but) the absolute values vary. O_2 was not detected in the thermally released sample. Mechanical opening causes higher H_2, CH_4, O_2 and N_2 (contamination) and the volume percent of components from contamination varies widely. Thermal opening of inclusions causes removal of the most gas, hence this method is the most applicable one. Leaching in air causes, oxidation of S^{2-} to SO_4; S^{2-} was determined polarographically with a sensitivity of $5 \cdot 10^{-8}$ g·ion/ℓ, relative error ≤ 15%. On the basis of composition of G/L inclusions, pH and Eh were calculated at T 25°C. (Authors' abst.)

ALEKSEENKO, V.A., 1976, Vacuum-decrepitometric studies of the stratiform polymetallic deposits of the S. Kazakhstan (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 151-152 (in Russian; translation by A. Kozlowski).

Deposits from Dzhungar Alatau and Karatau were studied. Tel'man and Elochnoe deposits have very distinct aureoles of impregnation at T (T_D? - A.K.) 360-60°C and vertical T zoning indicating their hydrothermal origin. Aureoles at Tekeli ore zones bear high amount of inclusions (300 arbitrary units), whereas barren zones are poorer in inclusions (∿150 a.u.). A similar pattern is found at Mirgalimsay ore level. However, there are also parts of ore zones poor in inclusions. The above is the evidence that primary sedimentary ores have recrystallized during epigenetic processes. At the deposits of N. Suuktyube type neither aureoles of impregnation nor T zoning were found. These deposits were formed by sedimentary and diagenetic processes. At the skarn deposits during T decrease from 900 to 70°C following minerals were formed: pyroxene → quartz → tremolite (calcite) → serpentine (calcite). Most of ore elements were redistributed at low T 290 ± 70°C. (Author's abst.)

ALEKSEENKO, V.A. and KLEVTSOV, S.F., 1976, Aureoles of impregnation at stratified polymetallic deposits of S. Kazakhstan (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 136-137 (in Russian; translation by A. Kozlowski).

Metamorphism of carbonates and schists caused aureoles of impregnation at T 460-60°C. Contact aureoles gave T_D of pyroxenes and quartz 790-910°C at 300-500m from intrusion. Hydrothermal aureoles have the smallest dimensions: 40-80m thick, T similar to metamorphic aureoles, but the release of gases on heating is significantly higher. Deposits that are weakly altered by hydrothermal activity have narrow aureoles (5-15m thicker than ore bodies). Also zones conducting hydrothermal solutions may be found unambiguously. (From the authors' abst.)

ALEKSEENKO, V.A., KOLOMENSKIY, G.Yu., GOLIKOV-ZAVOLZHENSIY, I.V., and ERMEKOV, O.M., 1976, Application of vacuum-decrepitometric studies during prospecting and research of some deposits of Southern and Central Kazakhstan, in Thermobarogeochemistry of mineral formation, N.P. Ermakov, ed.: Rostov, Rostov Univ. Press, p. 117-126 (in Russian).

Full paper corresponding to abstract in Fluid Inclusion Research volume 6, p. 4-5, 1973.

(Authors and title changed from the earlier version.)

ALIBAEVA, G.S., 1976, Thermographic studies of pyrites - the method necessary for interpretation of their decrepigraphs (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 178 (in Russian; translation by A. Kozlowski).

DTA curves of pyrite reveal an endothermic peak at 30-100°C, a weak exothermic peak at 320-340°C and a double endothermic peak at 560-610°C; the loss of weight from 60 mg of sample is 17-21 mg. The first peak is probably caused by the removal of elemental sulfur, the second one probably proves the presence of a small admixture of magnetite; new crystal phases (hematite, marcasite) form from 350 to 700°C. These data should be taken into account during interpretation of decrepigraphs. (From the author's abst.)

ALISKEROV, A.A., 1977, Physico-chemical conditions of formation of the subsurface hydrothermal deposits of the Avachinsko-Kitkhoyskaya zone (abst.), in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Sib. Branch, v. II, p. 109-110 (in Russian; translation by A. Kozlowski). Author at Inst. of Volcanology of the Far-East Sci. Center of Acad. Sci. U.S.S.R.

Metasomatic quartz-pyrite ores and vein mineralization formed at 410-80°C; quartz crystallized at 350-250°C in sericite association and at 150-50°C in quartzites. Parent solutions were of SO_4-HCO_3 type. (From the author's abst.)

ALLARD, P., LE GUERN, F. and SABROUX, J.C., 1977, Thermodynamic and isotopic studies in eruptive gases: Geothermics, v. 5, p. 37-40.

ANDREEV, G.V. and SHVADLUS, M.I., 1977, P-T conditions of formation of alkaline rocks of the Synnyr complex, on the basis of results of studies of the first melt inclusions found there: Akad. Nauk SSSR Doklady, v. 235 no. 4, p. 910-913 (in Russian). Authors at the Geol. Inst. of the Buryat Div. of the Siberian Branch, Acad. Sci. USSR, Ulan-Ude.

Minerals of the rocks bear melt inclusions, usually crystallized, with G phase in the interstices between dms, and inclusions of solutions-melts (of silicate-salt composition). T data are as in table:

Massif	Rock	Mineral	Temperatures, °C		
			beginning of melting	melting of solid phases	homogenization
Goudzhekit	nepheline syenite	nepheline (24)*	780	940	990-1060
Burpala	pulaskite	pyroxene (16)	870	940	1050-1130
	fine-grained trachite-like quartz syenite	quartz (11)	780-790	900-910	1030-1070
Synnyr	porphyry-type pseudoleucite syenite, phenocrysts	pseudoleucite (11)	860-890	950-990	1050-1100
	same rock, matrix	nepheline (31)	800-820	920-940 950-980	1020-1080
		pyroxene (15)	900-930	1050-1090	1120-1130
	nepheline syenite	nepheline (26)	800-850	930-960	990-1100
		K-feldspar (46)**	220	830	840-890

*No. of inclusions homogenized; **inclusions of solutions-melts.

(Continued next page)

Nepheline syenite bears also three-phase inclusions: G + LH_2O + dmNaCl (halite occupies ~25 vol.%). At 90-110°C G phase disappears and at 190-210°C dm + L homogenize. P calculated from these data on the basis of the Lemmlein and Klevtsov's P-T plot for 30% NaCl water solution equal 900-1300 atm. P derived from thermodynamic evaluation of conditions of brucite formation in Synnyr pluton in contact brucite marble at 850°C is 1250 atm. (Abst. by A.K.)

ANDRIANOVA, N.A., KHAYRETDINOV, I.A. and NESTERENKO, N.I., 1976, P-T conditions of formation of the copper-sulfide deposit (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 93 (in Russian, translation by A. Kozlowski).

A deposit from S. Urals occurs at the depth 1000-1500 m, P-T conditions are as follows:

Mineral Association			Number of Samples	T_H, °C	T_D, °C	P, atm
	Early pyritic	Quartz in intensively sericitized rock with pyrite	3	350-50	370-340	675-660
Commercial Ores	Chalcopyrite -pyrite	Quartz in chlorite rocks with spotty chalcopyrite-pyrite ore and chalcopyrite veinlets	3	390-65		
	Chalcopyrite -sphalerite -pyrite	Sphalerite from chalcopyrite-sphalerite-pyrite ore	1		290	
	Bornite -barite	Barite from bornite-pyrite ore	1	340-155		
Post-ore	Quartz -carbonate with tennantite	Quartz with tennantite from veinlet	1	285-115		
	Quartz -barite -carbonate	Quartz with barite from veinlets	2	300-120	365-250	685

(Authors' abst.)

ANDRUSENKO, N.I., 1977, Thermobaric parameters of ore-forming solutions at gold ore deposits formed in various depths (abst.) <u>in</u> Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibrisk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. II, p. 7-8 (in Russian; translation by A. Kozlowski). Author at the Central Sci.-Research Geol.-Prospecting Inst. by Geol. Ministry, Moscow.

Au deposits of moderate depth formed under high P reading 2000 atm, evaluated on the basis of T_D and T_H; shallow deposits formed under P reading 1000 atm, with origin of commercial ore under 1200 and 900 atm, respectively, and with sharp decreases of P down to a few tens of atm, especially under subsurface conditions. The obtained P values are independent of lithostatic P, being 2-3 times higher than the latter (sic.) Decreases of P more intensively stimulate ore precipitation from CO_2-rich solutions than from water solutions, since separating CO_2 influences pH of solution. Extensive development of brecciated subsurficial ores seemingly is connected with vivid escape of CO_2 during sharp P drop. Generalized values of baric parameters of gold-bearing solutions at deposits of various depths are given in the table. (From the author's abstract).

Type of deposit				Parameters of solutions	
				T, °C	P, atm
Moderate depth	The Urals:	object	1	410-120	1800-585
	E. Transbaikalia:	object	1	390- 95	1200- 5
		"	2	245-210	755-440
		"	3	410-260	1130-750
		"	4	935*-285	900-260
		"	5	420-180	2000-700
	Central Kazakhstan;	"	1	420- 95	980-260
		"	2	450-120	1100-220
	Yano-Kolyma:	"	1	280-250	1300-300
	W. Chukotka:	"	1	380-230	1210-350
	Buryatya:	"	1	500-100	1000-400
	Pamirs:	"	1	500-150	2000-500
	N. Caucasus:	"	1	375-240	1250- 75
Shallow	E. Transbaikalia:	object	1	230-200	30- 5
	NE USSR:	"	1	400-225	280- 24
		"	2	365-230	190- 25
		"	3	300-160	85- 5
		"	4	240-200	35- 14
		"	5	365-320	210-170
	Central Kamchatka:	"	1	365-290	640-450
		"	2	410-290	690- 85
		"	3	405-250	420-190
	N. Kamchatka:	"	1	360-195	190- 30
	Transcausasus:	"	1	415-235	1150-170
		"	2	305-290	850-540
	Aldan:	"	1	360-330	800-250
	Central Kazakhstan	"	1	310- 60	850- 30
	Yano-Kolyma:	"	1	250-160	900-650

*sic; possibly a typographical error (A.K.)

ANDRYANDVA, N.A., ISMAGILOV, M.I. and BOLOTIN, Yu.A., 1976, Thermobaric conditions of formation of the Podol'skoe copper sulfide deposit (S Urals) (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept. 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 84-85 (in Russian; translation by A. Kozlowski).

The deposit is connected with a hidden volcanic dome structure; ore bodies are not metamorphosed but the complex overlying the ore beds is weakly altered hydrothermally.

Mineral Association	Description	No. of Samples	T_H, °C	T_D, °C	P, atm.
Early sulfides	Quartz and pyrite from spotty and massive pyrite ores	4	220-120	190-130	
Commerical ores	Quartz and chalcopyrite from veinlets and massive chalcopyrite ore	5	330- 70	365-265	680-665
	Quartz from pyrite-chalcopyrite-sphalerite ore	1	335- 95	390	715
	Carbonates and sphalerite from veinlets and sphalerite ore	3	300-185	320-280	
	Fluorite with quartz and chalcopyrite in the spotty pyrite ore	2	340- 80		
	Quartz and carbonates with chalcopyrite and tennantite in the spotty pyrite ore	3	240-215	300-150	630
Post-ore	Barite with fluorite	2	205-150	240-160	
	Post-ore quartz	3	340-115	440	650

ANDRYANOVA, N.A. and KHAYRETDINOV, I.A., 1976, Hydrothermal aureole of decrepitation at Uzel'ginskoe copper-sulfide deposit (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 137-138 (in Russian; translation by A. Kozlowski).

At a deposit of sulfides in volcanites and overyling carbonate rocks, typical for S. Urals, it was found that intensity of hydrothermal impregnation depends on thickness of ore body, distance from the channels leading hydrotherms, duration of activity, and composition of wall-rocks. T_D of rocks altered by hydrothermal impregnation varies from 400-430°C to 350-360°C. T_D of limestones distant from ore body ranges from 320-390°C. Post-ore calcite has T_D 260-320°C. (From the authors' abst.)

ANONYMOUS, 1977, Fifth All-Union Conference on Thermobarogeochemistry: Geokhimiyia, 1977, no. 8, p. 1276-1280 (in Russian).

A summary of the conference (ER)

APLONOV, V.S. and MOSKALYUK, A.A., 1976, Chemical composition of solutions forming the Noril'sk ores (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 90-91 (in Russian; translation by A. Kozlowski).

Minerals of the Noril'sk differentiated intrusions bear G/L inclusions; the inclusions are almost absent in the non-differentiated intrusions. G occupies 5-10 vol.% of vacuole, sometimes halite is present. By water leachates total salts range from 3.66 to 33.99 mg per 100 g of sample. pH of samples decreases from picritic gabbro (8.10) to taxitic gabbro (7.45). Cl and HCO_3 ions are the main anions, sulfates are of very low concentration. Picritic gabbro-dolerites are divided into two varieties: a) chloride, and b) chloride-bicarbonate, on the basis of leachate composition. Leachates from taxitic gabbro-dolerites also had a $Cl-HCO_3$ composition; solutions of the picritic basalts from Noril'sk region and NW Taimyr have very similar composition.

Leachates from taxitic gabbro-dolerites are rich in K and Na, poor in Ca and they do not contain Mg; picritic gabbro-dolerites bear inclusions enriched in Ca. Na/K ratio in taxitic gabbro-dolerites has the highest values. The higher the Cl content in hydrotherms, the greater ore capacity of intrusion. (Authors' abst.)

APLONOV, V.S., SUKHANOVA, Ye.N., and DYEL'NIK, G.P., 1976, Decrepitation prospecting for massive copper-nickel ores (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 143-144 (in Russian; translation by A. Kozlowski).

At the Talnakh deposit the method of decrepitation studies of boreholes was applied, with heating up to 800°C. Massive ores are surrounded by impregnation aureoles. Rocks underlying ores have low decrepitation activity, without peaks, as well as the bottom 25-40 m part of the rocks. Still higher part of overlying aureole has decrepitation activity several hundred to several thousand times higher than background. It is typical for massive ores. (From the authors' abst.)

ARKHIPCHUK, R.Z., 1977, Temperature gradients in fluorite deposits of Western Transbaikal: Geologiya i Geofizika, v. 18, no. 1, p. 155-159 (in Russian; translated in Soviet Geol. & Geophysics, v. 18, no. 1, p. 133-136).

The maximal temperature gradients for fluorite formation are fixed in distinct large-crystalline aggregates of fluorite, as well as along the trend of the ore bodies; minimal gradients occur along the dip. Temperature gradients are conditioned by the cooling effect of the ore-enclosing rock on mineralization and by the directed movement of ore-forming solutions. Comparable gradients within the deposits under study suggest that the formation of fluorite occurred under complex geological conditions (author's abstract).

ARNASON, B., 1977a, The hydrogen-water isotope thermometer applied to geothermal areas in Iceland: Geothermics, v. 5, p. 75-80. Author at Univ. Iceland, Sci. Inst., Reykjavik, Iceland.

The surface deuterium concentrations of the deep thermal water and of the molecular hydrogen in geothermal gases has been measured in several geothermal areas in Iceland. The object of these studies was to find whether such measurements could be used as an indicator of the water temperature in the deep circulating base.

The method is based on the assumption that the hydrogen isotope equilibrium between water and dissolved hydrogen gas, established in the circulating base, remains unchanged as the gas-water mixture flows to the surface and cools. In this case the equilibrium constant and the corresponding base temperature can be calculated. The isotope temperatures obtained are then compared with the temperature calculated from the silica content of the water, and temperatures directly measured in drill holes.

Where gas samples were collected from natural emanations at the surface the isotope temperatures were usually found to be significantly lower than the highest temperature measured in a drill hole in the same geothermal area. When the gas samples were collected from blowing drillholes the isotope temperatures were either similar to the bottom temperature of the hole or they were higher.

Of a special interest are results obtained for the Reykjanes thermal area where the isotope data indicate a base temperature of at least 380° or approx. 90°C higher than the highest temperature measured in a drillhole. (Author's abstract)

ARNASON, B., 1977b, Hydrothermal systems in Iceland traced by deuterium: Geothermics, v. 5, p. 125-151. Author at Univ. Iceland, Sci. Inst., Reykjavik, Iceland.

This paper summarizes the results obtained for hydrothermal systems in Iceland by using deuterium and oxygen-18 as natural tracers.

It is shown that the deuterium content of a single sample of a local cold spring or river, except those rivers fed by considerable amounts of glacier melt water, can be used to estimate the mean deuterium concentration of precipitation in the corresponding locality. (From the author's abstract)

ARUTYUNYAN, L.A., 1977, On one feature of the behavior of sulfide droplets in sulfide-silicate melts: Akad. Nauk SSSR Doklady, v. 236 no. 4, p. 957-960 (in Russian). Author at Geol. Inst. of Kola Div. of

Akad. Sci. USSR, Apatity.

Pertinent to melt immiscibility in inclusions. (A.K.)

ARZAMASTSEV, Yu.A., KUZNETSOV, A.F., SIMONOV, A.V. and CHERNYI, L.N., 1976, Influence of inclusions on physico-chemical properties of quartz (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 159 (in Russian; translation by A. Kozlowski).

Crystals grown at various rates were studied. The rate influences physico-chemical properties of crystals. Studies of those crystals by shadow projections revealed only small differences, although various properties: hardness, susceptibility to hydrothermal etching, and etching figures, are different. Probably the amount of trapped inclusion is correlated with physico-chemical peculiarities rather than with defects revealed by shadow projection. The role of inclusions in different sectors of growth was presented. (Authors' abst.)

AUTHIER, A., 1977, X-ray and neutron topography of solution-grown crystals: Chapter 11.3, pp. 515-548, in 1976 Crystal growth and materials, E. Kaldis and H.J. Scheel, eds: North-Holland Publishing Company. Author at Lab. de Min. Crist., associé au CNRS, Univ. P. et M. Curie, place Jussieu, 75230 Paris Cedex 05, France.

These two techniques are shown to be powerful tools for examining the imperfections in crystals, including even single dislocations; with 106 references (ER)

AVAKIAN, A.A., KARAMIAN, K.A. and MADANIAN, O.G., 1976, Temperature of formation of the Ankasar copper-molybdenum deposit (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 83 (in Russian; translation by A. Kozlowski).

The following types of quartz veins and their T of formation were distinguished: barren (-), with molybdenite (335-315°C), with chalcopyrite (315-270°C), with pyrite (270-205°C), with galena and sphalerite (-), and with carbonate (-). (Authors' abst.)

BAAR, C.A., 1977, Applied salt-rock mechanics 1, The in-situ behavior of salt rocks: Amsterdam, Elsevier Scientific Publ. Co.

Pertinent to any investigation of inclusions in halite (ER)

BAILLIEUL, T.A., 1976, The Cascade Slide: A mineralogical investigation of a calc-silicate body on Cascade Mountain, Town of Keene, Essex County, New York: Contrib. no. 27, Geol. Dept., Univ. Mass., Amherst, Massachusetts, 128 pp.

Calcite shows orange fluorescence from tube-like inclusions ∿5x50μm that apparently contain a fluorine-bearing gas (from microprobe data, p. 34-37) (ER)

BAKHANOVA, Ye.V., LEVIN, G.B., MAYDENOV, B.M., and POLYVYANNYI, E.Ya., 1976, Mineral formation in gold deposits on the basis of isotopes of argon from gas-liquid inclusions (abst.), Abstracts of Fifth All-Union

Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 191 (in Russian; translation by A. Kozlowski).

Quartz from veins of a deep Kazakhstan deposit (down to 500 m) was studied.

1. Ratios of heavy argon and light (air) argon distinctly differ in various intervals of T_D. (The argon evolved) at 200-400°C from quartz of one stage contains 0-30% of light Ar; at 50-170°C, light Ar prevails. Its percentage decreases when T_D increases, to 10-20% and less. Composition of Ar varies irregularly with depth.

2. Secondary quartz from the supergene zone bears only light Ar in G/L inclusions

3. The richest commercial Au ores bear the highest amount of light Ar in G/L inclusions in quartz. (Authors' abst.)

BAKHANOVA, Ye.V., NARSEEV, V.A., PUCHKOV, Ye.V, PUSHKO, Ye.P., and SADOVSKIY, Yu.A., 1976, Thermobarogeochemistry (used) during prospecting of (deposits) of rare and precious metals in Kazakhstan, (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 140-141 (in Russian; translation by A. Kozlowski).

Over twenty gold-ore, ten porphyry copper, ten rare-element pegmatite deposits, etc., were studied by fluid inclusion methods.

1) T curves of individual stages at the gold ore deposits of various depth show increase of inversion of T_H (sic.) from the deepest to subsurface ones. ΔT permits determination of the vertical extent of ore mineralization: for subsurface deposits the gradient is 20-40°C per 100 m, for moderate-deep ones - 10-20°C per 100 m. For deposits of great vertical extent, a wave-like variation of gradient was found, in agreement with the distribution of rich and average ores. T_D data were used for prognosis of ore mineralization at deep levels; especially important are: intensity of the main peak and T interval of decrepitation. Rich parts of ore bodies are characterized by the small T_D interval, 150-200°C. The applied method permits predicting existence of rich ores occurring 50-80 m from the point of sampling.

2) Optimum T interval of origin of porphyry-copper deposits is 430-400°C. For deposits of various subtypes depending on depth of origin, T of ore stage ranges as follows: chalcopyrite-molybdenite 430-360°C, chalcopyrite-enargite-polymetallic 340-220°C, bornite-chalcocite-chalcopyrite 210-160°C; in commercial deposits all three stages always occur.

3) Due to correlation between weight loss on calcination and T_H or T_D (correlation coefficient 0.65), specific gas capacity of samples (amount of impulses in defined T interval) is also a prospecting index -- for commercial deposits 0.5-0.7. Big porphyry-copper deposits have the reverse T zoning, in agreement with metasomatic zones. Also examples of use of fluid inclusion data for the detailed prospecting of Au, Ta and Cu deposits were discussed. (Authors' abst.)

BAKUMENKO, I.T., 1976, Studies of inclusions in minerals from deep xenoliths (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 97-98 (in Russian; translation by A. Kozlowski).

1. P and S melt inclusions were studied in minerals from xenolith nodules of ultrabasic, anorthositic and gabbroic composition in rocks of the alkali-basalt and basalt-andesite series.

2. Minerals of the cumulative nodules trapped numerous P melt inclusions similar to P melt inclusions in phenocrysts. Xenoliths of eucrite-like rocks were studied: anorthite-bearing forellenstein (i.e., troctolite) from Il'inskiy volcano (T_H 1375-1145°C) rougemontite (T_H 1320-1240°C) from Zheltovskiy volcano, both from Kamchatka. T_H of inclusion, occuring in the clinopyroxene found between cumulative nodules is 1185-1120°C. Crystallization of anorthite was accompanied by the occasional boiling of melt and trapping of P G inclusions of unusual N_2-H_2O composition, isolated at P 1.7-1.6 kb.

3. Spinel-bearing lherzolite and other hyperbasic nodules of the Avachinskiy volcano were relatively shallow xenoliths from the basement of the volcano. P inclusions are absent, whereas S melt inclusions (T_H in orthopyroxene 1210°C and higher) are typical, as well as abundant low-density water inclusions with T_H 375-335°C. Dehydration of the former serpentinite xenoliths in relatively "dry" andesite melt was the source of water, and for this reason andesite chips joined to xenoliths do not bear water inclusions.

4. In the mantle lherzolite xenoliths containing chrome diopside, water inclusions are absent; this (absence?) is typical for alkaline basaltoids from Mongolia, Australia, Minusinskaya depression etc. The xenoliths do not contain early inclusions, only rare late S melt inclusions of the basalt melt were found. Inclusions of dense CO_2 boiling from melt testify to very deep origin of the xenoliths. (Author's abst.)

BAKUMENKO, I.T., BAZAROV, L. Sh., MOTORINA, I.V., CHUPIN, V.P., GORDEEVA, V.I. and MIKHAYLOV, M. Yu., 1976, Inclusions in minerals of granitoids; in Genetic studies in mineralogy, Yu. A. Dolgov et al., eds.: Novosibirsk, Inst. Geol. and Geophy. Sib. Branch Acad. Sci. USSR, p. 68-74 (in Russian).

Studies of crystallized melt inclusions of very small size (1-10μm) revealed that T_H, and hence presumably T of crystallization of magmatic granites, are as presented in Table 15.

Anatectite from Suon-Tiit bears inclusions proving low H_2O content in melt (1.3-2.1 wt. %) but substituted in part by CO_2, "acid gases" -- total up to 0.4-0.6 wt. %, i.e., H_2O: other G ≈ 4:1. (Abst. by A.K.)

Table 15. T_H of melt inclusions in minerals of granites

Rock	Mineral	T_H,°C	Deposit
	ALLOCHTONOUS GRANITOIDS		
Granite	quartz, plagioclase	1080-940	Sakhalin, Aal'zinskiy massif
Do.	quartz	990-890	W. Transbaikalia, Bitu-Dzhida complex
Morion granite	quartz	990-750	W. Transbaikalia, Khamnigaday massif
Granite	quartz	859-700	Altay, Tigerek massif
Alaskite granite	quartz	700-660	Kalba, Dungalin polyphase massif II phase, Central Karakhstan

(Continued on next page)

Granite:			
a. Granulite facies	quartz	900-840	Aldan, between Nimgerkona and Champuly Rivers
b. Amphibolite facies	quartz	870-800	Aldan, vicinity of Suon-Tiit Village
Leukosomes of migmatites:			
a. Granulite facies	quartz	900-850	Lower part of Champuly River, tributary of Aldan River
b. Amphibolite facies	quartz	830-800	Aldan, vicinity of Suon-Tiit
Anatectite of amphibolite facies	quartz	780-760	Olekma River

BAKUMENKO, I.T. and KOSUKHIN, O.N., 1977, Water in inclusions of silicate melts of acid composition: Akad. Nauk. SSSR, Doklady, v. 234 no. 1, p. 164-167 (in Russian). Authors at Inst. Geol. Geophys. Siberian Branch of the Acad. Sci. USSR, Novosibirsk.

During P decrease magma, even that low in water, may boil to separate a H_2O-poor (sic.) fluid. Thus, in glass inclusions water may appear as L phase when H_2O-rich glass was trapped. Search for H_2O-bearing melt inclusions was made in pumice from Zhupanovo village and in quartz from pumice from volcano Khangar, both in Kamchatka. Crystallization of quartz from Khangar began at 1260°C from dry melt, giving crystallized inclusions. At T <1050°C the melt became richer in water, forming mainly glass inclusions. Before explosion (∿740°C) melt bears significant amount of water. Recently, in low-T, partly crystallized glass inclusions (T_H 800-780°C), water was found, forming rims around CO_2-rich gas bubbles. T_H of G + LH_2O is 400-270°C, hence water density in homogenized phase is up to 0.7 g/cm^3. General concentration of water in late pumice melt is over 3 wt.%. Similar inclusions in quartz from Zhupanovo (T_H 790-720°C) bear G + LCO_2 in bubbles, homogenizing at 410-280 in L; one of inclusions contained 3 G + L vesicles, homogenizing at various T: 410, 280, and 265°C. Thus, these inclusions were not in equilibrium with melt during quenching. Water phase appears usually only in partly crystallized melt inclusions. T_{Frz} is ∿-15°C.

Dikes of quartz porphyry from Altyn-Topkan (N. Tadzhikistan) bear melt inclusions (T_H 660-650°C) with LH_2O + G phase homogenizing in L at T ≥ 200°C; density of water ∿0.85 g/cm^3; quartz porphyry from Dzheltau (Golodnaya steppe, Kazakhstan) in melt inclusions (T_H 640-620°C) bear bubbles filled by LH_2O + G fluid with T_H ∿200°C.

Large quartz porphyry-granite porphyry massif Tashkesen (Tadzhikistan, foothills of Karamazar) formed (T_H of melt inclusions) at 1300-1250° (quartz porphyry) to 1180-900°C (granite porphyry); T_H were so high due to low water concentration. The problem of water-saturated melts is also important as an ore-forming factor.

Only small (<10 µm) inclusions of water-rich melts do not leak during homogenization, hence data on homogenization of large melt inclusions at low T (∿700°C), recently appearing in papers, should be re-evaluated as possibly derived from inclusions of salt melts-solutions, rather than water-rich melts. (Abst. by A.K.)

BAKUMENKO, I.T., POPOVA, N.M., KRASOV, N.F. and SHUGUROVA, N.A., 1976, Study of processes of volcanism by fluid inclusions; in Genetic studies in mineralogy, Yu. A. Dolgov et al., eds.: Novosibirsk, Inst. Geol. and Geophy. Sib. Branch Acad. Sci. USSR, p. 75-85 (in Russian).

Numerous measurements of T_H of melt inclusions in phenocrysts of clinopyroxene and plagioclase from basaltoids and plagioclase, sanidine and quartz from acid volcanites proved that these minerals begin crystallization at T >1200-1300°C. Such high Ts prove that at initial stages melts were poor in volatiles, especially in H_2O. During crystallization the melt enriches in water, and T of crystallization of plagioclase and especially quartz may decrease down to 960°C in basaltoids and 740°C in acid melts. In water-rich melts sometimes there is a distinct decrease of T of beginning of crystallization of phenocrysts, as in ignimbrites of Katmai, Alaska (840-800°C) or pantellerites from Pantelleria, Italy (860-820°C). Increase of H_2O content causes crystallization of amphiboles or mica at T of 100-200°C lower than T of crystallization of clinopyroxene. The influence of H_2O content on T of crystallization is clearly visible in results of studies of T_H for andesite-dacite lava flows of Karym volcano: two flows of January 1963 that were rich in water, a "dryer" flow of May 1963, and again one rich in water flow of May 1970. Plagioclases of all four flows bear high T (1440-1420°C) and moderate T (1320-1310°C to 1175-1160°C) inclusions, but low T inclusions (1120-1040°C) appeared only in flows rich in water of January 1963 and May 1970.

Similar changes were noted for T_H of quartz porphyry of the Salair region, depending on the position of the rock in the intrusion. The Kamenushinskiy porphyry, from deeper and hence poorer in water, has T_H 1370-1250°C, whereas porphyry in apical part of the intrusion, rich in water and volatiles, yielded T_H 1150-1125°C.

New aspects of studies of T_H in volcanites are as follows: 1) possibility of study of regime of crystallization, especially during migration of magmas to the Earth's surface, 2) determination of the minimum T of crystallization of phenocrysts under intratelluric conditions, 3) determination of the minimum T of mobility and plastic deformation of lava in flows.

Studies of inclusions permit distinguishing between "mantle" nodules and shallow xenoliths and nodules of segregation nature in basaltoids. Segregation nodules are characterized by numerous, poorly crystallized or glassy melt inclusions, similar to inclusions in phenocrysts, e.g., segregates of an early portion of basaltoid magma are xenoliths of anorthite-bearing forellenstein (T_H of inclusions in anorthite, P 1375-1225°C, S 1360-1145°C) and rougemontite (anorthite, P 1320-1240°C, S 1320-1300°C, clinopyroxene 1185-1120°C). Anorthite bears also PG inclusions filled by mixture of H_2O and N_2, unlike G CO_2 inclusions in other basalts. Lherzolite nodules from Avachinskiy volcano, in addition to S melt inclusions (T_H 1210°C and more), bear in olivine and orthopyroxene numerous water inclusions of low density, homogenizing in L phase at 335-375°C. The nodules formed due to thermal metamorphism of fragments of serpentinized intrusive hyperbasites by andesite melt. Water released from serpentine caused crystallization of hornblende rims around nodules. Minerals of the andesite do not bear water inclusions. Lherzolite nodules bearing chrome diopside from Victoria (Australia), Mongolia, Minusinskiy region and Transbaikalia do not contain early inclusions since they presumably formed under quiet mantle conditions. Such nodules bear only late melt and dense L CO_2 inclusions of the transporting magma. For basalt melts usually CO_2 is the main gas;

N_2 + rare gases occupy usually <20-25 vol. %, only rarely reaching 40-50 vol. %. Commonly small admixtures of sulfur-bearing gases were found, and occassionally CO and H_2. Gases in acid melts vary over a wide range, although CO_2 and N_2 remain the essential constituents; variations are usually smooth, without abrupt changes. (Abst. by A.K.)

BANSHCHIKOVA, I.V., 1976, Microinclusions in metamorphic veins from actinolitized diabases in northwestern USSR (abst), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 203-204 (in Russian; translation by A. Kozlowski).

1. Inclusions in epidote-albite-quartz veins with actinolite were studied; the veins are isofacial with the wall rocks (actinolitized diabase). Primary, metamorphogenic paragenesis of the veins is cut, parallel to schistosity, by retrograde epidote-chlorite veinlets.

2. Vein quartz bears two types of inclusions: a) Syngenetic with the first paragenesis, often polyphase, F 0.65-0.55, when polyphase - F ~0.5, T_H 400-435°C (polyphase 460-465°C), T of dissolution of the cubic isotropic dms up to 505°C. In G phase CH_4 is present (20-60 mol./1000g of solution), light hydrocarbons, O_2, N_2 (by differential G chromatography). b) Inclusions connected with early retrograde paragenesis; dms are common, as well as solid inclusions. T_H of G & L phases 310-360°C, isotropic dms dissolve at 25-40°C higher. G phase contains CH_4 (to 150 mol./1000g of solutions), N_2, and O_2.

3. Paragenesis of actinolite subfacies of the greenschist facies formed under action of H_2O-salt solutions of T_H from 400 to 505°C, increasing downwards in the section; salt concentration was 20-40 wt.%. Retrograde alteration occurred in zones of fracturing, initially under action of L pore solutions of high total salt content (60 wt. %), T_H 310-400°C; CH_4 often prevailed in G phase. (Author's abst.)

BANSHCHIKOVA, I.V., SHCHERBACHEV, D.K. and VASIL'YEV, Ye.V., 1977, Studies of chemical composition of transparent mineral microinclusions by use of optical methods, <u>in</u>: Methodic mineralogical investigations, editors: Ye.I. Semenov and T.N. Chvilyova, p. 16-19, "Nauka" Publishing House, Moscow (in Russian).

Transparent inclusions were analyzed by laser and laser-spark high-voltage excitation of sample with spectrographic recording. The analyzed area is 100-200μm in dia. By this method also glassy melt inclusions in quartz phenocrysts from extrusive andesite-dacites were analyzed, yielding composition: Al, Si (nx10%), Fe, Mg, Ti, Na, Zn (nx1%). The inclusions and spectra are presented in Plate XII, p. 154, explanation to which are printed under title Plate II in p. 139. (Note: erroneously all plates I-XIII are printed in reverse sequence, Plate XIII should be Plate I, XII should be II, XI should be III, etc.; abst. by A.K.)

BARANOVA, N.N., 1977, On composition of gold-bearing hydrothermal solutions (abst.) <u>in</u> Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. II, p. 9 (in Russian; translation by A. Kozlowski). Author at IGEM Acad. Sci. USSR, Moscow.

By water leachate method Na and HCO_3 were found as main ions in gold ore-forming solutions. K and Ca contents are comparable one with one another and Na/K and Na/Ca range from 1.3 to 17.1 and from 1.5 to

3.7, respectively; Mg, F, SO_4, NH_4 and S^{2-} were found. By voltamperometric oscillography in water leachates Au and Ag were determined in concentrations $(5.4 \text{ to } 38)\times10^{-7}$ mol/L and $(0.5 \text{ to } 2.0)\times10^{-5}$ mol/l, respectively. T_D and T_H ranged from 250 to 450°C. CO_2 prevailed over CH_4 and N_2; traces of CO and H_2 were ascertained. Calculations of pH yielded weakly alkaline to almost neutral values, and of Eh--weakly reducing conditions. Au probably occurs in hydrotherms in hydroxyl-chloride, hydrosulfide and hydroxyl complexes. (Author's abst.)

BARANOVA, N.N., CHULKINA, L.S., and SUSHCHEVSKAYA, T.M., 1976, Gold and silver in hydrothermal solutions (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 190-191 (in Russian; translation by A. Kozlowski).

1. Gold was determined by the method of inversion voltampermetry, which is extremely sensitive (10^{-9}% in the 1.5-2g samples of quartz that were used), in 0.5 (N?) HCl solution leachates from fluid inclusions in quartz.

2. Au was determined in both ionic and colloid form; from 20 to 80% of Au in hydrothermal and pore solutions, in sea water and in superficial waters occurs in colloid form.

3. In quartz of the gold ore deposits of various types in Priamur'ye and the northeast, the concentrations of Au in solutions of leachates range from 10^{-10} to 10^{-9} mol/l, hence Au content in hydrothermal solution was 10^{-7} to 10^{-6} mol/l. Leachates were analyzed also for Ag. (Authors' abst.)

BARBIER, E., ed., 1977, The application of nuclear techniques to geothermal studies: Geothermics, v. 5, p. 1-178.

The whole issue is devoted to the proceedings of a Symposium held in Pisa on September 8-12, 1975. Practically all the papers presented are of interest to fluid inclusion students, as they deal with geochemistry and isotope chemistry of geothermal fluids (Piero Lattanzi). Abstracts of most will be found in this volume (ER).

BARBIERI, M., MASI, U. and TOLOMEO, L., 1977, Geochemical evidence on the origin of the epithermal fluorite deposit at Monte delle Fate near Cerveteri (Latium, central Italy): Mineral. Deposita (Berl.), v. 12, p. 393-398 (in English). Authors at Instituto di Geochimica, Univ. di Roma, Roma, Italy.

Sr content was measured in 6 fluorite and 7 calcite samples from an epithermal deposit of fluorite at Monte delle Fate near Cerveteri (Latium, Italy). Sr isotope ratios were obtained from two selected samples. Sr contents of calcite range from 1,200 to 2,620 ppm and of fluorite from 10 to 360 ppm. $^{87}Sr/^{86}Sr$ values of calcite and fluorite are 0.7087 and 0.7091, respectively. Such isotope ratios clearly indicate that the bulk of strontium present in both minerals was provided by marine sedimentary reservoirs. According to the Sr distribution coefficient, the low contents measured in fluorite, which formed after calcite, clearly prove that the mineral was not deposited by the same kind of waters from which calcite originated. The high Sr contents of calcite suggest that the bicarbonate-bearing waters have largely interacted with Ca-sulphate evaporites of Upper Triassic age. On the contrary, the waters from which fluorite precipitated were apparently involved in a more superficial circulation through post-Triassic sedimentary formations. (Authors' abstract)

Note by Piero Lattanzi: There is an incomplete reference in text to another study, by others, claiming "low homogenization temperatures for gas-liquid inclusions."

BARBU, A. and PETREUS, I., 1974, Preferential directions of fracturing of quartz crystals in deformed rocks: Ann. Ştiint. Univ., Al. I. Cuza Iasi, Sect. II, b, Geol., v. 20, p. 61-68 (in French with Romanian summary).

Studies of fractures in quartz grains from granite, gneiss, and pegmatite show that their directions are crystallographically controlled. Those parallel r and z rhombohedrons are most common, but four other forms are recognized. Laboratory fracturing is not as rigorously controlled by crystallography. (Pertinent to recognition of secondary inclusions). From the authors' abstract, translated by H.A. Stalder.

BARKHUDARYAN, N.B., BOLOTOVA, N.Ya., ANDREEVA, M.G., ZHADNOVA, T.P., MIKHAYLOVA, L.V., BOCHEK, L.I., FILIPPOV, V.P., and DOROFEEV, A.D., 1977, Water and carbon dioxide in quartz (data from IR spectroscopy: Novosibirsk abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Countil on Ore Formation, Sib. Branch, v. II, p. 10-11 (in Russian; translation by A. Kozlowski). Authors at Central Sci.-Research Geol.-Prospecting Inst. of Ministry of Geology.

A search for regularities of water and carbon dioxide content in vein quartz (presumably in fluid inclusions?) versus genetic factors. (A.K.)

BARKHUDARYAN, N.B., and GREBENCHIKOV, A.M., 1976, IR spectra of CO_2, hydrocarbons and water in quartz (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 176-177 (in Russian; translation by A. Kozlowski).

Carbon dioxide, hydrocarbons and water in quartz are determined contemporaneously in arbitrary units, using doubly polished plates 0.1-0.5 mm thick. Measurements (at room temperature) were made of the intensities of absorption bands at 3400, 2350, 2960 and 2600 cm^{-1}, from water, CO_2 and hydrocarbons, and compared with the band at 2200 cm^{-1} of the quartz lattice. Examples are presented. (From the authors' abst.)

BARSUKOV, V.L., (ed.), 1977, Geochronology and problems of ore formation: Moscow, "Nauka" Publishing House, 216 pp. (in Russian).

Contains 24 papers in four sections: Geochronology of ore deposits, Ore formation in sedimentary-metamorphogenic cycle, Hydrothermal ore formation, and Ore formation connected with magmatic processes. (A.K.)

BARTANYAN, S.S. and ANDRUSENKO, N.I., 1977, Temperature conditions of formation of the commercial mineral associations of the gold-silver ores in the Southern Kamchatka (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Sib. Branch, v. II, p. 14-15 (in Russian; translation by A. Kozlowski). Authors at the Central Sci.-Research Geol.-Prosp. Inst. of Geol. Ministry.

The studied deposits occur in Neogene volcanites of basic to acid composition and consist of quartz, quartz-adularia and quartz-adularia-carbonate veins. Characteristics are given in the table.

Type	Commercial mineral associations	Studied mineral	T_H, °C
Tetrahedrite-hessite	Gold-tennantite-hessite	Quartz	410-200
Sulfosalts	Gold-As-polybasite	Carbonate, quartz	380-260; 360-210
Sulfide	Gold-polymetallic	Quartz, sphalerite, carbonate	310-250; 280-230; 250-180

(From the authors' abst.)

BARTON, P.B., JR., BETHKE, P.M. and ROEDDER, EDWIN, 1977, Environment of ore deposition in the Creede mining district, San Juan Mountains, Colorado: Part III. Progress toward interpretation of the chemistry of the ore-forming fluid for the OH vein: Econ. Geol., v. 72, p. 1-24.

Mineral assemblages involving pyrite, hematite, chlorite, quartz, K-feldspar, sericite, sphalerite, galena, and chalcopyrite are interpreted with the aid of data from fluid-inclusion studies to show that the environment most typical of ore deposition for the OH vein had the following characteristics: (1) temperature of 250°C, (2) pressure of about 50 bars (the fluids were boiling near the top of the ore zone), (3) pH of 5.4, (4) salinity of $(Na_{0.9}K_{0.1})$ Cl fluid of about 1 molal, and (5) total concentration of sulfur in solution of $10^{-1.7}$ molal. Consideration of the iron content of sphalerite shows that the activities of oxygen and sulfur varied considerably during ore deposition. Reactions between hematite, iron-rich chlorite, pyrite, quartz, and water controlled redox reactions and prevented the chemical environment from varying sufficiently to form bornite, anglesite, or magnetite. The bulk of the ore was deposited from solutions that were clearly sulfate rather than sulfide rich, yet at times the chemical conditions became so reducing that H_2S would have been the dominant sulfur species in aqueous solution had equilibrium prevailed. The chlorite-bearing buffer is incompatible with a chemistry in which equilibrium is maintained between oxidized and reduced sulfur species, unless large changes in the amount of total sulfur in solution are permitted. Since the mineralogical evidence does not support large changes in sulfur concentration, we conclude that there were recurrent departures from redox equilibrium among the aqueous sulfur species.

The ores were deposited from a freely convecting hydrothermal system that probably was initially charged by meteoric solutions, although the salts, metals, and sulfur may well have been derived from deeper sources. The circulating solutions deposited gangue and ore minerals near the top of the convecting cell in a hypogene enrichment process that extracted metals and sulfur from whatever sources were available at depth and swept them toward the surface. Boiling, with the loss of acid components (H_2S and CO_2) which recondensed in the cooler overlying rocks, led to the formation of an intensely altered, sericitic capping above the ore. Precipitation of ore is attributed to cooling and perhaps to a slight pH rise complementary to the loss of acid constituents through boiling.

Clusters of finely banded, iron-rich zones in otherwise iron-poor sphalerite are a consequence of the introduction of small quantities of more reduced (magmatic?) fluid that imposed a local, temporary, low-redox chemical signature upon the circulating system. Each successive pass of the same low-redox pulse produced an iron-rich band in the sphalerite. The mass ratio of fluid to sphalerite deposited requires only a few parts per million of zinc to be deposited in each cycle. Combined with a previous estimate of flow rate, this results in the geologically uncomfortable, but quantitatively tenable, estimate of length of time for mineralization of from a few hundred to a few thousand years.

A circulating-fluid model for ore deposition has important implications for mineral exploration. Minerals having retrograde solubilities (e.g., anhydrite or molybdenite) will be concentrated in the hottest part of the system. In contrast to the conventional "once-through-and-out" model, the circulating model predicts a wide, barren gap between the shallow and deep facies of mineralization. (Authors' abstract)

BASSETT, A.M., 1977, Progress in fluid inclusion studies - a report on the International Geological Congress, 1976 (abst.): Inst. Mining and Met., Trans., Sect. B, v. 86, p. B155.

BATARD, Francine, MERGOIL-DANIEL, Juliette, and MERGOIL, Jean, 1977, Calcite and role of CO_2 in the genesis of the peralkaline and agpaitic rocks of eastern Velay (Massif central, France): Bull. Soc. fr. Mineral. Cristallogr. v. 100, p. 343-347 (in French with English abstract). Authors at Dept. Geol. Min. Univ. de Clermont-Ferrand II.

The Velay alkali-sodic series shows phonolites with transitional characters: the early miaskitic crystallization is followed by an agpaitic stage. This fact is connected by the occurrence of calcite in these rocks and associated trachytes. Calcite in peculiar position (inside plagioclasic core of feldspathic phenocrysts) suggests that plagioclase is corroded by CO_2 and selectively releases Ca and Na. Therefore, agpaitic character of some phonolites would come from autofenitisation effect and calcite would be considered as a "diffuse carbonatite"; in this case, carbonatite and alkaline rocks seem to be two effects of a same process. The role of CO_2 is confirmed by the abundance of CO_2 fluid inclusions, specially in feldspars. (Authors' abstract)

BATCHELDER, John, 1977, Light stable isotope and fluid inclusion study of the porphyry copper deposit at Copper Canyon, Nevada: Economic Geology, v. 72, p. 60-70.

A copper, gold, and silver deposit of the porphyry type occurs adjacent to an altered granodiorite at Copper Canyon, in Lander County, Nevada. The ore is predominatly hypogene disseminated chalcopyrite-pyrite-pyrrhotite in the wall rock of the granodiorite; ore also occurs in veins. The total volume of the adjacent 1,500-meter-wide grandiorite is small, and its shape is approximately laccolithic. Three primary biotite separates from the grandiorite yielded an approximate age of 38 million years (Theodore et al., 1973). The fluids that deposited the ore were chiefly brines with salinities of about 40 weight percent NaCl equivalent. A light stable isotope study of quartz and biotite (both primary and secondary) was undertaken together with standard heating- and freezing-stage studies of fluid inclusions. Fluid inclusion water in quartz yielded δD values that range from -102 to -76 per mil. The calculated δD values of water in equilibrium with biotite at temperatures indicated by the fractionation of ^{18}O between quartz and biotite ranged from -99 to -76 per mil. The calculated $\delta^{18}O$ values of water in equilibrium with quartz ranged from +2.7 to +9.2 per mil. Calculated $\delta^{18}O$ values of water in equilibrium with biotite range from +5.8 to +10.4 per mil. These data suggest that the ore-forming fluids were most likely composed of magmatic water that had mixed with some meteoric water during metallization. (Author's abstract)

BAYBULATOV, E.V., GROSHEV, A.K., SOLOMOVICH, L.I. and TUREYAEV, R.T., 1976, Vertical temperature and mineralogical zoning as a criterion for the search for hidden rare-metal ore mineralization, in Thermobarogeochemistry of mineral formation, N.P. Ermakov, ed.: Rostov, Rostov Univ. Press, p. 129-135 (in Russian).

Full paper corresponding to abstract in Fluid Inclusion Research volume 7, p. 14-15, 1974.

Title changed here from that used earlier.

BAZAROV, L. Sh., 1976a, Mineral-forming media in the rare-metal pegmatites (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 76 (in Russian; translation by A. Kozlowski).

1. In the aplite and graphic zones of pegmatites T_H of melt inclusions ranges from 1040-860°C, and pressure from 4000 to 1500 atm.

2. In the coarse pegmatoid, block, quartzo-feldspathic and core quartz zones inclusions of solution-melt homogenize at 780-520°C.

3. In spodumene T_H of inclusions of solution-melt is 580-220°C, P 3000-280 atm, density 1.8 g/cm^3.

4. Ts of crystallization of blue beryl are from 660 and 400 to 260°C, T_H for pink beryl--from 480 to 200°C.

5. Pressure in inclusions at 700°C (beginning of crystallization), by CO_2 density and P of salt solution, without influence of solid phases, equals about 3500 ± 500 atm. Density of the homogeneous melt-solution with T_H = 670°C, when salt concentration in solution is 20%, equals roughly 1.75-1.85 g/cm^3.

6. In the liquid phase of inclusions of melt-solution, by water leachate method, there were found: Li up to 1.60, Na--8.34, K - 3.87, Nb--0.75, Ta--0.052, F--3.45, HCO_3--17.23, SO_4--6.33, CO_2--31.12 (wt%) (sic.) (...) (From the authors' abst.)

BAZAROV, L.Sh., 1976b, Physico-chemical conditions of crystallization of the rare-metal granitic pegmatites: in Genetic studies in mineralogy, Yu.A. Dolgov, et al., eds.: Novosibirsk, Inst. Geol. and Geophy. Sib. Branch Acad. Sci. USSR, p. 94-101 (in Russian).

Outer zones of pegmatites: aplite-like zone and granophyric intergrowths yielded T_H of melt inclusions 1040-860°C, P 4000-1480 atm. Polyphase inclusions of melt before heating are partly faceted. Ratio G:glass (after heating and quenching) varies from 5:95 to 8:92; $H_2O:CO_2$= 98:2. High T_H proves small concentration of volatiles at the initial stage of origin of pegmatites, since T_H of most high T inclusions is very close to T of melting of dry systems. Black quartz-feldspar and inner quartz zones crystallized from solutions-melts at 780-520°C (and presumably lower). At that T interval G inclusions are absent, hence there existed no boiling at that time. Crystallization of spodumene occurred from solution-melt at 580-220°C, 3000-280 atm. Density of solutions-melts reached 1.8 g/cm^3 (including, in g/cm^3, up to 0.3 of H_2O and CO_2, 0.3 of salts, and 1.2-1.3 of solid rock-forming minerals). Blue beryl crystallized at 660-520°C down to 260°C; the interval for pink beryl is 480-200°C; for emerald from the Urals - 680-470°C, but most high-T inclusions decrepitated before homogenization, and thus T_H may be evaluated from kinetics of dissolving dms as 750°± 5-10°C, P 3500 atm (±500 atm), calculated from density of CO_2 and P of salt solution. Probable depth of formation of pegmatites was 12-14 km. Density of melt-solution (T_H 670°C), with 20% salt, was 1.75-1.85 g/cm^3. Measurements of T_H are extremely difficult for inclusions where solids dissolve after G bubble disappeared due to decrepitation of inclusions before homogenization. Only when rate of heating was as low as 10°C/hour, it was possible to homogenize 2 inclusions of each 100 heated.

Solutions bear salts of Na, K, Li, F, Cl and HCO_3; CO_2 concentration varies from 18.37 to 42.47 wt.%. Nb was found in all leachates, in concentrations of 0.0066 to 0.02 wt.%, Ta - from nil to 0.0006 wt.%. CO_2 is main gas, besides H_2, "acid gases" and N_2+rare gases were found; O_2, CO and hydrocarbons were absent (by analysis of individual inclusions). (Abst. by A.K.)

BAZAROV, L.Sh., 1976c, Solutions-melts in rare-metal pegmatitic process: in Genetic studies in mineralogy, Yu.A. Dolgov et al., eds.: Novosibirsk, Inst. Geol. and Geophy. Sib. Branch Acad. Sci. USSR, p. 115-120 (in Russian).

Paper bears essentially the same experimental data and no differences in discussion as in article translated in Fluid Inclusion Research-Proceedings of COFFI, v. 8, 1975, p. 204-207. (A.K.)

BAZAROV, L.Sh., 1976d, Solubility of minerals in the system SiO_2-$NaAlSi_3O_8$-$KAlSi_3O_8$-$LiAlSi_2O_6$-H_2O at 600°C and 2000 atm depending on CO_2 content: in Genetic studies in mineralogy, Yu.A. Dolgov et al., eds.: Novosibirsk, Inst. Geol. and Geophy. Sib. Branch Acad. Sci. USSR, p. 120-124 (in Russian).

Studies of T_H of inclusions bearing silicate dms and CO_2 revealed that increase of CO_2 content causes decrease of solubility of silicates, i.e., higher T_H. Detailed studies of CO_2 content in pegmatite-forming solutions showed that at the very early stage of forming of rare-metal pegmatites (950°C) concentration of CO_2 is surprisingly low (5 wt.%) compared to H_2O content (95 wt.%). Experiments on solubility were carried out using routine autoclaves, 3-8 mm chips of quartz, feldspars and spodumene, water and solid CO_2. After the run autoclaves were quenched in water. Results confirmed studies of fluid inclusions and proved that admixture of 20 wt.% of CO_2 to water solvent decreases the solubility of quartz, microcline and spodumene by 50%, when compared with pure water. Further increase of CO_2 content causes very small decrease of solubility of silicates. When CO_2 concentration was very high ($\leq$50 wt.%), spodumene solubility was lowest. (Abst. by A.K.)

BAZAROV, L.Sh., and ORLOVA, L.M., 1976, Character of changes of chemical composition of solutions-melts in process of crystallization of minerals of rare-metal pegmatites: in Genetic studies in mineralogy, Yu.A. Dolgov et al., eds.: Novosibirsk, Inst. Geol. and Geophy. Sib. Branch Acad. Sci. USSR, p. 106-115 (in Russian).

Analytical data obtained by water leachates made from inclusions that decrepitated at T intervals 50-100, 100-200, 200-250, 250-300°C, etc., may be summarized as follows.

Spodumene. Solutions were of type Na>Ca>Li (K and Mg subordinate), $HCO_3>Cl>SO_4>F$. Li concentration ranges from 1.92 to 0.15 wt.%, decreasing on T drop. Na is commonly present, minimum of its concentration appears at 200°C, maximum (22.7%) at 100°C. K ranges from 0.63 to 0.001 wt.%. Ca concentration either increases on T drop or varies randomly. Mg was found occassionally in amount 0.76-0.03 wt.%. CO_2, HCO3 and Cl are present continuously, SO_4 content increases in lower T, and F was found only in one sample.

The above results are confirmed and completed by analyses of water leachates from pink and blue beryl, and black quartz of pegmatite. In addition, Nb was found in leachates from beryl (0.028-0.003 wt.%) as well as Ta (0.014-0.0006 wt.%. Also SiO_2 occurs commonly in inclusions in beryl (0.47-5.6 wt.%). (Abst. by A.K.)

BAZAROVA, T. Yu. and KAZARYAN, G.A., 1977, Peculiarities of crystallization of leucite phonolite from Azat River-Vedi River area (Armemian SSR): Akad. Sci. SSSR, Doklady, v. 232 no. 6, p. 1418-1420 (in Russian). First author at Inst. Geol. Geophys. Siberian Division of the Acad. Sci. USSR, Novosibirsk.

This rock, consisting of leucite, sanidine, clinopyroxene, melanite, apatite, sphene and magnetite, has unusual ratio of alkalies (Na_2O 7.8%, K_2O 5.57%). Inclusions in apatite are 3-10 μm long; small ones are filled with glass, and the large ones are crystallized T_H 1200-1150°C. Each phenocryst of sphene bears euhedral melt inclusions (3-5 μm), consisting of glass, G and 1-2 leucocratic dms, T_H 1150-1120°C. Melanite bears two types of inclusions: P and S. P inclusions are oval or spherical (up to 30 μm dia.), filled by G + glass, T_H determinations are difficult due to the shape of the inclusions. S inclusions are flat, irregular. Big S inclusions are crystallized with several L and G-filled interstices between crystals in each inclusion; T_H 1070-930°C. Pyroxene is rich in P melt inclusions up to 50 μm long, usually crystallized; T_H = 1170-1130°C for inner zones of phenocrysts and 1070-1030°C for outer zones. Also sanidine bears numerous melt inclusions, glassy or crystallized to various degrees. When crystallized, they usually bear L (95 vol.%) and G (5 vol.%) in the interstices between crystals in the inclusions; usually several such interstices occur in one inclusion. T_H of the filling of the interstices is 750°C; when inclusion was heated up to T 850°C, on cooling heterogenization of interstice-filling may be observed. T_H of all inclusion filling is in interval 1050-930°C; after homogenization cooled inclusions quench. Big inclusions in leucite leak, and T_H were measured only for one-phase inclusions, which heterogenize at 500-600°C (droplet of L and G bubble appear), T_H 1060-930°C. Thus, leucite phonolite crystallized in T interval from 1200- ∿930°C. Temperatures are similar to those obtained for nepheline syenites. Studies of processes of homo- and heterogenization proved that possible diffusion of H^+ through the crystal lattice does not influence in significant degree T_H of water-bearing melt inclusions (Abst. by A.K.)

BAZAROVA, T. Yu. and KUZNETSOVA, I.K., 1976, Alkaline basaltoids; in Genetic studies in mineralogy, Yu. A. Dolgov et al., eds.: Novosibirsk, Inst. Geol. and Geophy. Sib. Branch Acad. Sci. USSR, p. 29-31 (in Russian).

Temperature conditions of crystallization of trachybasalts and similar rocks of Atlantic Ocean (T_H of melt inclusions) are as follows: the lowest-temperature trachybasalts from Tenerife Island began to crystallize apatite at 1240-1220°C, then crystallized clinopyroxene (1200-1100°C) and plagioclase (1180-1100°C). Higher-T trachybasalts at 1270-1250°C crystallized pyroxene, and later, at 1240-1220°C-plagioclase. T_H for alkaline basaltoids of W. Kamchatka were >1200°C (olivine), 1280-1260°C (plagioclase), 1250°C (apatite), 1250-1220°C (K-spar), 1220-1200°C (pyroxene, biotite). Alkaline basalts from Minusinstiny region yielded T_H: clinopyroxene 1280-1150°C. Nepheline-bearing basalts are characterized by T_H: etindite from Mayo Island -- apatite 1180°C, pyroxene 1160-1140°C; basanite, same location Ti-augite 1180-1120°C; melilitic ankaratrite, same location -- olivine 1180-1150°C, boiling of melt and separation of CO_2 1170-1150°C, pyroxene 1170-1110°C, P_{CO_2} 4.5 kb, i.e., lithostatic P for $\sim$15 km.

E. African nephelinites began to form apatite at 1220-1150°C, then pyroxene 1150-900°C, nepheline 1050-770°C (from homogeneous silicate melt) or 1170-1080°C (from heterogeneous silicate + water-chloride melt); leucite-bearing basalts: B. Anyuy (USSR?) - pyroxene 1330-1220°C; pseudoleucitite from Central Aldan - olivine 1240-1180°C, phenocrysts of pyroxene 1210-1150°C, apatite 1180-1160°C, pyroxene of matrix 1170-1150°C; same from massif Tommot Yllynakh-pyroxene 1170-1140 and 1180-1160°C; wyomingite from Wyoming - phlogopite 1270°C-1040°C, pyroxene 1270-1220°C, leucite 1250-1150°C; leucite basalts from Kivu Lake (Africa) - olivine 1300-1180°C pyroxene-1280°C-1190°C, magnetite 1200-1180°C; leucite from Visoke volcano - pyroxene 1240-1220°C, leucite 1220-1200°C, another sample, leucite 1250-1230°C and 1110-1100°C, pyroxene 1200-1140°C; Dezhnevskiy massif, pseudoleucite shonkinite - K-spar in pseudoleucite aggregate 1050-1020°C.

Inclusions in megacrysts of Cenozoic basalts from Central Asia and Mongolia homogenized as follows: Ti-augite 1260-1220°C, high-Al clinopyroxene >>1300°C; L CO_2 in S inclusions yielded P 5 kb; P at origin of megacrysts should be much higher.

Intrusive alkaline basic rocks (teralites) and their hypabyssal analoques (bereshites) from Kuznetskiy Alatau crystallized at: plagioclase 1260-1240°C, pyroxene 1170-1140°C, nepheline 1140-1020°C. Nepheline syenites yielded T: pyroxene 1170-1140°C, nepheline 980-930°C. Nepheline crystallized from silicate and/or silicate-salt melt, relatively rich in water, as indicated by presence of LH_2O phase in melt inclusions. (abst. by A.K.)

BEALES, F.W. and HARDY, J.L., 1977, The problem of recognition of occult evaporites with special reference to southeast Missouri: Econ. Geol., v. 72, p. 487-490.

BEANE, R.E., 1977, Calculation of hydrothermal fluid composition using mineral stability relations and fluid inclusion studies (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 892. Author at Department of Geosciences, University of Arizona, Tucson, Arizona 85721.

The barite-fluorite-galena deposits of central New Mexico have provided an excellent opportunity to determine the composition of a mineralizing hydrothermal solution using fluid inclusion studies and solution mineral equilibria considerations. Crushing of hydrothermal fluorite in mildly acidified distilled water permits determination of molal ratios of various cations:sodium in fluid inclusions by analysis of the decantate. These ratios, coupled with freezing point depression measurements ($\sim$ 10°C), indicate absolute concentrations of Na, K, Pb, Ba, and Zn in the trapped hydrothermal fluid on the order of 1.5m, 0.5m, 250 ppm, 2000 ppm, and 675 ppm, respectively. Pressure-corrected homogenization temperatures are then combined with ion association data for chloride solutions at elevated temperatures to convert molalities of Pb and Ba to activities which in turn permit calculation of $S^{=}$ and $SO_4^{=}$ activities from galena and barite hydrolysis constants. The ratio of $S^{=}$ to $SO_4^{=}$ ($\sim 10^{-7}$:1) defines an oxygen fugacity of $10^{-38.5}$ which is more oxidizing than the hematite-magnetite buffer but less than that of the galena-anglesite pair, which is compatible with observed minerals. The Pb:Zn activity ratio, although significantly less than unity, is compatible with deposition of galena rather than sphalerite from the solution at the temperature and salinity defined by fluid inclusion studies. When combined with experimentally determined stability data for alteration phases identified adjacent to mineralized fractures, the concentration of K calculated from fluid inclusion analysis predicts that the solutions which formed these deposits had pH $\sim$ 4.2 at 200°C and 150 bars. (Author's abstract)

BELEVTSEV, Ya.N., LAZ'KO, Ye.M. and ZARITSKIY, A.I., 1977, Problems of geology of Precambrian and mineral deposits, at XXV Session of the International Geological Congress in Australia: Geologicheskiy Zhurnal, v. 37 no. 5, p. 28-44 (in Russian). First author at Inst. Geochem. and Physics of Minerals, Acad. Sci. Ukrainian SSR, Kiev.

Paper bears information on meeting of COFFI, p. 30.

BELEVTSEV, Ya.N. and TERESHCHENKO, S.I., 1977, Thermobaric conditions of formation of rocks of the iron ore formations of the Ukrainian shield (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. I, p. 75-76 (in Russian; translation by A. Kozlowski). Authors at Inst. Geochem. and Physics of Minerals of Acad. Sci. Ukrainian SSR.

Quartz, calcite, garnet, pyroxene and amphiboles from wall-rocks of iron ores bear G/L, G, LH_2O-LCO_2, LCO_2 and polyphase inclusions. Metamorphism of greenschist facies was at 346-438°C, epidote-amphibolite facies--408-525°C, homogenization in L phase; granulite facies--$T_H > 550$°C, in G phase. H_2O and CO_2 are the main components of the inclusion filling. Pyroxenes from rocks of granulite facies bear LCO_2 inclusions and inclusions of melts-brines, with T_H 680-720°C. P calculated from density of CO_2 range from 5-6 kbar for granulite facies to 2-4 kbar for greenschist and amphibolite facies. (Abst. by A.K.)

BELLIENI, Giuliano, 1977, Geobarometry of the Vedrette di Ries-Rieserferner granitic massif using the system Q-Or-Ab-An-H_2O: Rend.

Soc. Ital. di Mineral. e Petrolog., v. 33, no. 2, p. 631-645 (in Italian with English abstract). Author at Istituto di Mineralogia e Petrografia dell'Universita di Padova.

An attempt to evaluate the pressure during crystallization of the batholith. P_{H_2O} ranged from 5 to 2 kb, due to water loss. (ER)

BELTRAME, R.J., 1977, Gas release rates by step-heating a cordierite to 1200°C (abst.): Amer. Geophys. Union, Trans., EOS, v. 58, no. 6, p. 522-523.

Volatiles released by step-heating a cordierite from 100°-1200°C were measured using a quadrapole mass spectrometer. Of the 11 volatiles measured, H_2O and CO_2 accounted for 95% of the total amount released. (From the author's abstract)

BENCINI, A., DUCHI, V. and MARTINI, M., 1977, Geochemistry of thermal springs of Tuscany (Italy). Chem. Geol., v. 19, p. 229-252. Authors at Istit. Min., Pet. e Geoch., Univ. Florence, Florence, Italy.

Seventy-seven thermal springs, spread over an area of about 23,000 km^2, including the geothermal field of Larderello, were studied. Temperature and fundamental chemical composition, as well as distribution of several minor constituents (Li,Rb,Sr,F,Br,H_3BO_3 and SiO_2) were taken into account in order to distinguish some principal hydrochemical types.

Relationships between geological situation and water chemistry were investigated and a genetic model of the regional geology proposed. (Author's abstract)

BERGER, Emmanuel, 1977, Role of CO_2 in the genesis of alkaline basalts of the French Massif Central: C.R. Acad. Sc. Paris, Ser. D, v. 284, p. 1859-1861 (in French).

Free CO_2 resulting from decarbonation of the upper mantle during adiabatic uprising and, to a lesser degree, pre-existing H_2O traces (which probably resulted from the breakup of phlogopite) together allowed partial melting which in turn generated the French Massif Central alkali basalts. (Authors' abstract)

BERGER, V.I., GOLUBCHINA, M.N., LEVITSKII, Yu.F., MIRKINA, S.L., MOSKALYUK, A.A., and PRILUTSKII, R.E., 1977, Structure and genetic features of the Kelyan antimony-mercury deposits: Sovets. Geol., 1977, no. 4, p. 102-116 (in Russian).

BERGER, V.I. and LEVITSKII, Yu. F., 1976, Temperatures of formation of the antimony deposits of the eastern USSR (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 82-83 (in Russian; translation by A. Kozlowski).

1. At the Au-Sb deposits of the berezite type of the Yano-Kolyma chain, the discontinuous decrease of T_H (380-280; 240-190; 180-130°C) is associated with the consequent pattern of changes of parageneses: arsenopyrite-pyrite→polymetal sulfides→antimonite-berthierite ($FeSb_2S_4$) respectively. At 180-130°C, drusy quartz and coarse-prismatic antimonite crystallized.

2. Sb deposits of the argillic metasomatic formation have a

variable sequence of ore parageneses, but in all deposits, the association of antimonite with chalcedony-like and opal-like quartz is typical. Within the ranges 370-100°C, T changes are very complicated. At the final period sometimes T increases over a range of 50-100°C; signs of solution boiling were found. T_H of G/L inclusions in antimonite (i.e., stibnite) (sic.): 200-180, 150-140, 120-100°C; crystallization was under sub-surface conditions. (Author's abst.)

BERTMAN, E.B., KHORVAT, V.A., and CHEBOTAREV, G.M., 1975, Thermobaric characteristics of the process of formation of gold ore deposits of Charmitan: Mineralog. obsh. Uzbekis. otdel. Zapiski, v. 28, p. 81-84 (in Russian). See Fluid Inclusion Research -- Proceedings of COFFI, v. 9, p. 15 (1976).

BERZINA, A.P. and SOTNIKOV, V.I., 1977, Physicochemical conditions of endogene processes in copper-molybdenum deposits in Central Asia: Economic Geology, v. 72, p. 25-36.

The evolution of mineral-forming solutions in copper-molybdenum deposits of Kuznetsk Alatau, Eastern Transbaikalia, and Middle Asia is considered on the basis of the study of gas-liquid inclusions in minerals of different stages and mineral assemblages. The data permit estimation of the temperature, the state of aggregation, the composition, and the pressure of the solutions at various stages. K-feldspathization was caused by gaseous solutions at 730° to 400°C and pressures over 1,400 atm. Argillic and sericitic rocks formed from near-critical and liquid solutions at 430° to 320°C. Silicification took place in a wide temperature range between 800° and 200°C that varied in state of aggregation from gaseous to critical to liquid. The principal ore deposition occurred from liquid solutions enriched in carbon dioxide at 400° to 200°C. Essential differences can be shown in the chemical composition of the solutions forming various deposits. Solutions from deposits of Kuznetsk Alatau are essentially fluoride during the early stages and fluoride-carbonate rich at later stages. Those of Eastern Transbaikalia deposits are rich in chloride at early stages, chloride and carbonate at later stages. Those of Middle Asia deposits are rich in chloride. (Authors' abstract)

BESKROVNYY, N.S., KUDRYAVTSEVA, E.I. and LOBKOV, V.A., 1975, Carbon isotopic composition of the natural gases of Kamchatka: Geokhimiya, 1975, no. 11, p. 1660-1667, (in Russian; translated in Geochem. Internat., v. 12, no. 6, p. 29-36, 1975). Authors at All-Union Inst. of Pet. Geol., Leningrad.

Chem. comp. of natural gases and carbon iso. comp. of CH_4, C_2H_6, C_3H_8, and CO_2 were det. in samples collected from ten active hyd. systems, four oil and gas prospects, and nine cold min. springs on Kamchatka. Depending on geol. setting N_2, CO_2, or CH_4 predominates in the gases. The gases from the zone of active water exchange are readily dist. from others by their δC^{13}_{PDB} values. "Heavy" methane probably of magmatic or meta. origin, occurs in some hyd. gases. The carbon iso. comp. of most HCs in the hyd. gases is very diff. from that in the natural gases of petroliferous provinces, but in Kamchatka the iso. comp. of methane from the hyd. systems is very similar to the comp. of methane from the areas being explored for oil and gas. This similarity is explained by similar cond. of form. of the gases and, possibly, by their having the same source. The HC component of gases from the hyd. systems may be used as an indicator of the presence of oil and gas in the areas favorable for accumulation of HCs. (Authors' Abstract)

BESKROVNYI, N.S. and LOBKOV, V.A., 1977, Regularities of distribution of hydrocarbon gases in recent hydrothermal systems of Kamchatka, in: Hydrothermal process in the areas of tectonic-magmatic activity, p. 110-119, "Nauka" Publ. House, Moscow (in Russian).

BETTETINI, E. and TURCO, G., 1974, The use of macro- and microcinematography in the study of inclusions in crystals and gems: Rend. Soc. Ital. Mineral. Petrol., v. 30, p. 423-434 (in French).

Essentially same material as in Bettetini, 1973, in Fluid Inclusion Research, v. 6, 1973, p. 20.

BILAL, Ahmad and TOURET, Jacques, 1977, Fluid inclusions in phenocrysts from basaltic lavas of Puy Beaunit (French Massif central): Bull. Soc. fr. Minéral. Cristallogr., v. 100, p. 324-328 (in French with English abstract). Authors at Dépt. de la Terre, Univ. Paris VII.

Homogenization temperatures of carbonic fluid inclusions in phenocrysts from Puy Beaunit basalts (French Massif central) range between +10 and +34°C. The fluid is pure CO_2 for the most dense inclusions, CO_2 mixed with hydrocarbons for the less dense ones. From melting temperatures of basaltic systems, pressures at the time of the trapping are estimated between 5 and 2 kb.

BLOUNT, C.W., 1977, Barite solubilities and thermodynamic quantities up to 300°C and 1400 bars: Am. Min., v. 62, p. 942-957. Author at Dept. of Geology, Idaho State Univ., Pocatello, Idaho 83209

BOBOKHOV, A.S., PAVLOV, A.V. and ERMAKOV, N.P., 1976, Inclusions in quartz and conditions of formation of porphyries of the S. Urals (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 100 (in Russian; translation by A. Kozlowski).

1. In quartz P (T_H 1300-1000°C) and PS (T_H 800-750°C) melt inclusions were distinguished. P inclusions are usually crystallized; with dms: plagioclase, hornblende, pyroxene(?). PS inclusions are of more basic composition and they are rather glassy.

2. Apatite, zircon and plagioclase (12-42% An) appear as dms (i.e., uzniki, sic.)

3. S G/L inclusions are connected either with melt or with hydrothermal impregnation of the cooled rocks. G/L inclusions of the first variety have T_D: 510-440, 400-220 and 190-140°C. (Authors' abst.)

BOBOLOVICH, G.N., 1976, Inclusions of mineral-forming solutions as sources of genetic information (abst.): Problems of genetic information in mineralogy (Proceedings of the All-Union Mineralogical Seminar), Syktyvkar, June 1-4, 1976: Syktyvkar, Acad. Sci. USSR, Komi Div., p. 70-71 (in Russian; translation by A. Kozlowski). Author at Inst. Geol. of the Komi Division of Acad. Sci. USSR, Syktyvkar.

A characterization of the correct procedures of study of fluid inclusions in minerals under the headings: a) distribution of inclusions, b) their chemical composition, c) phases and phase ratios of filling, d) external shape of the inclusions. (From the author's abst.)

BOCTOR, N.Z. and MEYER, H.O.A., 1977, Oxide and sulfide minerals in kimberlite from Green Mountain, Colorado, in Second International Kimberlite Conference 1977, Extended Abstracts (unpaginated).

The mineralogy and textures displayed by the sulfide minerals in Green Mountain kimberlite are not suggestive of an origin by sulfide liquid immiscibility. More likely the sulfides were the products of sulfurization reactions during serpentinization. (From the authors' abstract)

BODNAR, R.J. and BEANE, R.E., 1977, Temperature variations in pre-intrusive cover over a buried pluton (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 903-904. Authors at Department of Geosciences, University of Arizona, Tucson, Arizona 85721.

Geologic observations and fluid flow models suggest that the mineralized plutons of the SW United States generated convective circulation of hydrothermal fluids of diverse origin in permeable wallrocks. The convecting fluids would have transferred heat from the hot intrusive into the overlying rocks, producing a broad vertical zone of essentially constant temperature. This overlying zone is typically absent, owing to erosion which results in surface exposure of mineralized plutons, but recent disclosure of buried mineralization at Red Mountain, Arizona, has revealed an opportunity to study alteration characteristics of pre-mineral cover overlying a deep deposit. Vein and alteration mineralogy in this cover is largely quartz-sericite-pyrite at elevations > 700m above the intrusive, which changes with depth to include increasing amounts of carbonate, anhydrite, and chlorite. Homogenization studies of fluid inclusions in sulfide-bearing quartz veins indicate temperatures on the order of 300-400°C extended through a vertical range of 1 1/2km above the intrusive. This temperature range, which is higher than thermal models predict using normal geothermal gradients, suggests that the rocks overlying the central intrusive body were also heated by numerous dikes and sills related to the main pluton. Vapor-rich fluid inclusions observed throughout this interval, combined with measured salinities of $\sim$40wt% NaCl equivalent in liquid-rich inclusions, suggest the pluton was emplaced at about 4km below earth surface. Fluid inclusion homogenization temperatures measured across a single quartz-pyrite vein provide an indication of temperature variation with time and indicate an initial decrease in temperature from 400 to 320°C followed by an increase to 380°C and a second cooling episode.

BOGOLEPOV, V.G., BOLOTOV, B.M., NAIDENOV, B.M. and POLYVIANNYI, E.Ya., 1976, Nature of skarn-forming solutions (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 66 (in Russian; translation by A. Kozlowski).

1. Copper deposit Karatas (NW Pribalkhash'ie) occurs in a lens of limestones between banded Upper Paleozoic granodiorites and it associates with pre-skarn dikes of aplite-pegmatite and diorite porphyrite. Skarns are of the garnet type and endoskarns of the pyroxene-

garnet type. Also almost monomineralic epidote and K-spar rocks appear, as well as products of silicification and sulfide metasomatosis.

2. Isotopic composition of Ar from G/L inclusions from skarn minerals was studied. T of sampling of Ar was chosen by decrepigraphs.

3. Skarns and quartz with overlapping ore mineralization formed from heated meteoric waters. Quartz, when compared with garnet skarns, bears more water (in fluid inclusions, A.K.). (Authors' abst.)

BOGOMOLOV, M.A., 1977, Temperature conditions of formation of the Seligdar apatites: Akad. Nauk SSSR Doklady, v. 235 no. 5, p. 1159-1161 (in Russian). Author at the Moscow State Univ., Moscow.

On the basis of analysis of the tremolite-calcite-quartz association and F-OH apatite-biotite (phlogopite) geothermometer, T of origin of apatite (and presumably carbonatite) is 330-520°C; T for carbonatite from the Arbarastakh massif was ∿730°C, by the second method. (Abst. by A.K.)

BOGOYAVLENSKAYA, I.V., 1976, Investigations of inclusions of mineral-forming fluids abroad (1968-1972), in Thermobarogeochemistry of mineral formation, N.P. Ermakov, ed.: Rostov, Rostov Univ. Press, p. 135-144 (in Russian).

Full paper corresponding to abstract in Fluid Inclusion Research volume 6, p. 24, 1973.

BOGOYAVLENSKAYA, I.V., DOLOMANOVA, E.I., and BOYARSKAYA, R.V., 1976, Studies of fluid inclusions in minerals by German and Russian geologists in the 19th century and the early 20th century and the present status of Soviet-German investigations: Z. geol. Wiss. Berlin, v. 4, no. 2, p. 267-272 (in German).

A review; no new data. (ER)

BOIARKIN, A.P. and KALMURZINA, G.Z., 1976, Temperatures of recrystallization of rocks and ores in the Bakal-Satka region (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 92-93 (in Russian; translation by A. Kozlowski).

T_D (vacuum method) and T_H were determined in dolomites of the Burzianskaia series, in magnesite and siderite from deposits Satka and Bakal, and in dolomites from Avzianskaia and Min'iarskaia complexes. Maximum T of the secondary alteration of dolomite was 300-400°C. T_H and T_D of magnesite are in ranges 400-100°C; (...). Modal values of T_H in the Bakal siderite are 120-90°C (98% of inclusions) and 270-150°C (2%). Precipitation of magnesite from sea water is impossible, and replacement of dolomite under elevated T rather improbable. Thus, strata-bound magnesite formed presumably by influx of endogene Mg-bearing solutions along fault zones in a sequence of marine sediments. Hydrothermal recrystallization determined the metasomatic pattern of ores.

Siderite formed after alterations of wall dolomite and rare G/L inclusions with T_H 270-150°C are presumably connected with overlapping sulfide mineralization (...). (From the authors' abst.)

BOKONBAEV, K.Dzh, GROSHEV, A.K., and ABAKIROV, Sh.A., 1976, Time and temperature conditions of formation of quartz and accessory topaz from granites of the Sukhodol'skii massif (SE Kirgizia):Zapiski Kirgiz Otdel., Vses. Mineralog. Obshch, v. 9, p. 91-95 (in Russian).

BONEV, I.K., 1977, Primary fluid inclusions in galena crystals. I. Morphology and origin: Mineral. Deposita (Berl.) v.12, p. 64-76. Author at Geological Institute, Bulgarian Academy of Sciences, 1113 Sofia, Bulgaria.

Large primary gas-liquid inclusions as negative crystals are found in the galena crystals from some hydrothermal lead-zinc deposits. Their habit, macro- and micromorphology and arrangement are studied. It is assumed that gas bubbles formed in heterogeneous boiling solutions have played an important role in their formation. The galena surface over the outermost inclusions is plastically deformed, and specific depressions, or infrequently bulges, are formed. The causes and conditions of the deformation are discussed. Similar positive plastic deformation is reproduced experimentally. The liquid released by opening the inclusions evaporates rapidly depositing NaCl and KCl in an epitaxic orientation on the fresh galena cleavage surface. (See also Piperov et al., 1977, this volume.) (Author's abst.)

BONEV, I. and PIPEROV, N.B., 1977, Ore deposition, boiling and vertical extent of the lead-zinc mineralization in the Madan district: Geologica Balcanica, v. 7, no. 4, p. 27-42 (in Russian with English abstract). First author at Inst. Geochem., 1113 Sofia, Bulgaria.

The ore-forming processes in the Madan deposits are considered on the basis of new evidence on the specific physico-chemical, chemical and structural features of the mineralizations. High temperature (≥310°C) but relatively low concentration (4-5% salinity) solutions filled an open fracture system reaching the earth's surface. It is suggested that the solutions above a definite level were in a boiling state because of the gradual drop in pressure upwards. Above that level P and T decreased following the boiling curve. Boiling is considered as a continuous process rather than as an episodic event following the manifestation of tectonic activity. The physico-chemical and physical changes in the state of solutions in the zone of boiling led to dissociation of the transporting metal complexes and to crystallization of the main sulphides. (From the authors' abstract)

BORISENKO, A.S., 1976, Analysis of chloride, carbonate and sulfate solutions by the cryometry method (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 171 (in Russian; translation by A. Kozlowski).

In solutions in artificial inclusions (...) mainly of the following ions have eutectic T equal: 1) LiCl -74.8 to -78°C, 2) $CaCl_2$ -49.8 to -55°C, 3) $MgCl_2$, $FeCl_2$, $FeCl_3$ -35 to -38°C, 4) NaCl without LiCl, $CaCl_2$, $MgCl_2$, $FeCl_2$, $FeCl_3$ -21.2 to -23.5°C, 5) carbonates and sulfates -1.2 to 5.0°C. In each of the five groups T of eutectics varies somewhat. Additional information may be obtained by studies of solid phases precipitating on cooling. By use of the appropriate plots one may determine concentrations from T of melting of solids. Following salts were found in G/L inclusions by such cryometry: NaCl, KCl, $CaCl_2$, LiCl, $MgCl_2$, $NaHCO_3$, Na_2CO_3, etc. (Author's abst.)

BORISENKO, A.S., 1977, Cryometric technique applied to studies of the saline composition of solution in gaseous fluid inclusions in minerals: Akad. Nauk SSSR, Sib. Otdel., Geol. i. Geofiz., 1977, no. 8, p. 16-27 (in Russian with English abstract). Author at IGiG, Novosibirsk.

The behaviour of solutions contained in both synthetic and natural gas fluid inclusions on freezing provides methods of analysing the solution and establishes a series of diagnostic criteria permitting one to fix the component composition of the solution under study. The data obtained permit one to enlarge the possibilities of cryometric technique when studying the composition of solutions from inclusions in minerals. (Author's abstract)

BORISENKO, A.S., LEBEDEV, V.I., OBOLENSKIY, A.A., ZAYKOV, V.V. and TYUL'KIN, V.G., 1977, Physico-chemical conditions of formation of hydrothermal deposits of Western Tuva (abst.), in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Sib. Branch, v. II, p. 113-114 (in Russian; translation by A. Kozlowski). First author at Inst. Geol. Geoph. of Siberian Branch of Acad. Sci. U.S.S.R., Novosibirsk.

Gold ore deposits (Ulugsiar, Akdag) formed at 350-100°C and $\sim$800 atm from CO_2-H_2O solutions, total salts 4-8 wt. %. Arsenide-nickel-cobalt, sulfoarsenide-nickel-cobalt-copper deposits (270-50°C), copper-bismuth (230-70°C), mercury (180-50°C) and barite deposits (110-50°C) developed from Cl-Ca-Na or Cl-Na-K solutions bearing CO_2 or $CO_2 + N_2$; concentrations were: NaCl 10-32 wt. %, $CaCl_2$ 5-20 wt. % KCl up to 17 wt. % and CO_2 0-10 wt. % (deposits Chazadyr, Ooraskhem, Karasug, Khovu-Aksy). (From the authors' abst.)

BORISENKO, A.S., OBOLENSKAYA, R.V. and OBOLENSKIY, A.A., 1977, Physico-chemical conditions of formation of the various mineral parageneses at epithermal deposits of fluorite (abst.), in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Sib. Branch, v. II, p. 115-116 (in Russian; translation by A. Kozlowski). Authors at the Inst. Geol. Geoph. of Siberian Branch of Acad. Sci. U.S.S.R., Novosibirsk.

Following epithermal types of fluorite deposits were distinguished: quartz-fluorite, quartz-barite-fluorite, fluorite-carbonate, barite-fluorite-siderite, etc. T of formation were 280-70°C, P up to 1000 atm. Quartz-fluorite deposits (e.g., Berkhe, Kharayryg in Mongolia) formed from Cl-HCO_3 solutions of low concentration, 1-2 wt. %. Sulfide-fluorite deposits (Akkaya and Sarasa in Gornyi Altai, Chauvay and Plavikovaya Gora in Tyan'-shan) developed from Cl solutions of total salt concentration 3-7 wt. % High CO_2 content in parent solutions is typical of deposits in carbonate rocks (Abagaytuy and Stepnoe in Transbaikalia, several deposits in Tyan'-shan). Fluorite deposits commonly bearing Fe minerals(siderite, hematite, ankerite) and barite (Karasug, Ulatay, Sushenskoe in Tuva, El-Khamam in Morocco, Ba-Fe-F-type deposits in the GDR) formed from highly concentrated (up to 45 wt. %) Cl-Ca-Na solutions. Juvenile mantle fluids are the source of F, whereas Cl, Na and Ca were derived from buried saline brines of the ancient evaporite basins. (Authors' abst.)

BORISENKO, A.S., OBOLEVSKIY, A.A., and VASIL'YEV, V.I., 1976, Composition of mineral-forming solutions that formed deposits of some ore provinces of the USSR (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 196-197 (in Russian; translation by A. Kozlowski).

1. Mercury deposits of various types were studied in the Altae-Sayan, Middle Asian, Verkhoyano-Kolyma, Okhotsko-Chukotka, Koryak-Kamchatka etc. provinces. Mineral-forming solutions were divided into S-Cl, S-Cl-CO_2 and S-CO_2 groups. Concentration of total salts varied from 0.5-1 to 40 wt. %.

2. Ores of the Altae-Sayan mercury province formed from highly concentrated (from 5-10 to 40 wt.%) S-Cl (Tuva) and S-Cl-CO_2 (Gornyi Altai) solutions. Middle Asian Hg and Hg-Sb deposits formed from S-CO_2 solutions (CO_2 up to 30 wt%); Okhotsko-Chukotka, Koryak-Kamchatka and Verkhoyano-Kolyma Hg deposits formed from dilute S-Cl-SO_2 solutions.

3. Waters from modern thermal sources and solutions from fluid inclusions have similar compositions, but the concentration in thermal waters is 1-2 orders lower than that of solutions in fluid inclusions.

4. Formation of ores with mercury sulfosalts is connected with highly concentrated, essentially S-Cl-type solutions; antimonite-cinnabar and realgar-orpiment-cinnabar ores with concentrated S-Cl-CO_2 or S-CO_2 solutions; and realgar-orpiment ores with S-CO_2 solutions. Composition of hydrotherms essentially determines not only ore parageneses, but also the type of wall rock alteration of the deposits (carbonatization, listvenitization, argillitization, pyritization, silicification etc.). (Authors' abst.)

BORODAEV, Yu.S., EREMIN, N.I., MEL'NIKOV, F.P. and STAROSTIN, V.I., 1975, Laboratory methods of studies of minerals, ores and rocks, editor V.I. Smirno : Moscow, Publishing House of the Moscow Univ., Moscow 251 pp. (in Russian).

The book, written as a procedural guide for students, bears one chapter written by F.P. Mel'nikov (Chapter 3, p. 109-164), devoted to methods of studies of fluid inclusions and interpretation of the results obtained. The chapter covers the following topics: I) Classification of fluid inclusions - magmatic (melt), gaseous and liquid varieties; II) short review of methods of fluid inclusion studies; III) T measurements including principles of the method, devices and study techniques and determination of T of crystallization of minerals; IV) Cryometry (method, devices and technique, interpretation of results); V) Decrepitation (method, devices and examples of determinations); VI) Methods of determination of composition of inclusion fluids, including salts and gases; VII) Dynamics of physico-chemical processes and phenomena in inclusions during T change. Most of the data presented is from published papers. (Abst. by A.K.)

BORSHCHEVSKIY, Yu.A, DOLOMANOVA, Ye.I., and LISOVSKAYA, O.Yu., 1977, Conditions of formation of mineral associations of the tin ore deposits in Zabaikal'ye, as indicated by oxygen isotopic data (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Sib. Branch, v. 1, p. 117-118 (in Russian; translation by A. Kozlowski). First author at VIMS, Moscow.

The oxygen isotopic geothermometer and fluid inclusion data suggest T of cassiterite crystallization was 170-450°C; the solutions were aqueous, of CO_2-Cl type. (A.K.)

BOUBERLOVA, Ludmila, 1977, Analysis of fluid-filled inclusions in minerals: Časopis pro mineralogii a geologii, v. 22, no. 2, p. 151-162. (In English with Czech summary). Author at Ústředni ústav geologický, Malostranske n. 19, 118 21 Praha, ČSSR.

As a part of the study of the physicochemical conditions of the genesis of ore deposits in the chemical laboratory of the Geological Survey Prague (ÚÚG), a method for the analysis of fluid-filled inclusions in minerals is being developed.

The ions in the inclusion fluids are determined in the water slurry of the ground material using modern analytical methods, after filtration through a membrane filter. To ascertain their total concentration in the initial minerogenic fluids, the water content is determined after mechanical crushing of the walls of the inclusions in the pre-dried isopropyl alcohol by analyzing an aliquot part of the organic extract using gas chromatography. (Author's abstract, modified)

BOWEN, R. and GUNATILAKA, Ananda, 1977, Copper, its geology and economics: New York, J. Wiley and Sons, 366 p.

Brief mention of fluid inclusion data on p. 114-115 (ER)

BOWMAN, J.R. and ESSENE, E.J., 1977, Contact metamorphism of chlorite-bearing dolomites at Elkhorn, Montana (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 908. Authors at Department of Geology and Mineralogy, University of Michigan, Ann Arbor, Michigan 48104.

Contact metamorphism in the Black Butte aureole has converted Chl- and Tr-bearing marbles to Fo+Cc+Sp and Fo+Cc assemblages, respectively. Application of Cc-Dol thermometry and T-X(CO_2) topologies at P=1kb allow T-X(CO_2) estimates for these isograds:

Chl+Dol=Fo+Cc+Sp+H_2O+CO_2 T=490+20°C $.04<X(CO_2)<.30$
Tr+Dol=Fo+Cc+H_2O+CO_2 T=510+20°C $.15<X(CO_2)<.40$

Relevant Chl equilibria have been calculated to fix X(CO_2) within the marbles. These calculations, whether from thermochemical data or combination of appropriate experimental data, are subject to large T errors (60°C), precluding narrowly defined fluid composition limits. These errors result from wide experimental brackets for the Chl and Opx equilibria (Fawcett & Yoder, 1966; Skippen, 1971) used for derivation of the Chl isograd reaction and from uncertainty in the ΔS(Chl). A ΔS (Chl)=113e.u./mole (Chernosky, 1975) is preferred to that of Zen (1971)-104e.u./mole-because it does not utilize unreversed experimental brackets, it involves less extrapolation error, and is consistent with values calculated by combination of minerals with analogous structures. T-X(CO_2) paths defined for the aureole indicate lack of fluid buffering and suggest that no large differences in X(CO_2) were maintained between the two isograds. Given the evidence above, the isobaric invariant assemblage Tr+Dol+Chl+Fo+Cc+Sp+H_2O+CO_2 has been placed at T=540°C and X(CO_2)=.45. Rice (1976) has placed this invariant point at much higher X(CO_2) values=.80, but has used the upper T limits of these thermodynamic calculations. However his observation of CO_2-rich fluid inclusions suggests that real C(CO_2) differences for this point could

exist. ΔG_R calculations indicate that significant $T\text{-}X(CO_2)$ shifts can result from variable site order in Chl and solid solution effects, accounting for the apparent discrepancy.

BOWMAN, J.R. and ESSENE, E.J., 1977, Skarn formation at Elkhorn, Montana (abst.): Amer. Geophys. Union Trans., EOS, v. 58, p. 1246. (see preceding abstract)

BOYARSKAYA, R.V., DOLOMANOVA, Ye.I., NOSIK, L.P. and FADYUKOV, Ye.M., 1977, Morphology and chemical composition of inclusions of parent solutions in reticulate quartz from pegmatites of Volhyn, data of scanning electron microscopy and mass spectrometry, in Problems of regional and genetic mineralogy, Ye. K. Lazarenko, ed., "Naukova Dumka" Publishing House, Kiev, p. 98-108 (in Russian).

Preparations of quartz were made from cleavage chips of random orientation coated by gold or for transmission microscopy -- carbon replicas. Reticulate ("honeycomb") quartz was chosen since it was especially well investigated by different methods. Size of inclusions varies from tens to tenths of µm. Opened inclusions bear various minerals, both dms and salts crystallized from evaporation of solution filling inclusions; habit and intergrowths of those minerals are described. Hexagonal dm yielded quantitative composition: Na, Al, F (cryolite Na_3AlF_6). Aggregate of tabular and isometric crystals consisted of Na, K, Ca, S, Cl and Zn, being probably a mixture of sphalerite and Na, K and Ca chlorides. Elongated prismatic dm of composition Ag and Cl is most probablychloroargyrite, hexagonal one consisting of Na, Al and Cl cannot be defined by name of any currently known mineral. Other prismatic and cubic dms (analysis revealed Mn, Fe and Cl) seemingly are scacchite ($MnCl_2$) and lawrencite ($FeCl_2$) or molysite ($FeCl_3$), although after opening of inclusion, the minerals might alter into hydroxy- and hydrated chlorides. In aggregates of dms chloroargyrite. Fe sulfides, $CaCl_2$ and Ti oxides were tentatively determined. By mass spectrometry CO_2, H_2O and SO_2 were determined; $\delta^{13}C$ (PDB standard) equals -2.07, -2.089 and -2.14. (Abstract by A.K.)

BOYKO, S.M., 1976, Conditions of formation of the Au, Sn, and Pb-Zn ore mineralization in the Khapcheranga ore region,(abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 189 (in Russian; translation by A. Kozlowski).

On the basis of composition of G/L inclusions and pore solutions as well as geochemical zoning it was found that Cl-Na hydrotherms of the first stage of mineralization were formed by mobilization of pore solutions, Au and other components by the thermal field of intruding granites. Gold-quartz veins were formed by solutions with F/Cl = 0.11, Na/K = 3.1, Li/Na = 0.28. During crystallization of the internal parts of the magmatic chamber hydrotherms formed bearing Sn, Zn, Pb and with F/Cl 0.045-0.50, Na/K 2.4-3.1, Li/Na 0.1-0.15 (Khapcheranga); F/Cl=0.84, Na/K=2.4; Li/Na 0.66 (Kurultey); F/Cl 0.28-0.67, Na/K 0.73-3.6, Li/Na 0.5-1.3 (sic.).

During crystallization of the apical part of the intrusion pneumatolytic-hydrothermal solutions appeared of F-K-Na composition, forming greisen mineralization of the second stage; their composition was F/Cl = 0.88, Na/K = 0.97, Li/Na = 0.33. In all deposits a distinct zon-

ing was found, seen as an increase in Cl-Na toward the end of the hydrothermal process. Early solutions are acid, of F-K type, especially in Tarbal'dzheyskoe quartz-cassiterite stockwork. Ore-bearing quartz has higher Li. High content of Li and F in inclusions may be the indicators of the hidden Sn mineralization. (Author's abst.)

BOYKO, S.M., 1977, Evolution of composition of ore-forming solutions in the deposits of the Khapcheranga ore system (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Sib. Branch, v. 1, p. 115-116 (in Russian; translation by A. Kozlowski). Author at the Inst. Geochem. of Siberian Branch Acad. Sci. USSR.

All deposits of the Khapcheranga Sn-polymetallic ore system are characterized by acid, K-F solutions in fluid inclusions of early stages, and their change into relatively alkaline, $NaHCO_3$-Cl ones in fluid inclusions of later stages. (A.K.)

BOYKO, S.M. and MARKOVA, M.Ye., 1976, Zonal changes of composition of gaseous-liquid inclusions in minerals from Khapcheranginskoe tin ore deposit (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci USSR, Inst. of Geol., p. 70-71 (in Russian; translation by A. Kozlowski).

Zonal distributions of values of pH, Eh, Na/K, F/Cl, Li/Na and were studied by water leachate method. Solutions of various stages of mineralization had different sources; tin-bearing hydrotherms were replaced by lead-zinc ones and the following carbonate solutions without ore precipitation. From greisens and quartz-cassiterite ores to essentially galena-sphalerite ores, features of leachates changed: in sphalerite pH 6.5-8.0, Na/K 0.07-4.2, Li/Na 0.13-0.04, Li/K 0.15-0.05, F/Cl 0.46-1.8; in galena pH 5.9-8.0, Eh +0.287 - +0.209, Na/K 1.3-1.9, in quartz pH 7.4-9.5, Na/K 0.97-2.2, Li/Na 0.33-0.05, Li/K 0.35-0.15, F/Cl 0.87-0.05. (Author's abst.)

BRADY, J.B., 1977, Experimental reaction zones between quartz and periclase and intergranular diffusion of silica (abst.): Amer. Geophys. Union, Trans., EOS, v. 58, no. 6, p. 520.

Reaction zone thicknesses did not show a significant variation with run temperature, but were three to five times greater if NaCl solutions were used. (From the author's abstract)

BREY, G. and GREEN, D.H., 1977, Systematic study of liquidus phase relations in olivine melilitite + H_2O + CO_2 at high pressures and petrogenesis of an olivine melilitite magma: Contrib. Mineral. Petrol., v. 61, p. 141-162. First author at Research School of Earth Sci., Australian National Univ., P.O. Box 4, Canberra, A.C.T. 2600, Australia.

Near-liquidus phase relationships of a spinel lherzolite-bearing olivine melilitite from Tasmania were investigated over a P,T range with varying x_{H_2O}, x_{CO_2}, and f_{O_2}. At 30 kb under MH-buffered conditions, systematic changes of liquidus phases occur with increasing x_{CO_2} ($x_{CO_2} = CO_2/CO_2+H_2O$+olivine melilitite). Olivine is the liquidus phase in the presence of H_2O alone and is joined by clinopyroxene at low x_{CO_2}. Increasing x_{CO_2} eliminates olivine and clinopyroxene becomes the only liquidus phase. Further addition of CO_2 brings garnet + orthopyroxene onto the liquidus together with clinopyroxene, which disappears with even higher CO_2. The same systematic changes appear to hold at higher and lower pressures also, only that the phase boundaries are shifted to different x_{CO_2}. The field with olivine+clinopyroxene becomes stable to higher x_{CO_2} with lower pressure and approaches most closely the field with garnet+orthopyroxene+clinopyroxene at about 27 kb, 1160°C, $x_{CO_2} \sim 0.08$ and $x_{H_2O} \sim 0.2$ (i.e., 6-7% CO_2+7-8% H_2O). Olivine does not coexist with garnet+orthopyroxene+clinopyroxene under these MH-buffered conditions. Lower oxygen fugacities do not increase the stability of olivine to higher x_{CO_2} and do not change the phase relationships and liquidus temperatures drastically. Thus, it is inferred that olivine melilitite 2927 originates as a $\sim$5% melt (inferred from K_2O and P_2O_5 content) from a pyrolite source at about 27 kb, 1160° with about 6-7% CO_2 and 7-8% H_2O dissolved in the melt. The highly undersaturated character of the melt and the inability to find olivine together with garnet and orthopyroxene on the liquidus (in spite of the close approach of the respective liquidus fields) can be explained by reaction relationships of olivine and clinopyroxene with orthopyroxene, garnet and melt in the presence of CO_2. (Authors' abstract)

BRISTOW, C.M. and WILSON, I.R., 1977, Postemplacement events in the Cornubian Batholith - a discussion: Econ. Geol., v. 72, p. 307-310.

Includes some preliminary results on a study of fluid inclusions (by N.J. Jackson) in "quartz cassiterite and quartz wolframite and a spatially associated greisen envelope", showing up to T_H $\sim$500° for boiling fluids with <24% NaCl. (ER)

BRYZGALIN, O.V., 1976, Geochemistry of tungsten in hydrothermal processes: Moscow, "Nauka" Press, 68 pp. (in Russian).

BULAKH, D. and BULAKH, A.G., 1977, Thermodynamic properties of water in the region up to 1000°C and 100 kb and features of phase transition in the H_2O system: Zap. Vses. Min. Obsh., v. 56, no. 4, p. 448-459 (in Russian).

BULYNNIKOV, V.A., DENISENKO, N.P. and ANDREEVA, T.A., 1977, On temperature of formation of quartz veins of the Central Gold-Ore Field (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Sib. Branch, v. II, p. 12-13 (in Russian; translation by A. Kozlowski).

The central Gold-Ore Field formed within a large granitoid batholith; sections of the field (Oktya Oktabr'shiy, Tsentral'nyi, Yubileynyi, Khrebtovyi, etc.) occur in the granodiorite inner core of the batholith, and parts (Varvarinskiy and Burlevskiy) occur in the hybrid diorites of the S. contact zone. The stages of ore-formation are as follows: 1) black and gray quartz, pyrite, molybdenite, 2) white and gray quartz, apatite, 3) fine-grained mosaic quartz, pyrite, scheelite, arsenopyrite, 4) framboidal quartz (sic), pyrite, sphalerite, galena, bismuthinite, gold, 4) chalcedony-like quartz, calcite, pyrite. T of formation of the quartz-sulfide veins was determined from T_H and T_D of white (w) and gray (g) quartz. The veins formed from dilute hydrothermal solutions at 360-140°C; T_{frz} -3.4 to -6.7°C. Dms dissolve at $T<T_H$. The detailed results of studies are given in the table.

Table: Main thermodynamic indices (sic.) of quartz from the Central Ore Field

Ore Section	Variety of quartz	T_H, °C		T_D, °C	T_{Frz}, °C	Gas content, cm^3/kg			
		ranges	mean			H_2	CO_2	CH_4	Total
Oktiabr'skiy	w	160-240	201	200-360	-4.2 to -4.6*	1.7	6.2	0.2	8.1
	g	-	-	240-380					
Tsentral'nyi	w	190-290	238	-	-4.6 to -5.9	3.0	7.9	0.1	11.0
	g	210-310	265	-					
Yubileynyi	w	210-320	217	-	-5.1 to -6.1	5.8	3.7	-	9.5
	g	210-330	298	-					
Khrebtovyi	w	140-240	173	180-280	-3.4 to -3.7	1.2	4.6	0.1	5.9
	g	-	-	220-300					
Varvarinskiy	w	240-320	298	340-390	-6.1 to -6.5	0.7	1.1	-	1.8
	g	-	-	300-400					
Burlevskiy	w	250-360	310	300-400	-6.6 to -6.7	1.2	0.4	-	1.6
	g	-	-	320-400					

*In the original table the T_{Frz} values are given without a minus sign, but from the abstract it appears to have been omitted in error. (A.K.)

(From the authors' abst.)

BURRUSS, R.C., 1977, Analysis of fluid inclusions in graphitic metamorphic rocks from Bryant Pond, Maine, and Khtada Lake, British Columbia: Thermodynamic basis and geologic interpretation of observed fluid compositions and molar volumes: Ph.D. thesis, Princeton University, 156 pp.

Approximately 600 fluid inclusions have been analyzed by microthermometric techniques in 13 samples of graphitic, metasedimentary rocks and 5 samples of granitic intrusive rocks from the upper amphibolite facies metamorphic terrane of Bryant Pond, Maine. In addition, fluid inclusions in 5 samples of graphitic, lower granulite facies metamorphic rocks from Khtada Lake, British Columbia, have been analyzed. These samples were examined in an attempt to define: 1) observable fluids which may have been present in the host rocks at peak metamorphic P and T; 2) whether the chemical and physical properties of the fluids in the inclusions constrain the P, T history of the samples; 3) the sources of the observable fluids; and 4) the degree to which the phase equilibria observable in individual inclusions allow quantitative analysis of the composition and molar volume of the fluid.

A review of published data on experimentally determined phase equilibria and volumetric properties of fluids in the quaternary system CO_2-CH_4-H_2O-NaCl allows construction of a graphical equation of state for these fluids. Observation of two independent, univariant phase transitions (final melting of solid and liquid-vapor homogenization) in individual inclusions allows quantitative determination of composition and molar volume of fluids in the binary CO_2-CH_4 and H_2O-NaCl systems. Observations on CO_2-H_2O fluids are less precise due to the necessity of making a phase volume estimate. These techniques were applied to the quaternary system through use of an ideal mixing model for these fluids.

The observations permit the following conclusions:

1) The ability to define the bulk molar volume of the fluid in the one phase field and therefore the isochore P, T path, allows discrimination of fluids which may have been entrapped at peak

metamorphic P and T from those which are inconsistent with entrapment at those conditions.

2) Within the Bryant Pond, Maine, samples, three distinct fluid compositions appear to be consistent with entrapment at independently determined peak metamorphic P and T of 3 to 4 kbar at 635°C to 685°C. These are (a) CO_2 with no aqueous phase and $X_{CH_4} < 0.05$, (b) CO_2 + H_2O mixtures ($0.2 < X_{H_2O} < 0.8$) with $X_{CH_4} < 0.05$ and about 5.5 wt.% equivalent NaCl and (c) H_2O+NaCl inclusions with about 6 wt.% equivalent NaCl and no equilibria attributable to the presence of CO_2.

3) H_2O bearing inclusions on healed fractures in three Bryant Pond, Maine, samples provide direct evidence of P and T of entrapment at 200 to 800 bars and 300° to 400°C. This strongly suggests that a high geothermal gradient (>70°C/km) existed during the retrograde history of these samples. Under these conditions P_{fluid} may have been less than $P_{lithostatic}$.

4) In the Khtada Lake, British Columbia, samples, the molar volumes of the $CO_2 \pm CH_4$ inclusions with $X_{CH_4} < 0.08$ and no aqueous phase are not consistent with independently determined peak metamorphic conditions of 6±1 kbar and 800±50°C. The molar volumes of some CO_2 + H_2O inclusions with X_{H_2O} in the range 0.5 to 0.8 ± 0.1 are consistent with these conditions. In one graphite bearing sample several inclusions have $X_{CH_4} > 0.2$ and one inclusion has a bulk composition of $X_{H_2O} = 0.45$, $X_{CO_2} = 0.30$, and $X_{CH_4} = 0.25$. (Authors' abstract)

BURT, D.M., 1977, Mineralogy and petrology of skarn deposits: Rendiconti Soc. It. Mineral. Petrol., v. 33, p. 859-873. Author at Dept. Geol., Arizona State Univ., Tempe, AZ 85281.

To aid in understanding the various processes which occur during the formation of Ca-Fe-Si skarn deposits, a theoretical study has been made of mineral stabilities and compatibilities in the eleven-component model system Ca-Fe-Si-C-O-S-F-Zn-Cu-W. Reactions in this model system clarify many previously unexplained phenomena observable in skarns, and also explain some characteristics of carbonatites, greisen and vein tungsten deposits, and metamorphosed ferruginous marbles and iron formations. (From the author's abstract)

BURYAK, V.A. and KONOVALOV, I.V., 1976, Conditions of metamorphic-hydrothermal ore formation (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 122-123 (in Russian; translation by A. Kozlowski).

Ore formation is genetically connected with regional metamorphism and palingenetic-metasomatic granitization.

1. Ore-forming processes had small gradients of ΔP and ΔT in time and space, and these conditions caused origin of deposits with extensive reserves. ΔT of Au ore deposits of the Lena region in a horizontal plane are 2-5° per km, and in vertical plane up to 40° per km. Beginning of quartz crystallization of associations of various age differs in its T over a range of 10-20°C. Maximum T_H of Au-bearing pyrite lenses and veinlets, quartz-pyrite veinlets and lenses and quartz veins completing the process of ore formation decreases from 385 to 320°C.

2. Ore formation was under P total 0.7-1.6 kb and more, over 0.3-1.0 kb higher than lithostatic P.

3. Hydrotherms are of HCO_3-Ca-S type. Bulk content of CO_2 in

inclusions in quartz veins from the greenschist zone of metamorphism ranges from 55 to 135g per m^3; ratio CO_2/H_2O changes from 0.06 to 0.98, depending on T_H. From the greatest facies to amphibolite CO_2 content in inclusions increases up to 90 wt. %; in magmatogenetic fluids molar content of $CO_2<0.5$.CO, CH_4, NH_3, Ca, Na, Cl, F, S, As, Au and other components were also found in inclusions. (Authors' abst.)

BUSECK, P.R., 1977, Pallasite meteorites--mineralogy, petrology and geochemistry: Geochim. Cosmo. Acta, v. 41, p. 711-740. Author at Dept. Geol., Arizona State Univ., Tempe, Arizona 85281, U.S.A.

Some evidence is presented for an immiscibile sulfide melt. (ER)

BUSECK, P.R., and HOLDSWORTH, Edward, 1977, Phosphate minerals in pallasite meteorites: Min. Mag. v. 41, p. 91-102. First author at Dept. Geol. Ariz. State Univ., Tempe, Arizona 85281.

Evidence for an immiscible phosphate liquid is shown. (ER)

BYDTAEVA, N.G., 1976, Temperatures of formation of accessory minerals in metamorphic rocks of the Aldan shield (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 117-118 (in Russian; translation by A. Kozlowski).

Among accessory minerals from quartzites of the Iyengrian series (Archean), four generations of monazite, four of zircon and three of apatite were distinguished on the basis of studies of fluid inclusions. In these minerals crystalline-gas inclusions (G 15-20 vol. %) were found, T_H for monazite and zircon 780°C, for apatite 830-810°C, i.e., the quartzites are intrusive rocks (sic.). During regional metamorphism (amphibolite-facies) zircon, monazite and apatite, all of the second generation, crystallized at minimum T (T_H) 550°C. Zircon and monazite of the third generation, connected with microclinization, have minute inclusions with T_H 530-520°C. The fourth generation consists of zircon, monazite and apatite, bearing G/L inclusions (25-30 vol. % of G phase) with T_H 400-390°C (zircon and monazite) and 420°C (apatite); they were formed by hydrotherms during local metamorphism. (Author's abstract.)

CAMERON, Aubrey, 1977, Physical conditions of low grade metamorphism of the Jacksonburg Formation, Northampton County, Pennsylvania. MS thesis, Lehigh Univ., Bethlehem, Pennsylvania, 86 pp.

Veins of quartz and calcite cut the highly deformed carbonaceous lower Paleozoic Jacksonburg limestone. Fluid inclusions in the quartz have T_H 130-160°C; S inclusions have T_H of 40-55°C and 90-100°C. Stepwise heating the limestone in vacuo yielded condensates of yellow brown liquids at ∿250°C, and a white waxy material >300°C. Authigenic albite is present throughout the formation. (ER)

CARRAT, H.G., 1976, The role of the geochemistry of uranium and thorium in the distribution of intragranitic uranium ore deposits (abst.): Mem. h. ser. Soc. geol. France, 1976, no. 7, p. 213 (in French and English)

Experimental studies on fluid inclusions lead one to consider the fractures (in which the deposits occur) originated from the upper mantle, due to the high value of CO_2 in the fluids. (From the author's abstract)

CARSON, D.J.T. and JAMBOR, J.L., 1977, Phyllic overprinting: a fundamental cause of variations in zoning at porphyry copper deposits (abst.): Geol. Assoc. Canada-Min. Assoc. Canada Program with Abstracts, v. 2, p. 11.

CASADEVALL, Tom and OHMOTO, Hiroshi, 1977, Sunnyside mine, Eureka mining district, San Juan County, Colorado: Geochemistry of gold and base metal ore deposition in a volcanic environment: Econ. Geol., v. 72, p. 1285-1320.

Full paper corresponding to abstract published in Fluid Inclusion Research -- Proceedings of COFFI, v. 8, p. 32, 1976. (ER)

CATHLES, L.M., 1977, An analysis of the cooling of intrusives by ground-water convection which includes boiling: Econ. Geol., v. 72, p. 804-826.

A finite difference model of the cooling of an igneous intrusive of limited volume is developed and used to investigate the relation between igneous intrusion, the formation of liquid and vapor dominated geothermal systems, and the formation of porphyry-type ore deposits. The model takes into account the properties of pure water and accommodates the phenomena of boiling and condensation. Permeability, level of intrusion, and pluton volume are systematically varied. Pressure, temperature, and fluid velocity are computed as functions of time.

It is found that a self-supported, vapor dominated steam zone is commonly (but briefly) formed above the intrusive. Condensed water bounds the steam zone above, and if the hydrothermal solutions are saline, a zone of boiling bounds the steam zone below. For pure water condensation is far more important than boiling - the solutions circulate around the critical point of water to become gaseous without boiling. Despite large temperature variations, convection causes fluid pressures throughout the whole uniform permeability system to be close to normal cold-water hydrostatic values. Thus, even in an active convecting system with moderate permeability variations, fluid pressure will tend toward normal hydrostatic values. Fluid circulation appears easily sufficient to produce a typical porphyry copper ore shell, but base metal precipitation probably must be controlled by mechanisms other than simple temperature drop. (Author's abstract)

There is a short discussion of saline fluids and the dispersion of salinity (p. 823), but the problem of possible reversal of fluid flow due to high density saline fluids is not addressed. (ER)

CHAPMAN, H.J. and SPOONER, E.T.C., 1977, ^{87}Sr Enrichment of ophiolitic sulphide deposits in Cyprus confirms ore formation by circulating seawater: Earth and Planetary Science Letters, v. 35, p. 71-78.

CHARLES, R.W. and VIDALE, R.J., 1977, Reaction of granodiorite with water at 300°C and 1/3 kb in a circulation system (abst.): Amer. Geophys. Union, Trans., EOS, v. 58, no. 6, p. 539.

CHEPUROV, A.I., 1976, Studies of chemical composition of inclusions of magmatic melts in minerals by use of electron microprobe Ms-46: in Genetic studies in mineralogy, Yu.A. Dolgov et al., eds.: Novosibirsk, Inst. Geol. and Geophy. Sib. Branch Acad. Sci. USSR, p. 131-137 (in Russian).

Silicate melt inclusions were analysed by microprobe technique, similar, e.g., to that used in U.S. Geol. Survey laboratories. Crystallized melt inclusions are recommended to be homogenized and quenched before analytic runs. Significant differences of composition of melt inclusions and bulk parent rock are noted, due to alteration of melt and rocks in various stages. The paper bears three 9-component analyses of inclusions in minerals of pseudoleucitites from Central Aldan, four analyses of inclusions in minerals of teralites from Kuznetskiy Alatau, two analyses of inclusions in clinopyroxene of biotite peridotite porphyrite from Central Aldan and two analyses of inclusions in pyroxene of fergusite-porphyry (E. Pamir). Also studies of change of inclusion composition during heating were performed; the author concluded that on heating, melt in inclusion dissolves walls of host mineral, approximately reacting with the rim that was precipitated on inclusion cooling under natural conditions, i.e., that melt becomes similar to the former magma. (Abst. by A.K.)

CHERNOV, A.A. and TEMKIN, D.E., 1977, Capture of inclusions in crystal growth: Chapt. 11, pp. 3-77, in 1976 Crystal growth and materials, E. Kaldis and H.J. Scheel, eds.: North-Holland Publishing Company. First author at Inst. Cryst., USSR Acad. Sci., Moscow, USSR.

A highly mathematical treatment of the theory of trapping pure melt inclusions, gas bubbles and solid inclusions. Conditions of fluctuating flow velocities, impurity buildup ahead of growth front, critical growth rate, shape of growing face, size and density of trapped bubbles, movement of inclusions in thermal gradients, capture of immiscible fluid droplets, etc., are also discussed, with some experimental data, and 79 references. (ER)

CHERNOV, A.A., TYOMKIN, D.Ye., and MEL'NIKOVA, A.M., 1976, Theory of trapping of solid inclusions during growth of crystals from melt: Kristallografiya, v. 21, no. 4, p. 652-660 (in Russian). Authors at Inst. of Cristoallography of Acad. Sci. USSR.

Conditions of crystallization of melt were studied, locating the crystallization zone in a thin region between growth front and foreign particle repulsed by the front. The repulsion appears due to molecular forces in the thin region, and attraction of particle by viscous melt. Approximate shape of the thin region was calculated and critical speed of growth V_c was found, at which a spherical particle of radius R is trapped by the growing crystal. For small particles with $R<\lambda^2/1$, critical speed $V_c=(0.14B_3/\eta R)(\alpha/B_3R)^{1/3}$, where $\lambda=(\Omega\alpha/\Delta S\Theta)^{1/2}$, $1=(B_3\Omega/\Delta S\Theta)^{1/4}$, Ω-specific molecular volume in melt, α-specific free energy of crystal/melt interface, η-viscosity, B_3-constant, determining decrease of chemical potential in the thin layer of melt, compared with main part of liquid ($\approx 10^{-14}$ erg), Θ-T gradient at the growth front. For big particles of $R>\lambda^2/1$, $V_c=0.15B_3/\eta R1$. (Author's abst. translated by A.K.)

CHERNOV, A.A., TYOMKIN, D.Ye. and MEL'NIKOVA, A.M., 1977, On the influence of thermal conductivity of a macroparticle on its trapping by a crystal growing from melt: Kristallografiya, v. 22, no. 6, p. 1152-1156 (in Russian). Authors at Inst. of Crystallogr. of Acad. Sci. USSR.

Behavior of a particle at the growth front of a crystal in melt was studied. Thermal conductivity of the particle differs from the conductivity of melt and crystal; and the conductivities of the latter two are assumed to be the same. The decrease of melting point in the thin layer of melt due to wedging pressure is compensated by the movement of front under the particle to the cooler area. The critical speed of growth was found, the overstepping of which causes the trapping of particles and gas bubbles. The critical speed increases with decrease in the thermal conductivity of the particle. Critical speed for trapping of G bubbles is significantly higher than for solid particles. (Authors' abst., transl. by A.K.)

CHERNYI, L.N. and KASHKUROV, K.F., 1976, Influence of inclusions on growth of quartz of scepter habit (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 159 (in Russian; translation by A. Kozlowski).

Trapping of inclusions causes growth of hexagonal prism of scepter habit. (From the authors' abst.)

CHERNYI, L.N., KASHKUROV, K.F. and KUZNETSOV, A.D., 1976, Influence of macroinclusions on formation of quartz crystals of various habits (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 158 (in Russian; translation by A. Kozlowski).

Variations of morphology of quartz crystals usually is connected with the conditions of growth: composition of solution, T and P, orientation of nucleus, etc. Development of the upper faces is especially connected with the influence of gravity on crystal-forming complexes. It was found that the influence of gravity is not essential. Upper faces trap many G/L inclusions and solid macroparticles. The latter cause different types of dislocations, leading to an increase in the speed of growth of different faces and to a large number of habits. (Authors' abst.)

CHIKHELIDZE, K.S. and KHMALADZE, I.I., 1977, On thermodynamic conditions of formation of crystalline rocks of the Dzirula outcrop of the Georgian block: Acad. Sci. Georgian SSR, Bull., v. 86, no. 1., p. 136-139 (in Russian, with summaries in Georgian and English). Authors at Geol. Inst. Acad. Sci. Georg. SSR, Tbilisi.

Paper bears thermodynamic parameters of volatiles (fO_2, F_{H_2O}, P_{H_2O}) and T determined by various mineralogical geothermometers. (A.K.)

CHIVAS, A.R. and WILKINS, R.W.T., 1977, Fluid inclusion studies in relation to hydrothermal alteration and mineralization at the Koloula porphyry copper prospect, Guadalcanal: Econ. Geol., v. 72, p. 153-169.

The Koloula Igneous Complex on the island of Guadalcanal, part of the British Solomon Islands Protectorate, consists of a calc-alkaline sequence of 26 intrusive phases ranging from leucogabbro through diorites and granodiorites to andesite dikes. The intermediate and felsic rocks of the younger central part of the complex are host to porphyry copper mineralization, characterized by two well-defined separate alteration systems.

The earlier or "A" system has five distinguishable concentric zones. The innermost is sulfide-free and contains K feldspar-quartz-magnetite-actinolite-pyroxene (salite). It is succeeded by zones containing potassic and propylitic assemblages, with chalcopyrite and bornite associated with the potassic zones. The later, or "B" system, is characterized by four zones in which sericite and lesser amounts of clay minerals predominate.

Fluid inclusion assemblages are closely similar to those from porphyry copper deposits of the Bingham type. Three types of inclusions are common: gas-rich, moderately saline,+highly saline inclusions which contain NaCl±KCl±hematite±birefringent phases. Homogenization temperatures obtained from moderately and highly saline inclusions range up to approximately 700°C in the A system and up to 480° in the B system. There is a continuous variation in salinity from 2 percent equivalent NaCl in some two-phase inclusions up to approximately 60 percent equivalent NaCl in some highly saline inclusions.

The evolution of fluids in the A hydrothermal system has not proved easy to elucidate, but the best development of high-salinity inclusions containing KCl daughter crystals is found in areas of strong potassic alteration. Information derived from the sequence of secondary fluid inclusion planes and from the coincidence of alteration and late-intrusive activity suggests that in the B system high-salinity fluids dominated the early phase of alteration and moderate-salinity fluids dominated the later phases. It is considered that both hydrothermal systems developed predominantly under lithostatic pressure conditions with a cover of about 3 km.

Counts of inclusions in primary quartz in standard petrographic thin sections reveal a close relationship between fluid inclusion abundance and the location of Cu soil geochemistry anomalies. Such counts may well prove to be a simple preliminary exploration technique for porphyry copper prospect evaluation. (Authors' abstract.)

CHKHARTISHVILI, T.A. and NAUMOV, V.B., 1977, Thermometric study of aplite-orthotectites in the Kelasuri massif: Acad. Sci. Georgian SSR, Bull., v. 85 no. 1, p. 117-120 (in Russian, with summaries in Georgian and English). First author at Caucasian Inst. Miner. Raw Mat., Tbilisi.

Kelasuri granitoid stock-shape massif of Batonian age, occurring in the Gagra-Dzhava structural zone, consists of rocks varying from gabbro to alaskite with prevailing biotite granite. Granite-aplites, aplite-pegmatites and granite-porphyry are the final rocks. T_H of melt P inclusions, bearing G phase and numerous unidentified, mostly anisotropic dms, equal rarely 800°C, commonly 780-720°C (over 300 determinations in block quartz). Oftedal's Sc biotite geothermometer yielded T >620-650°C. (Abst. by A.K.)

CHLEBUS, S.W., 1977a, Pegmatitic cordierite from the Owl Mts. (Sudetes): Acta Geologic Polonica, v. 27, no. 1, p. 75-83 (in English with Polish abstract).

The first reported cordierite from pegmatitic formations of the Sudetes Mts. reveals a high concentration of FeO and small amount of BeO. Both crystallochemical formula and unit cell parameters of this cordierite were calculated. The distortion index $\Delta = 0.18$ suggests that the investigated cordierite presents an intermediate form between the high and low variety. Studies of fluid inclusions reveal its crystallization under the conditions characterized by pressure about 2 kbars, and temperatures at the range of 700-750°C. (Author's abstract)

Immiscibility between a "white, transparent melt" (silicate) and "liquid" (presumably aqueous) in the inclusions is postulated. The pressure was estimated from the water content of the cordierite. (ER)

CHLEBUS, S.W., 1977b, Representative minerals of cassiterite placers in the Izera upland: Archiwum Mineralog., v. 33, no. 2, p. 75-82 (in Polish with English abstract). Author at Inst. Geochem., Min., and Petrog., Warsaw Univ.

T_D of cassiterite, topaz, scheelite were determined to be 390-395°C, 350-355°C and 315-320°C respectively. (From the author's abstract)

CHOU, I-Ming and EUGSTER, H.P., 1977, Solubility of magnetite in supercritical chloride solutions: Amer. Jour. Sci., v. 277, p. 1296-1314.

CHOU, I.M. and WILLIAMS, R.J., 1977, Activity of H_2O in CO_2-H_2O at 600°C and pressure to 8 kilobars (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 928. Authors at SN7, NASA Johnson Space Center, Houston, TX 77058.

Using the hydrogen fugacity sensor technique of Chou and Eugster (1976), we have determined the equilibrium hydrogen fugacity in CO_2-H_2O mixtures at 600°C between 4 and 8 kbars for the redox conditions of the Ni-NiO buffer. The measured hydrogen fugacity and the buffered oxygen fugacity were used to calculate the H_2O fugacity in the mixture. The activities of H_2O, given in the table, were computed assuming that the mixtures are essentially binary.

P (Kbars)/XH_2O	0.2	0.4	0.6	0.8
4	0.31	0.47	0.61	0.74
6	0.43	0.56	0.68	0.81
8	0.54	0.70	0.78	0.89

The uncertainties in a H_2O range from ±0.08 in the H_2O-rich mixtures to ±0.04 in CO_2-rich mixtures.

At 6 and 8 kbars with XH_2O less than 0.5 and 0.75 respectively, $NiCO_3$ crystallized according to the reaction $NiO+CO_2 \rightarrow NiCO_3$. However, within four days, the duration of all runs, the equilibrium state of this reaction has not been reached. This was indicated by the varied fluid compositions, determined after quench, at fixed P and T. In these conditions, it is possible that f_{O2} of the system is not defined when NiO is completely enveloped by $NiCO_3$. Therefore, the reported values for a H_2O in the presence of $NiCO_3$ are the maximum ones.

The data indicate significant positive defiations from ideality for all of the conditions investigated, except for H_2O-rich mixtures at 4 Kbars. The deviations increase with increasing pressure at constant temperature. These deviations will significantly effect dehydration and decarbonation equilibria, particularly at high pressure and in CO_2-rich fluids. (Authors' abstract)

CHUPINA, L. Yu., 1976, Inclusions in minerals of meteorites (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 126 (in Russian; translation by A. Kozlowski).

Pallasite Bragin: in olivine phenocrysts, glass + G and glass + rectangular ore dms were found.

Chondrite Nikol'skoe: in pyroxene chondrules there are inclusions: solidified, partly crystallized melt (glass) + ore dm + G; ore dm + G; glass + G. Individual grains of olivine and pyroxene bear only G inclusions.

Chondrite Yelenovka: pyroxene and olivine bear inclusions of glass, recrystallized glass + ore dms + G, recrystallized glass + ore dms and pure G.

Achondrite Norton County: enstatite bears inclusions of glass or glass + ore dm and glass + G, of flat habit, T_H 1420-1400°C. One-phase glass inclusions, when heated up to 1300°C, on cooling G bubble appeared; subsequent T_H 1420-1400°C. Analysis of G composition of individual inclusions yield mean values: CO_2-70, CO-8.0, H_2-11.5, N_2+ rare gases -10.5 (all vol. %) testifying to reducing conditions. (Authors' abst.)

CHUPINA, L.Yu., and DOLGOV, Yu.A., 1976, Investigations of meteorites and inclusions in their transparent minerals: in Genetic studies in mineralogy, Yu.A. Dolgov et al., eds.: Novosibirsk, Inst. Geol. and Geophy. Sib. Branch Acad. Sci. USSR, p. 9-11 (in Russian).

Inclusions were investigated in olivine, plagioclase and pyroxene from meteorites: Nikol'skoe, Elenovka and Norton County. There were found G, G + glass + solids and G + glass inclusions; T_H were measured only for G + glass inclusions. Results are given in the table.

Meteorite	Mineral	Inclusion filling	T_H, °C	Dia. of bubble analysed, mm	Composition of G phase, vol. % * (analysis of individual inclusion)				
					CO_2	Hydro-carbons	CO	H_2	N_2 + rare gases
Nikol'skoe	olivine	G	-	0.014	61.0	-	2.5	28.0	8.5
	do.	G	-	0.012	59.5	-	3.0	25.0	12.5
	do.	G	-	0.010	60.5	-	2.8	23.0	13.7
	do.	G	-	0.012	63.0	-	3.5	21.8	11.7
	do.	G	-	0.017	68.0	-	3.2	19.5	9.3
Elenovka	do.	G	-	0.076	73.0	-	13.0	14.0	0.0
	do.	G	-	0.017	72.0	-	15.0	11.8	1.2
	do.	G	-	0.005	72.8	-	12.5	14.0	0.4
	do.	G+glass+solids	-	0.012	76.0	-	10.8	6.4	6.8
Norton County	enstatite	glass+G	1400	0.010	76.4	7.4	7.9	3.5	4.8
	do.	do.	1410	0.010	75.8	6.8	7.2	4.0	6.2
	do.	do.	1420	0.011	68.5	6.5	7.1	4.09	13.8

*No O_2 or acid gases found in any.

G in inclusions were under P 5-10 times exceeding atmospheric P, only ∿30% of inclusions yielded P 2-3 times lower than atmospheric. (Abst. by A.K.)

CLINE, H.E. and ANTHONY, T.R., 1977, Nonequilibrium morphology of liquid inclusions migrating in solids: J. Appl. Phys. v. 48, p. 5096-5104. Authors at General Electric Research and Development Center, Schenectady, New York 12309.

The nonequilibrium shape of a liquid droplet migrating in a thermal gradient in a solid depends on both anisotropic surface energy and its anisotropic interface kinetics. In contrast, in equilibrium, the droplet shape is simply a surface of minimal total interfacial energy. From the surface energy and interface kinetic anisotropy the shape of brine droplets migrating in KCl is calculated for different migrating rates, droplet volumes, and orientations of the thermal gradient. As the migration rate increases, the droplet flattens by having its dissolving facets grow and the solidifying facets shrink in size. A gradient in the curvature of the interface is generated by the non-equilibrium composition gradient in the liquid. The shape of molten-metal wires used to dope semiconductors by thermomigration is also discussed. (Authors abstract)

CLOCCHIATTI, Robert, 1977a, Melt inclusions in olivine, plagioclase and pyroxene phencorysts as samples of magmatic liquid during host mineral crystallization. An application to a low-K basalt of emerged mid-oceanic ridge (Asal, T.F.A.I.): C.R. Acad. Sci., Paris, v. 284, Ser. D, p. 2203-2206 (in French).

Chemical composition of silicate melt inclusions can be directly represenative of trapped magmatic liquid. However, chemical interaction between included melt and host crystal can occur after entrapment. Therefore the melt is depleted in chemical components of the host. The simultaneous occurrence of glass inclusions in several mineral phases permits the estimation of initial melt composition. The results show that olivine, plagioclase and pyroxene crystallize simultaneously in the same liquid at temperatures between 1,260 and 1,240±25°C. (Author's abstract)

CLOCCHIATTI, Robert, 1977b, Melt inclusions from phenocrysts of olivine and chromite of a "picritic basalt" from the mid-Atlantic ridge: amount of contamination of a basalt with olivine: C.R. Acad. Sci., Paris, v. 285, Ser. D, p. 1155-1158 (in French).

The silicate melt inclusions in phenocrysts may or may not be directly representative of trapped liquids because chemical interaction between inclusions and host crystals can occur after melt entrapment. The simultaneous occurrence of glass inclusions in olivine and chromite of a picritic basalt allows the estimation of initial melt composition. The original trapped liquid composition is determined by the intersection of host-minerals fractionation lines in a triangular diagram ($CaO+Al_2O_3$, MgO, FeO). The olivine and chromite fractionation lines intersect at a single point of olivine basalt composition. In the diagram the length of fractionation lines between intitial melt and bulk rock composition indicates the approximate amount of olivine mechanically precipitated. The distribution coefficients (K_d) show that the olivine phenocrysts are equilibrated with the initial melts trapped. (Author's abstract)

CLOCCHIATTI, R., and BASSETT, A.M., 1978, Skeletal growth and melt inclusions in quartz crystals of rhyodacite ignimbrites of the Valley of Ten Thousand Smokes, Katmai, Alaska (abst.): Amer. Geophy. Union, Trans; v. 59, no. 4, p. 225.

Ignimbrite samples, containing numerous pumiceous fragments, from the 1912 eruption of Katmai, were collected by a mission of CNRS 1/ in 1962 from the bottom of Knife Creek Canyon in the middle part of the Valley of Ten Thousand Smokes. These pumices are rhyodacitic in composition1/. Crystals of quartz and sodic plagioclase, covered with bubbly glass, constitute about 5% of the total rock. The morphology of the quartz crystals, which are ≤ 0.7 mm, becomes visible after the removal of the glass coating by a brief exposure to hydrofluoric acid (HF).

Surface study by SEM reveals stepped depressions (window quartz) increasing in depth toward the center of the pyramidal faces, yielding open cavities of highly varied morphology2/. Further growth of quartz closes such cavities and traps very small quantities of magma as glass inclusions.

Study on the heating microscope stage indicates the minimum temperature of crystallization was between 800° and 840° ± 15°C. Chemical analyses of the glass inclusions by electron microprobe are very close to that of the host rock, indicating very limited crystal fractionation (only 5% of crystals). The content of dissolved volatiles (H_2O, CO_2) should be ~ 5-6%. Morphology of the crystals, temperature of crystallization, and chemical composition of the entrapped liquid suggest that the quartz crystallized very rapidly at a P_{H_2O} of 0.5 to 1 kb, at depths between 1 and 3 km 3/. (Authors' abst.)

1/ P.Bordet et al, 1963, Mem. Soc. Belge de Geologie, No. 7, 114 pp, Bruxelles.
2/ R.Clocchiatti, 1972, C.R.Ac.Sc. Paris v. 274, p. 3037-3040.
3/ R.Clocchiatti, 1975, Mem. Soc. Geol. France, no. 122, 96 pp, Paris.

CLOCCHIATTI, Robert and EL GHOZI, Tahar, 1977, The inclusions and daughter minerals in quartz crystals from the "silicified granodiorite" of the Oued Belif (Nefza volcanic group, north Tunis): C.R. Acad. Sci. Paris, v. 284, Ser. D., p. 203-206 (in French).

Quartz of the Oued Belif metasomatized granodiorite trapped highly saline fluids. These fluid inclusions are contemporaneous with quartz crystallization. Usually the highly saline fluids in such porphyry copper deposits occur with low density fluids. But, in this study low density fluids were not encountered. Daughter minerals of the inclusions were analyzed using X-rays and ion microprobe. (Authors' abstract)

CLOCCHIATTI, Robert and METRICH, Nicole, 1977, Comparison between glassy inclusions in cordierite from rhyodacites of Tuscany (San Vincenzo) and those of the rhyodacites of north Tunisia (Ain ed Deflaia): C.R. Acad. Sci. Paris, v. 284, Ser. D., p. 887-890 (in French).

Melt inclusions trapped in cordierite phenocrysts from rhyodacitic lavas from Tuscany and Tunisia have many similar characters: size, shape, distribution of cavities, chemical composition of filling. The glass trapped in both crystal types have the same chemical evolution as the composition of bulk rock and residual glass. Cordierites were crystallized at high temperature (950°C) and low pressure (1 to 2 kbar) under the same physical and chemical conditions. (Authors' abstract)

CLYNNE, M.A. and POTTER, R.W.,II, 1977, Freezing point depression of synthetic brines (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 930. Authors at U.S. Geological Survey, Menlo Park, California 94025.

The freezing point depression curves for binary systems $NaCl-H_2O$, $KCl-H_2O$ and $CaCl_2-H_2O$ were measured experimentally, as well as the freezing point depression of 23 brines in the system $Na-K-Ca-Mg-Cl-Br-SO_4-H_2O$. A generalized equation was found that can be used to calculate the freezing point of a complex brine from its binary components (i.e. simple salt + water): $\theta_s = \Sigma f_i \theta_i$, where θ_s = freezing point depression of the brine, f_i is the mole fraction of component i, and

θ_i is the freezing point depression of the binary component i at the same equivalent molality as the complex brine. This equation predicts the freezing point depression within $\pm$ 2% of the measured values.

The total dissolved solids in fluid inclusions are generally obtained from freezing point measurements and reported as weight % NaCl equivalents. The freezing point depression data for the complex brines was used to calculate the weight % NaCl equivalents and compared with the synthesized compositions. The weight % NaCl equivalents were generally within $\pm$ 5% of the actual concentration.

However, there are certain compositions of brines whose weight % NaCl equivalents will lie outside of the $\pm$ 5% error band described above. These limits expressed as atomic ratios of Ca/Na, K/Na, and Mg/Na are 0.5, 0.3, and 0.2 respectively. These limits, however, do not appear to exceed the observed ion ratios in the majority of inclusions. Hence the concentration of fluid inclusions can be reliably determined using the NaCl equivalent method. However, if atomic ratios are known, a better estimate can be obtained using the generalized equation described here. (Authors' abstract)

COLE, D.R. and OHMOTO, H., 1977, The degree of oxygen isotopic exchange between rocks and hydrothermal fluids of meteoric origin (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 931-932. Authors at Department of Geosciences, The Pennsylvania State University, University Park, Pennsylvania 16802.

Eighty thermal spring samples from the western United States were analyzed for $\delta^{18}O$ and δD and their degree of ^{18}O shift was compared to their chemistry. Similar comparisons were made on published data from 120 thermal springs from the United States and Japan.

In the first model (nonmixing), the degree of ^{18}O exchange (X_1) between water and rock is computed from $X_1 = 100(S-L)/(E-L)$; where S = $\delta^{18}O$ of spring water, L = $\delta^{18}O$ of local water and E = $\delta^{18}O$ of water in equilibrium with country rocks calculated from temperatures obtained by Na-K-Ca geothermometry. X_1 increases with an increase in $[Cl^-]$ with $\sim$80% of the data falling within 30% of the values computed from the equation $X_1 = 0.01283(\log Cl)^3 - 0.06567(\log Cl)^2 + 0.1533(\log Cl) - 0.05456$ for a range of $[Cl^-]$ in ppm up to 10^5. This indicates that the salinity in the fluid is one of the major factors in controlling the rate of oxygen isotopic exchange reactions between rock and water. In the second model (mixing), each spring was assumed to be a mixture of local cold water and hot aquifer water. Using surface temperatures and $[SiO_2]$ in the fluids, the aquifer temperatures, $\delta^{18}O$ of hot water and of equilibrium water, and degree of ^{18}O exchange (X_2) were calculated. X_2 increases with an increase in $[Cl^-]$. However, the slopes of this relation differ significantly between spring areas, probably reflecting differences in water/rock ratios and rock types.

These results suggest that $\delta^{18}O$ data on geothermal waters, combined with chemistry, temperature and discharge rates might be used to predict the size of the hydrothermal system.

COLEMAN, R.G., 1977, Emplacement and metamorphism of ophiolites: Rendiconti Soc. It. Mineral. Petrol., v. 33, p. 161-190 (in English). The same paper appeared also in Ofioliti, v. 2, p. 41-74 (1977).

Includes a discussion of fluids responsible for hydrothermal alteration (spilitization) of ophiolites. (P. Lattanzi)

COMMER, P.G. and ROBINSON, B.W., 1976, Sulphur and sulphate-oxygen isotopes and the origin of the Silvermines deposits, Ireland: Mineral. Deposita (Berl.), v. 11, p. 155-169.

COMMITTEE FOR RETIREMENT VOLUME COMMEMORATING PROF. T. MIYAZAWA (eds.), 1977, Commemorative volume for Prof. Toshiya Miyazawa: Published November 1, 1977 in Tokyo by the Committee, 231 pp., in Japanese (not for sale).

Consists of two sections with separate pagination: pages A-1 thru A149 are by T. Miyazawa, with title: Contact-metasomatic deposits in Japan and Korea (in Japanese with English figure and table captions, and English contents, pp. A147-A149). It includes at least 8 pages on studies of multiphase fluid inclusions (salinity, dm identification, and T_H).

The second section, pages B1-B82, consists of six separate papers by various authors, including H. Imai and M. Enjoji; these have no English titles, but do have English tables and figure captions (ER).

COPLEN, T.B., 1977, Oxygen, hydrogen and carbon isotope studies of the Mesa geothermal system, California (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 935. Author at U.S. Geological Survey, Reston, Virginia 22092.

CORAZZA, E., MENCHETTI, S., SABELLI, C. and STOPPIONI, A., 1977, Hydrothermal synthesis at 150°C and X-ray study of resulting products in the $NaOH-B_2O_3-H_2O$ system. Neues Jb. Miner. Abh. v. 131, p. 208-223.

Possibly of pertinence to daughter mineral studies. (ER)

CRAWFORD, M.L., KRAUS, D.W., and HOLLISTER, L.S., 1978, Temperature, pressure, and metamorphic fluid compositions from calcsilicate assemblages near Prince Rupert, British Columbia (abst.): Amer. Geophy. Union, Trans; v. 59, no. 4, p. 226.

We compare T, P and fluid compositions predicted from calcsilicate assemblages with T and P estimated from associated staurolite and kyanite grade pelitic assemblages and with observed fluid inclusion data from the calcsilicate rocks. The primary fluid inclusions contain aqueous brines with no detectable CO_2 ($<.02X_{CO_2}$). Melting temperatures for the fluids are as low as -43°C, suggesting a significant proportion of $CaCl_2$ in the aqueous inclusions, and about 25 wt.% total dissolved salts. Mineral reactions in lower grade rocks of the area demonstrate that the fluids in rocks containing calcite and zoisite have been buffered at high X_{H_2O} at all metamorphic grades. Temperatures and pressures calculated from pelitic assemblages lie between 650 and 725°C and 9 and 11 Kb. Calculations based on the observed calcareous assemblages Pl(An_{35})-Zo-Ms-Cc-Q-Or-Bi-Am-vap from one locality and Pl(An_{40})-Zo-Cc-Q-Or-Bi-Am-Di-vap from another predict temperatures of 580-600°C at 9 Kb and a fluid composition with less than .05 X_{CO_2}, using experimental data for the reaction $2Zo+CO_2=3An+Cc+H_2O$ from Johannes and Orville (1972). Other data from the literature for this reaction provide a better correspondence in temperature with the estimate from the pelitic assemblages, but they do not predict the sequence of phase assemblages nor the observed water-rich fluids. The effect of the concentrated brine solutions on the activity of water is an unknown factor; it may shift the positions of the equilibrium curves for both the pelitic and calcareous assemblages. (Authors' abst.)

CUNEY, M., 1977, Detailed analysis of the paragenetic sequence and fluid inclusions of the Bois Noirs, Limouzat, uranium deposit, Massif Central, France (abst.): Inst. Mining and Met., Trans., Sect. B, v. 86, p. B156.

See Fluid Inclusion Research -- Proceedings of COFFI, v. 8, p. 45 (1975) (ER)

CUNNINGHAM, C.G., Jr., 1977a, Pressure variations as a mechanism for localizing hydrothermal ore deposits (abst.): Geol. Assoc. Canada - Min. Assoc. Canada Program with Abstracts, v. 2, p. 14. Author at U.S. Geological Survey, Denver Federal Center, Denver, Colorado, 80225.

Variations in pressures that cause changes in the physicochemical conditions of hydrothermal fluids in porphyry and vein systems are important mechanisms in the deposition of ore deposits. Immiscible exsolved aqueous fluids in a silicate melt confined by a partially solidified shell of an epizonal intrusion are under lithostatic pressures; circulating, dominantly meteoric waters in adjacent rocks are under hydrostatic pressures. Steep pressure gradients exist at the margin of the stock. A sharp drop in pressure in an epizonal environment is more likely to cause boiling than a comparable change in a deeper environment, because the slope of the isochore steepens as pressure increases. Under nearly isothermal conditions, the change in state from liquid to vapor causes hydrofracturing of the solidified shell, which produces a crackle breccia, and also causes localization of the ore deposit.

The physical and chemical changes in hydrothermal fluids across a sharp pressure gradient can be measured using fluid inclusions and light stable isotopes. Boiling is a common result of the pressure change, and if the temperature is great enough at a given pressure, a vapor-dominated hydrothermal system can result. A simple change in state that results from crossing a 2- or 3-phase boundary has a dramatic effect on the metal-carrying of a fluid. When boiling occurs, certain dissolved species such as H_2S and CO_2 are partitioned into the vapor phase while other components such as the alkali chlorides remain in the liquid phase. The loss of H_2S and CO_2 directly affects the solubility of sulfides and carbonates, as well as changing the pH and ionic strength of the fluid. Fractionation of oxygen and hydrogen isotopes also accompanies boiling. Some daughter minerals in fluid inclusions, such as anhydrite, have prograde and retrograde solubilities as a function of pressure; the distribution of these daughter minerals may indicate the spatial distribution of pressure gradients. (Author's abstract).

CUNNINGHAM, C.G., Jr., 1977b, The evolution of fluids associated with an epizonal plutonic complex in the Colorado mineral belt (abst.): Geol. Soc. Amer. Abstr. Programs, v. 7, no. 5, p. 601-602.

The Italian Mountain Intrusive Complex, of Oligocene age, consists of simple and composite intrusives with associated dikes and hydrothermal ore deposits. It is located at the junction of the Elk Mountains, Sawatch Range, and Colorado mineral belt.

Fluid inclusions in quartz phenocrysts and quartz veins document the evolution of aqueous phases coexisting with the silicate minerals during the magmatic and postmagmatic stages. Three types of fluid inclusions are present: Type I contains low-salinity (less than 26 weight percent NaCl equivalent) fluids and homogenizes to a liquid when heated; Type II contains low-salinity fluids and homogenizes to a vapor when heated; and Type III contains high-salinity fluids, which commonly contain several daughter minerals, and it homogenizes to a liquid when heated.

The complex fluids in the inclusions contain 11 daughter minerals, the most common of which are halite, sylvite, anhydrite, and hematite. The oldest fluids associated with plutonic rocks contain anhydrite and the youngest fluids contain sylvite, indicating that the composition changed with time from Ca-rich to K-rich. When modeled on a NaCl-KCl-H_2O ternary diagram the homogenization behavior of the K-rich fluids is remarkably similar to that in the Bingham ore deposit.

The intrusive complex vented and the fluids present boiled when the pressure dropped. Typical Type III inclusions containing 38 weight percent NaCl equivalent and homogenizing at 435° coexist with Type II inclusions which homogenize at the same temperature. P-T-X diagram models of the fluid compositions and homogenization temperatures indicate that the pressure on boiling fluids of this composition and temperature is 250 bars. Pressure constraints imposed by these data indicate a depth of emplacement of about 2700 metres, using the inferred hydrostatic model. (Author's abstract)

CUNNINGHAM, C.G., Jr., 1977, Fluid inclusion geothermometry: Geol. Rundschau, v. 66, p. 1-9 (in English with German, French and Russian abstracts).

A review with 15 references. (E.R.)

CZAMANSKE, G.K., 1977, Sulfide globules in Mid-Atlantic Ridge basalts (abst.): Geological Research 1977, U.S. Geol. Survey Prof. Paper 1050, p. 168.

Electron microprobe analyses were made of immiscible sulfide globules from fresh submarine basalts. They contain <10 to 26 wt. % (Ni + Cu), the lower values being found in the more differentiated basalts. Sulfur analyses were also made. Material balance calculations suggest that one-third of the copper and commensurate amounts of sulfur, nickel, and iron have settled from the magma as immiscible globules.

The sulfide globules contain less than 4 weight percent magnetite, compatible with low oxygen fugacity in the magma. Three sulfide phases coexisted in the globules at about 600°C; monosulfide solid solution, intermediate solid solution; and pentlandite. At lower temperatures the intermediate solid solution has broken down and the monosulfide solid solution has exsolved a second generation of pentlandite. (From the author's abstract)

CZAMANSKE, G.K. and MOORE, J.G., 1977, Composition and phase chemistry of sulfide globules in basalt from the Mid-Atlantic Ridge rift valley near 37°N lat.: Geol. Soc. Amer. Bull., v. 88, p. 587-599.

The electron microprobe was used to determine the bulk composition of immiscible sulfide globules trapped in the glass phase of 25 fresh submarine basalt samples from the Mid-Atlantic Ridge. Twenty-three samples represent a spectrum of primitive through differentiated tholeiites from the FAMOUS dive area; two are differentiated basalts from the Reykjanes Ridge. The analyzed globules range in diameter from 11 to 233 μm. On the average, they constitute only 0.0022 volume percent of the rocks and contain less than 1.5 percent of the sulfur. Compositions of the globules change with differentiation as measured by Fe/(Fe+Mg) or TiO_2 content of the host glass. Globules in glass containing 0.66 to 1.0 wt percent TiO_2 typically contain 20 to 26 wt percent Ni + Cu and have an average atomic Ni/Cu of 1.6. With differentiation toward 1.6 wt percent TiO_2, Ni + Cu content of the globules falls to less than 10 wt percent and atomic Ni/Cu falls to 0.4.(Authors' abstract)

D'AMORE, F., CELATI, R., FERRARA, G.C., and PANICHI, C., 1977, Secondary changes in the chemical and isotopic composition of the geothermal fluids in Larderello field: Geothermics, v. 5, p. 153-163. Authors at Inst. Internazi. Ricerche Geotermiche del C.N.R., Lungarno Pacinotti 55, Pisa, Italy.

Processes such as condensation of rising steam in colder horizons, mixing of deep steam with shallower waters and non-geothermal gas inflow are known to exist in the vapour-dominated geothermal system of Larderello. Deep steam drawn up by geothermal wells modified its original chemico-physical characteristics in relation to the presence of one or more "secondary" phenomena occurring in each point of the field, $^{13}C/^{12}C$ ratios in CO_2 and CH_4, chloride-ammonia-boric acid contents, H_2/H_2S and gas/steam ratios are used as useful parameters in delimiting the different zones in which this kind of phenomena predominate. Six main areas seem to be characterized geochemically, showing marked variations that are essentially due to differences in the geohydrological situations and thermal conditions. (Authors' abstract)

D'AMORE, F. and NUTI, S., 1977, Notes on the chemistry of geothermal gases: Geothermics, v. 6, p. 39-45. Authors at Inst. Internazi. Ricerche Geotermiche, CNR, Via del Buongusto I, Pisa, Italy.

This paper deals with some chemical reactions that may (result in) the presence of the more common gas species and (establish) their relative abundance in the geothermal fluids (i.e., H_2O, H_2S, NH_3, N_2, CO_2, CH_4). These reactions are used as geothermometers for characterizing the deep temperatures in the main geothermal reservoir and are applied to the Larderello field as an example.

Preliminary results indicate that a "mosaic model" may be used to interpret the behaviour of a geothermal system. (Authors' abstract)

DAVIS, J.H., 1977, Genesis of the southeast Missouri lead deposits: Econ. Geol., v. 72, p. 443-450.

Increased understanding of carbonate rocks, solution chemistry, lead and sulfur isotopes, and fluid inclusions has led to near consensus that the southeast Missouri ores occur where brines moving up from the Lamotte Sandstone encountered sulfide produced locally in the Bonneterre Formation.

The early belief that the ores were deposited by descending or artesian ground water was disproved by the discovery of brines in fluid

inclusions. The more recently held concept that the ore fluids originated in an unknown magma is incompatible with the lead isotope data. There were never adherents of syngenesis among those familiar with the deposits because abundantly exposed geometry clearly indicates otherwise.

The following postulates an early diagenetic model, specific to the southeast Missouri district, based largely on temporal and spatial relationships and chemical considerations:

(1) Metal-rich algal limestones were deposited in the back reef zone.

(2) An "evaporation pan" in the back reef zone produced magnesian brines which percolated downward and seaward, in late Bonneterre time, dolomitizing the back reef and reef facies (seepage reflux).

(3) Metals were released from limestones by dolomitization, and the dolomitizing fluid became a metal-bearing brine which followed permeable strata to the edge of the bank facies and followed vertical permeability (i.e., breccias) to the top of the sediment pile.

(4) Sulfide (in sour gas?) moved updip in the Lamotte sand under poorly sorted Bonneterre to the edge of the bank facies where it could permeate the overlying carbonate sands or, alternatively, was produced locally by sulfate reduction.

(5) Metals were precipitated from brines as sulfides. (Author's abstract).

DE BOER, R.B., 1977, On the thermodynamics of pressure solution - interaction between chemical and mechanical forces: Geoch. Cosmo. Acta, v. 41, p. 249-256.

DE BOER, R.B., NAGTEGAAL, P.J.C. and DUYVIS, E.M., 1977, Pressure solution experiments on quartz sand: Geoch. Cosmo. Acta, v. 41, p. 257-264.

DEICHA, G., 1977, Relationships between intracrystalline cavities and their contents in minerals (abst.): Inst. Mining and Met., Trans., Sect. B, v. 86, p. B156.

See Fluid Inclusion Research -- Proceedings of COFFI, v. 9, p. 30 (ER)

DELANEY, J.R., MUENOW, D., GANGULY, J., and ROYCE, D., 1977, Anhydrous glass-vapor inclusions from phenocrysts in oceanic tholeiitic pillow basalts (abst.): Amer. Geophys. Union, Trans., EOS, v. 58, no. 6, p. 530.

Glass-vapor inclusions within olivine and/or plagioclase phenocrysts quenched in the glassy rims of typical oceanic tholeiitic pillow basalts from the Mid Atlantic Ridge (3), Kolbeinsey Ridge (1), Juan de Fuca Ridge (1), Paul Revere Ridge, near the Explorer Seamount (1), and Hawaiian East Rift (1), all contain less than 0.01% wt. H_2O, between 0.2 and 0.4 wt.% CO_2 and about 0.08 to 0.15 wt.% sulfur. The two- to four-fold enrichment of CO_2 in the inclusions compared to the matrix glass can be explained either by crystal growth (inclusion formation) in a magma which was initially richer in CO_2 or by volatile concentration at the crystal magma interface during crystal growth. Neither crystal growth kinetics nor pressure-induced diffusional gradients caused by decompression after inclusion entrapment could have produced the severe depletion of water in the inclusions. The data seem to require the source regions for these basalts to be virtually depleted in water, and possibly richer in CO_2 than the magmas quenched on the ocean floor. Water must enter the magma after inclusion formation and before quenching. (Author's abstract)

DELHAYE, Michel, LECLERCQ, Michel, and LANDON, Don, 1977, What, where, when: Industrial Research—April, p. 69-72. First author at Universite de Lille, France.

A brief description of the "MOLE" (microprobe molecular optics laser examiner) and an application to an inclusion in Swiss quartz. The gas bubble and the solution contained CO_2; the dm was calcite. (ER)

DEMENKO, D.P., 1977a, Dislocation loops in crystals of quartz, in Problems in regional and genetic mineralogy, E.K. Lazarenko, ed.: Kiev, Naukova Dumka Press, pp. 109-112 (in Russian).

DEMENKO, D.P., 1977b, Microrelief of quartz fractures, in Problems in regional and genetic mineralogy; E.K. Lazarenko, editor: Kiev, Naukova Dumka Press, p. 112-115 (in Russian).

DEMIN, V.M. and KURSHEV, S.A., 1976, Dimensions of gas-liquid inclusions in minerals as an indicator of the speed of mineral growth, in Thermobarogeochemistry of mineral formation, N.P. Ermakov, ed.: Rostov, Rostov Univ. Press, p. 60-64 (in Russian).

Full paper corresponding to abstract in Fluid Inclusion Research volume 7, p. 44-45, 1974.

(Title changed here from that used earlier.)

DEMIN, Yu.I, KOROLEV, G.G. and SOLODOV, A.A., 1977, Spatial reconstructions of thermal fields of granite intrusives and their application for metallogenic investigations (exemplified by Zmeinogorskiy region at Rudnyi Altai): Akad. Nauk SSSR Doklady, v. 236 no. 2, p. 411-414 (in Russian). First author at the Moscow State Univ., Moscow.

DERGACHEV, V.B., AMSHINSKII, N.N., KUMEEV, S.S., DOLGUSHINA, A.A., BULGAKOV, V.B., VINOKUROVA, T.N., DENISENKO, N.P., MELENEVSKII, V.N., ORLOVA, L.I., and CHIGLIN, A.G., 1975, Barburgazin massif rare metal granitic rocks of Gornyi Altai: Magmat. Form. Skladchatykh Reg. 1975, Edited by Il'enok, S.S. Kalmytskii Gos. Univ., Elista, USSR. p. 47-80 (in Russian). Authors at Sib. Nauchno-Issled. Inst. Geol., Geofiz. Mineral. Syr'ya, Novosibirsk.

Decrepitiation of fluid inclusions in minerals indicates the formational temps.: quartz 300-450, tourmaline 550-600 and 700-850, micropegmatite 650-700, and alkali feldspars 700-900°. (CA 88: 108185 v, 1978).

DE RITA, D., DOLFI, D., TERSIGNI, C., TRIGILA, R., 1977, Experimental results of water solubility in "ignimbrite campana" at P_{H_2O} between 10,000 and 30,000 psi: Rendiconti Soc.It.Mineral.Petrol., v. 33, p. 73-80 (in Italian). Authors at Inst. Min. Petrog. dell'Univ., Roma, Italy.

Water solubility of IC 1 sample from the "ignimbrite campana" has been determined in the range of P_{H_2O}=10,000-30,000 p.s.i. and of 780°

C-960°C. The results, from the solubility experiments, refer always to the sub-liquidus region and give values of more than 2% at 10,000 p.s.i and of more than 6% at 30,000 p.s.i. The role of crystallization kinetics and the volatiles solubility as physio-chemical components for the control of volcanic eruptions has been evaluated finally. (Authors' abstract)

DHAMELINCOURT, P., 1977, Laser molecular microprobe, in Lasers in Chemistry, Proceedings of a Conference held in London, England, May 31-June 2, 1977, M.A. West, ed.: Amsterdam, p. 48-53.

DHAMELINCOURT, Paul and SCHUBNEL, H.J., 1977, The laser molecular microprobe and its application to mineralogie and gemmology, I: Rev. de gemmologie, no. 52, p. 11-14 (in French).

A review of the use of laser-excited Raman spectroscopy for identification of solids and solid inclusions, including a spectrum of liquid CO_2 from an inclusion in beryl, showing peaks for both ^{12}C and ^{13}C isotopes. (ER)

DICK, J.D., 1976, Geothermal reservoir temperatures in Chaffee County, Colorado: MS thesis, Northeast Louisiana Univ., Monroe, LA (171 pp.).

Includes a section on fluid inclusion studies, pp. 75-108. Fluorite from "Poncha Springs region", Chaffee County, Colorado, gave Th of 57 to 184°C; that from "Browns Canyon region" gave 121-164°C and 7 inclusions at 295 to >324°C. (How these high values are possible in light of the near-surface nature of these deposits is not explained. Ed.) (ER)

DICKSON, F.W., 1977, The reaction of granite with seawater at 300°C and 1000 bars (abst.): Amer. Geophys. Union Trans., EOS, v. 58, p. 1251.

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DICKSON, F.W. and RADTKE, A.S., 1977, The unique mineralogy of Hg-As-Sb-Tl sulfides at the Carlin gold deposit, Nevada, and implications as to the origin of the deposit (abst.): in Program and Abstracts, Third M.S.A.-F.M. Symposium, Crystal Growth and Habit, Tucson, Arizona, Feb. 13-14, 1977 (unpaginated)

The Carlin veins formed late in the mineralization episode by the action of solutions that boiled at some stage and at temperatures from 200° to 150°C, according to liquid inclusion data. The fluids were of meteoric origin and they contained sulfur of marine affinity, judging from the isotopic data. They probably ascended from below along steep normal faults as part of a circulating water system set into motion by input of volcanic heat. Hot fluids passing through sedimentary rocks below and adjacent to the deposit could extract elements from the rocks, which are known to contain anomalously high levels of Au, Hg, As, Sb, Tl and Ba, and deliver them to the site of deposition. (From the authors' abstract)

DOLGOV, Yu.A., BAKUMENKO, I.T., BAZAROV, L.Sh., and KOSUKHIN, O.N., 1976, Granitic pegmatites: in Genetic studies in mineralogy, Yu.A. Dolgov et al., eds.: Novosibirsk, Inst. Geol. and Geophy. Sib. Branch Acad. Sci. USSR, p. 85-90 (in Russian).

Two groups of pegmatites were distinguished: zonal, connected with injection of remnant granitic melts,and azonal or weakly zonal of anatectic origin. High-T melt inclusions in early, outer zones of pegmatitic bodies homogenized at T listed in Table 18.

Table 18. Temperature of homogenization of melt inclusions in quartz of granitic pegmatites, °C

Anatectic pegmatites		
a) granulitic facies	Aldan River, between Nimgerkana and Champuly Rivers	850-820
b) amphibolite facies	Aldan River, vicinity of Suon-Tiit village	820-790
c) do.	W. Tuva, Mungun-Tayga	∼800-790
Orthotectic veins	Verkhnealdanskiy region	∼840
Outer zones of weakly zonal pegmatitic veins	Do.	840-790
Outer zones of chamber pegmatites	Kazakhstan, Bayan-Aul	880-700
Do.	Kazakhstan, Golodnaya Step' (Prairie of Hunger), Dzhel'tan	620-570

Secondary alterations in pegmatites were caused by solutions of salts, sometimes as concentrated as 80% of total salts, homogenizing at T up to 660°C. In numerous pegmatite zones of undoubtedly melt origin are absent due to subsequent hydrothermal recrystallization. Role of adiabatic mobilization in pegmatitic process is mentioned. (Abst. by A.K.)

DOLGOV, Yu.A., KOSTYUK, V.P. and BAZAROV, L. Sh., editors, 1976, Genetic studies in mineralogy: Novosibirsk, Inst. Geol. and Geophysics of the Siberian Branch of the Acad. Sci. USSR, Novosibirsk, 203 pp. (in Russian; price 72 kopecks).

The book contains papers detailing the physico-chemical conditions of mineral formation on the basis of studies of fluid inclusions in minerals, glasses and other substances. Also new methods of study of inclusions are described, as well as specific methods of investigations of minerals (electron paramagnetic resonance, IR spectroscopy, X-ray structural analysis, etc.). Data from studies of rock-forming amphiboles and micas are included. Abstracts of papers pertinent to fluid inclusion studies are given alphabetically by the author's names in this volume of Fluid Inclusion Research -- Proceedings of COFFI.

DOLGOV, Yu.A., SHCHERBAN, I.P., BOROVIKOVA, G.A., and GIBSHER, N.A., 1975, The physicochemical conditions of formation of the Vavilon ore deposit according to the thermodynamic and thermobarometric data: Geologiya i Geofizika, v. 16, no. 11, p. 35-45, 1975 (in Russian); translated in Soviet Geology and Geophys., v. 16, 1975, p. 23-31).

This is a full translation of paper abstracted in Fluid Inclusion Research - Proceedings of COFFI, v. 8, p. 49-50, 1975.

DOLGOV, Yu. A. and SHUGUROVA, N.A., 1976a,Studies of tektites based on inclusions, in Genetic Studies in Mineralogy, Yu. A. Dolgov et al., eds: Novosibirsk, Inst. Geol. and Geophy. Sib. Branch Acad. Sci. USSR, p. 16-21 (in Russian)

All inclusions found in any variety of the studied tektites were gaseous, with spherical, ellipsoid, clearly fluidal shape or intergranular voids. Inclusions occurred in tektite glass and in fragments of lechatelierite included in the glass. Size of inclusions varied from tens to hundreds of μm. Studies of G were made by method of analysis of single inclusions. Glass of two generations forms tek-

tites: I - essentially completely melted, II - included in the essential unmelted fragments. Sometimes those are rounded, with melted edges, fragments of amorphous silica-lechatelierite. Lechatelierite bears only round, not deformed inclusions. G composition of inclusions in lechatelierite differs from G in inclusions in tektite glass in low H_2 content (analyses No. 8,9,10,18,19,20) and rarely in presence of "acid gases" (analyses 9, 19). Tektites, in general, contain various G mixtures in inclusions, suggesting different origin of individual groups. E.g., moldavites contain G similar to mixed atmospheres (of comet and air) of melting as result of impact effect. Such impact might be connected with the origin of the Riess crater. Libyan glass has G in inclusions similar to moldavites. Both varieties of tektites bear G of very low density (bubble on crushing decreases 3000 times).

Tektites called "Darwin glass" should not be longer assumed to be true tektites, since they bear in inclusions air derived component (analyses 31-35), likewise artificial glass made from oxides present in tektites and melted under air conditions (analyses 36-40). Differences in P of G are still inexplicable: in artificial glass P is one or more orders higher than in Darwin glass.

One important fact was established during above studies: moldavites are 15 m.y. old. However, neither diffusion <u>into</u> inclusions, nor <u>from</u> inclusions outside was found. Very low P was also preserved in inclusions. Nature of this process is still not clear; maybe G on cooling is able to precipitate some mineral substance, strongly blocking process of diffusion through glass.

Idea of trapping of atmospheres of melting is supported by analysis of inclusion fillings of the terrestrial obsidians. Small increase of G bubble on crushing (analyses 41-43), and air-type composition of G surely proves their trapping in the terrestrial atmosphere. However, obsidians bear also other inclusions, probably of purely endogene origin, consisting exclusively of CO_2. Those bubbles are brought from the deep magmatic chamber. Analogous CO_2-bearing inclusions are common in all remaining types of tektites: CO_2 either reaches 100% or very close to this value. Thus, presumably indochinites, phillippinites, australites, bediasites, and tektites from the Ivory Coast are of volcanic origin. It is very probable that high CO_2 content is typical of the early-planetary stage (as in Venus). Air and CO_2 compositions of inclusions suggest a terrestrial origin of the glass. Hence, most tektites seemingly originate from Venus, as echoes of its volcanic activity, passing through the stage of "cosmic dust".

Table 7. Composition of gases from inclusions in tektites, cosmic microspherules, obsidians and artificial glasses

			Composition of gas, vol. % (see also footnotes)			
Sample	No. of analysis	Decrease of G bubble	CO_2	H_2	O_2	N_2 + rare gases
			TEKTITES			
Moldavite	1	610	53.02	40.10	0.0	2.68
M-1	2	999	62.48	32.60	0.0	0.18
	3	2980	69.40	24.63	0.0	1.17
	4	1460	69.20	22.10	0.0	6.10

(Continued on next page)

			Composition of gas, vol. % (see also footnotes)			
Sample	No. of analysis	Decrease of G bubble	CO_2	H_2	O_2	N_2 + rare gases
Indochinites						
I-1	5	14	100.0	0.0	0.0	0.0
	6	18	100.0	0.0	0.0	0.0
	7	60	100.0	0.0	0.0	0.0
I-2	8	78	91.20	8.8	0.0	0.0
	9	82	89.20	0.80	0.0	0.0
	10	210	98.80	1.20	0.0	0.0
Phillippinites						
F-1	11	5320	100.0	0.0	0.0	0.0
	12	807	100.0	0.0	0.0	0.0
	13	3680	100.0	0.0	0.0	0.0
	14	4300	100.0	0.0	0.0	0.0
Australites						
A-1	15	4370	100.0	0.0	0.0	0.0
	16	105	100.0	0.0	0.0	0.0
	17	202	100.0	0.0	0.0	0.0
A-2	18	240	99.0	1.0	0.0	0.0
	19	368	77.50	1.5	0.0	0.0
	20	280	98.70	1.3	0.0	0.0
Bediazites						
	21	437	100.0	0.0	0.0	0.0
	22	917	100.0	0.0	0.0	0.0
	23	572	100.0	0.0	0.0	0.0
	24	527	100.0	0.0	0.0	0.0
Tektites from Ivory Coast						
	25	1045	100.0	0.0	0.0	0.0
	26	1330	100.0	0.0	0.0	0.0
	27	456	100.0	0.0	0.0	0.0
Libyan glass						
	28	2100	45.50	22.8	0.0	31.7
	29	1850	47.00	28.0	0.0	25.0
	30	2060	46.00	25.5	0.0	28.5
Darwin glass						
	31	13	21.8	0.0	16.0	62.2
	32	23	24.2	0.0	15.0	60.8
	33	16	27.8	0.0	15.0	57.2
	34	30	25.8	0.0	15.0	59.2
	35	16	38.4	0.0	12.0	49.6
ARTIFICIAL GLASSES						
	36	525	12.1	0.0	17.5	70.4
	37	637	87.0	0.0	2.6	10.4
	38	3340	43.2	0.0	11.0	45.8
	39	1352	44.3	0.0	11.3	44.4
	40	1410	43.4	0.0	11.0	45.6
OBSIDIANS						
	41	1.5-10	0.0	0.0	20.80	79.20
	42	0.0	0.0	0.0	22.00	78.00
	43	0.0	0.0	0.0	20.69	79.31
	44		22.55	0.0	15.65	57.10
	45		100.0	-	-	-
	46		100.0	-	-	-
	47		100.0	-	-	-
MICROSPHERULES FROM TUNGUSSKA						
3044	48	92	95.5	0.0	0.0	0.0
3045	49	53	95.3	0.0	0.0	0.0
3046	50	125	92.0	0.0	0.0	0.0
1321	51	2.3	83.0	0.0	0.0	0.0
1041	52	2.4	57.8	8.6	0.0	17.9
1042	53	2.9	46.7	14.9	0.0	22.6
6221	54	92	90.0	10.0	0.0	0.0
6222	55	54	91.4	8.6	0.0	0.0

CO contents: analysis 44-4.7; 52-10.3; 53-15.9; 45, 46, and 47, not determined; all others 0.0%.

Acid gas contents (H_2S, SO_2, NH_3, HCl, HF): analysis 1-4.20; 2-4.74; 3-4.80; 4-2.60; 9-10.0; 19-21.10; 48-4.5; 49-4.7; 50-8.0; 51-17.0; 52-5.5; all others 0.0%.

DOLGOV, Yu.A. and SHUGUROVA, N.A., 1976b, Inclusions in the glass spherules and chips from the lunar soil (Luna 16), in Genetic studies in mineralogy, Yu. A. Dolgov et al., eds.: Novosibirsk, Inst. Geol. and Geophy. Sib. Branch Acad. Sci. USSR, p. 22-25 (in Russian).

In green glass particles of lunar soil (size ∿0.5 mm) globular and slightly deformed G inclusions were found. Results of the analysis of individual inclusions are given in Table 8.

Table 8. Results of quantitative analysis of composition of G in individual inclusions

				Concentration, vol. % (see also notes)			
No.	Sample	Dia. of G bubble after opening,	Increase (+) or decrease (-) of bubble on crushing	$H_2S, SO_2, HCl, HF, NH_3$	CO_2	H_2	N_2 + gases
1	1 sh.	0.126	-	15.9	0.0	74.4	9.7
2	do.	0.040	-	13.6	0.0	75.7	10.7
3	do.	0.042	1.59 (-)	23.0	28.2	28.4	20.4
4	do.	0.017	6.90 (-)	53.5	35.5	11.0	0.0
5	do.	0.017	-	53.0	35.0	12.0	0.0
6	do.	0.029	-	19.3	30.7	22.8	27.2
7	2 sh.	0.018	14.80 (-)	11.0	61.7	not analyzed	
8	do.	0.035	-	0.0	29.8	14.9	55.3
9	do.	0.016	-	52.2	32.2	15.6	0.0
10	3 sh.	0.014	16.6 (-)	0.0	4.5	95.5	0.0
11	5 sh.	0.084	-	0.0	0.0	0.0	80.1
12	1 s.	0.034	14.3 (-)	9.7	21.7	29.2	39.4
	do.	0.009	17.7 (-)	not analyzed			
	do.	0.013	54.5 (-)				
	do.	0.021	4.67(-)				
13	do.	0.005	7.22(-)	21.0	21.7	27.7	20.6
	do.	0.006	6.37(-)	not analyzed			
14	3 s.	0.156	2.64(+)	0.0	3.9	15.4	80.7
15	do.	0.090	2.5 (+)	0.0	3.0	17.7	79.3
16	do.	0.080	-	0.0	13.0	10.0	77.0
17	do.	0.004	17.7 (-)	8.0	20.2	30.5	41.3
18	do.	0.030	20.7 (-)	19.9	45.3	34.8	0.0

Notes - Analysis 11 had 19.9 % O_2; all others 0.0 %
All analyses showed 0.0 % CO, and 100.0% total.
No hydrocarbon analyses reported.

Conclusions:

1. G in inclusions consists of two, three and four components: CO_2+H_2*, $CO_2+H_2+(N_2$ + rare gases), "acid gases" + $H_2+(N_2$ + rare gases), "acid gases" + $CO_2+H_2+(N_2$ + rare gases).

2. H_2 is present in all analyses (except analysis 11, Table 8, A.K.)

3. N_2 + rare gases are present in all analyses (except analyses 4, 5,9,10, and 18, Table 8,, A.K.).

4. Reproducibility of analyses is shown by analyses 4 and 5, made on two bubbles released from the same inclusion, i.e., inclusion filling was divided into two parts.

5. Decrease of G volume on crushing is small, a good deal less than that of some tektites and ranges from 2.32 to 54.5 (sic., although in the table 2.32 is absent and the smallest value equals 1.59, A.K.).

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*in Russian text CO_2+H_2S seems to be a misprint, as appears from Table 8 (A.K.).

6. Two G bubbles had P >P atmospheric (2.5-2.65).

Most unexpected feature is relatively high density of G, strongly differing from density of the lunar atmosphere. If lunar glass spherules are the result of collision of meteorites with lunar surface, strong decrease of G content in melt should be expected. However, inclusions in the lunar spherules do not reveal this. One may suppose that in lunar soil there accumulated spherules and chips of glass of various origin: lunar impact without inclusions and non-lunar cosmic formed under conditions differing from lunar ones, and brought to Moon from space. Most of spherules found in the drilling core of the lunar soil do not bear inclusions. They might form by melting under lunar surficial conditions. Trapping of the lunar atmosphere as inclusions is not rather probable due to its low density. Inclusions of relatively high density may be of deep lunar origin or of extralunar origin, from a planet where density of atmosphere is higher than in the Moon.

Presence of H_2 may be accepted as typical of all lunar spherules. Similar features have been found in certain spherules extracted from the deep oceanic sediments and some spherules from peat in the area of Tungusskiy phenomenon, as well as in moldavites.

Lunar spherules bear inclusions relatively rich in N_2 + rare gases: it may be mainly N_2, mainly rare gases or in any ratio of those components, since such data are still an enigma. Some analyses yielded high contents of CO_2 and "acid gases".

The most difficult problem is the possibility of preservation of G in inclusions. Lunar material is special: rapid transport from Lunar to terrestrial conditions excludes diffusion during the transport. Another problem is that spherules might form under unknown conditions. However, the lunar atmosphere did not get into the inclusions (see analytical data). Inclusions that leaked easily are discerned by participation of air components. Lunar surface gets different material: cometary, meteoritic, protoplanetary and particles of lunar material. (Authors' text shortened and translated by A.K.)

DOLGOV, Yu.A. and SIMONOV, V.A., 1976, Studies of the possibility of diffusion of hydrogen through the walls of inclusions (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 167 (in Russian; translation by A. Kozlowski).

For evaluating the possibility of loss of H_2 from crystals experiments were made with inclusions having a low degree of filling ($F \approx 0.2-0.3$) that did not develop enough pressure to be destroyed (in the experiments).

Plates of "reticulate" quartz containing a single type of inclusion (all with the same F) were heated to 500, 600 and 700°C (T_H 350-450°C). Inclusions that did not decrepitate were heated again to check stability of T_H (i.e. the absence of leakage). Inclusions that had the same T_H were used for evaluation of the escape of H_2, by observations of F at T_H. In general, dissociation of water and loss of hydrogen at 1200-1400°C should lead to a decrease of F and, for G inclusions, to a decrease of T_H.

With increased overheating of nondecrepitated inclusions, T_H increases slightly, ie., escape of H_2 was not observed. These data also prove that the large role given to H_2 diffusion at T of melting of rocks by Volokhov (1975; see also <u>Fluid Inclusion Research - Proceedings</u>

of COFFI 1975, v. 8, p. 214-219, Translation Section). was suggested without real basis.

H_2 also does not escape during heating of inclusions in tektite glass, having relatively low-density filling. During long geological time (15 million years) diffusion of gases into vacuoles also does not appear. Inclusions in moldavites preserve their original low density G mixture, and have no air; the density is <0.001 atmospheric density. (Authors' abst.)

DOLGOV, Yu.A., and VISHNEVSKIY, S.A., 1976, High-pressure minerals and inclusions in impactites: in Genetic studies in mineralogy, Yu.A. Dolgov et al., eds.: Novosibirsk, Inst. Geol. and Geophy. Sib. Branch Acad. Sci. USSR, p. 12-16 (in Russian).

Diaplectic quartz glass bears very characteristic inclusions. Melting of this glass was in mixture of the terrestrial atmosphere plus unknown gases brought by the space object causing the impact. Those mixed atmospheres found by studies of inclusion gases are listed in the table.

Table 4. Mixed atmospheres of the Earth and comet in inclusions in glasses

		Composition of gases, vol.%					
No.	Specimen	O_2	H_2S, SO_2, HCl, HF, NH_3	CO_2	CO	H_2	N_2 + rare gases
1.	Moldavite	0.0	4.2	53.0	0.0	40.0	2.6
2.	Not calcined spherules of the Tungusskiy phenomenon	0.0	5.5	57.8	10.3	8.6	17.9
3.	Libyan glass	0.0	0.0	47.0	0.0	28.0	25.0
4.	Lunar soil	0.0	19.3	30.7	0.0	22.8	27.2
5.	Artificial glass melted under air	11.3*	0.0	44.3	0.0	0.0	44.4*

*air

Products of impact bear inclusions usually high content of H_2, lower but commonly sulfur-bearing G and CO_2. Oxygen is absent since it probably was used at high T for oxidation of the melted terrestrial substance. Impact rocks called zyuvites bear inclusions also filled with such mixed atmospheres (Table 5).

Table 5. Composition in vol. % of coexisting G inclusions in the chip of non-homogeneous glass of mixed composition from zyuvites *

No.	H_2S, SO_2, SO_3, HCl, HF, NH_3	CO_2	Hydrocarbons	O_2	CO	H_2	N_2 + rare gases
1.	0	0	0	0	0	30.4	69.6
2.	0	0	0	0	0	23.3	76.7
3.	0	0	13.7	0	0	19.7	66.4
4.	0	5.8	31.7	0	0	17.4	45.1
5.	0	23.5	16.7	0	0	18.2	41.6
6.	0	43.5	14.7	0	0	27.4	14.4
7.	19.8	15.5	22.6	0	0	28.3	13.8

*No O_2 or CO found in any.

Strong variations of P-T conditions during impact event cause great changes of all features of fluid inclusions, including shape, T_H (150-400°C), phase composition of filling, type of homogenization etc. Inclusions of "dry" gases were found in lechatelierite. Diaplectic quartz glass bears numerous minute crystals of various minerals, like parent quartz. In lechatelierite such solid inclusions were not found;

it contains solidified glass inclusions; diaplectic quartz glass contains similar inclusions. Melt inclusions are of two types of shape: globular and tubular. Glass in such inclusions has refractive indices higher than indices both of lechatelierite and diaplectic glass; 18 measurements ranged from 1.488 to 1.522. Tubular inclusions are one-phase or bear one or several G bubbles. In lechatelierite often there occur globules of one- to polyphase types (glass, glass + G, glass + G + aggregate of acicular of prismatic crystals). Size varies from tens to hundreds of µm. Inclusions present in quartz before impact event also altered during the event: they got spherical and rounded morphology, and decrepitated inclusions appeared. (Abst. by A.K.)

Table 6. Characteristics of association of inclusions in grain of diapletic quartz glass (n=1.462±0.002) from massive impactites, sample 517

Type of inclusions	Phase ratios	T_H, °C	Type of homogenization
1. Gaseous	--	--	--
2. Gaseous-liquid	from essentially G to essentially L	240-400, (41 inclusions	in G, in L critical
3. Gaseous-liquid with solid phase	G:L=1:1.5; vol. of solid very small	T of dissolving of solid 260, T_H 370	in L
4. Liquid	--	--	--
5. Incs. of melted glasses of different composition with or without G bubble	exclusively or essentially glass	T of melting of glass >800°C	not studied

DOLOMANOVA, Ye.I., BERZINA, I.G., and BERMAN, I.B., 1976, Distribution of lithium in certain minerals of tin ore deposits in Siberia on the basis of (n,α) radiography: Transactions of the Fersman's Mineralogical Museum of the Acad. Sci. of the USSR-New data on minerals of the USSR, v. 25, p. 147-152 (in Russian).

By (n,α) radiography Li was found in vacuoles of G/L inclusions in quartz (Fig. 1a), as well as Fe, Na, K, Cl, Ca, Al, and S by electron microprobe analysis (Fig. 6). (Abst. by A.K.)

DOLOMANOVA, Ye. I., BOIARSKAIA, R.V., BORISOVSKII, S. Ye., and LUPANOV, L.M., 1976, Chemical composition of precipitates in the vacuoles of minerals of tin ore deposits, as indicated by electron microscopy and electron microprobe analysis (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 76-77 (in Russian; translation by A. Kozlowski).

1. Quartz, cassiterite, topaz, beryl, tourmaline, and wolframite were studied. The following presumed daughter minerals were recognized: chlorides of Na, K, Ca, Mg, Fe, Al, Cr; in quartz seemingly cassiterite, zincite, corundum, ilmenite, chromite, and cobaltite were apparent; inclusions in cassiterite bear corundum, gahnite, rutile, ilmenite, hematite, scheelite, sphalerite, tantaloniobates of Fe, Mn, Ti, W, and Sc, Na sulfate, and alumosilicates of K, Ca, Fe; in beryl - sulfates of Ca, Ba, Mn, Fe, Cr; in topaz--ilmenite, barite, and topaz? (Al + Si + Cl + F); in tourmaline --sulfides of Ag, Cd, Pb, Bi, cassiterite, corundum, ilmenite, and sulfates of Na, Ca, Cu.

2. By scanning microscopy the composition of the daughter minerals

were found: in vacuoles in quartz--cryolite, chlorargyrite, sylvite, chlorides of Ca, Fe, Mn, sulfides (or sulfates) of Zn, Fe; in vacuoles of cassiterite - chlorides of K, Na; in vacuoles of ferberite - scheelite, cassiterite; in vacuoles of topaz - chlorides of K, Mn, Fe.

3. By the (X-ray) microdiffraction method, muscovite, jacobsite, sulfohalite, sylvite and tourmaline(?) were found in inclusions.

4. Precipitates from the drying of solution, forming dendrites around opened vacuoles in topaz, quartz and sphalerite consist of Na and K chlorides. (Author's abst.)

DOLOMANOVA, Ye.I., LOSEVA, T.I., and TSEPIN, A.I., 1976, Chemical composition of precipitates in gas-liquid inclusions by data of X-ray microspectral analysis, in Thermobarogeochemistry of mineral formation, N.P. Ermakov, ed.; Rostov, Rostov Univ. Press, p. 110-117 (in Russian).

Full paper corresponding to abstract in Fluid Inclusion Research volume 6, p. 39-40, 1973.

(Title changed here from that used earlier.)

DOLOMANOVA, Ye.I. and NOSIK, L.P., 1977, On the possibility of determination of chemical composition of inclusions of hydrothermal solution in vacuoles of minerals by mass-spectrometry: Akad. Nauk. SSSR Doklady, v. 234 no. 5, p. 1186-1188 (in Russian). Authors at the Inst. Geol. Ore Deposits, Petrogr. Mineral. and Geochemistry of the Acad. Sci. USSR, Moscow.

The method described permits quantitative determination of CO_2, SO_2, and H_2O, and isotopic composition of C, S and O_2 in hydrothermal fillings of fluid inclusions. Precision of determinations of isotopic composition is $\pm$ 0.05%, and of determinations of gas amount $\pm$ 0.1%. Samples (0.3-7.5g) of vein quartz, cassiterite, topaz, amazonite, fluorite, calcite, arsenopyrite and sphalerite from tin deposits (Malaya Kulinda, Etyka, Ushmunskoe, Budyumkanskoe, Badzhiraevskoe, Zun-Undur, Sokhondo, Sherlovaya Mt.-Transbaikalia and Pridorozhnoe--in Khabarovsk region). Gases were released from minerals, over a 6-hour period, by decrepitation at 250, 400, 500 and 600°C. CO_2 occurs in all minerals over the whole T range. No regular variation of CO_2 content was found in mineral sequences, only preference for some types of minerals, e.g., a high content in inclusions in sulfides and fluorite, lower in cassiterite and very low in calcite. At another deposit amazonite bears less CO_2 than topaz, cassiterite and quartz. $\delta^{13}C$ in cassiterite varies from +1.93 to +4.07% and from -0.21 to -3.30%, and in syngenetic quartz from +0.13 to +12.15% and from -0.29 to -3.30%, respectively, depending on wall-rock-water interaction; probably values from -0.21 to -3.30% characterize the initial hydrothermal fluid. $\delta^{18}O$ in CO_2 from cassiterite varies from +0.15 to +0.91% and from -0.20 to -2.40%, and from syngenetic quartz from +0.02 to +0.83% and from -0.26 to -1.60%, respectively; the data verify an endogene source of the solutions. SO_2 was released from quartz and cassiterite mainly at 400 and 600°C. All sulfides have in their inclusions a CO_2-rich fluid with high concentration of SO_2. $\delta^{34}S$ from quartz from deposit Malaya Kulinda is similar to $\delta^{34}S$ from meteorites; quartz from Etyka deposit yields $\delta^{34}S = 2.49\%$ cassiterite from Prirodnoe - +1.06%. Possible interpretations of the data are discussed. (Abst. by A.K.)

DOLOMANOVA, E.I., NOSIK, L.P., VLASOVA, E.V., BOGOYAVLENSKAYA, I.V., and BOYARSKAYA, R.V., 1977, The form of entry of carbon in minerals of tin-bearing deposits of Transbaikal and the concentration of CO_2 in gas-liquid inclusions: Izv. Vyssh. Uchebn. Zaved., Geol. Razved., 1977, no. 10, p. 65-73 (in Russian).

DONALDSON, C.H. and BROWN, R.W., 1977, Refractory megacrysts and magnesium-rich melt inclusions within spinel in oceanic tholeiites: indicators of magma mixing and parental magma composition: Earth and Planetary Science Letters, v. 37, p. 81-89. First author at Dept. of Geology, Univ. of Manchester, Manchester M13 9Pl (Great Britain).

Refractory megacrysts of olivine, plagioclase, chromian diopside and Cr-Al spinel, which were not in equilibrium with the host oceanic tholeiite on eruption, are present in samples from several dredge sites and DSDP drill sites in the Atlantic and Pacific Oceans. They have multiple origins: (1) cognate or accidental mantle fragments; (2) relict fragments from fractional crystallization of parental liquids considerably more primitive than oceanic tholeiite; and most commonly (3) the fractional crystallization products of such liquids mixed with oceanic tholeiite magma. Melt inclusions in chrome-spinel phenocrysts provide evidence for this postulated Mg- and Ca-rich magma which has counterparts in the Scottish Tertiary Province and in west Greenland. (Authors' abstract)

DONALDSON, C.H. and REID, A.M., 1977, Emplacement and crystallization of a kimberlite dyke from the DeBeers mine, Kimberly, South Africa: in Second International Kimberlite Conference 1977, Extended Abstracts (unpaginated) (extra, late abstract, not in bound volume).

Carbonate-rich amygdales are ascribed to melt segregation, liquid immiscibility, or infilling of gas cavities (ER).

DORFMAN, M.D. and PETERSIL'YE, I.A., 1976, Gases from quartz veins of Central Kazakhstan as indicator of tungsten possibilities (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 146 (in Russian; translation by A. Kozlowski).

Hydrothermal quartz from different deposits was studied, especially its gas release. Beginning of peaks for pitchblende I - chlorite association 210-240°C, molybdenite II - pitchblende II hydromica 150-200°C, coffinite III - pitchblende III - jordisite 90-160°C. (Authors' abst.) (Title ≠ text;sic.)

DOROGOVIN, B.A. and SHATAGIN, N.N., 1977, Behavior of inclusions of mineral-forming media at temperatures and pressures [typical for] contact and regional metamorphism (experimental data): Akad. Nauk SSSR Doklady, v. 236 no. 5, p. 1192-1195 (in Russian). First author at the All-Union Sci.-Research Inst. of Synthesis of Mineral Raw Materials, Aleksandrov.

25 experiments at 500-800°C and 0.4-0.8 kb with fluid inclusions in synthetic quartz grown at 338°C and 400 atm from HCO_3 solution (T_H of inclusions 311-313°C in L, T_D 360-390°C) proved that under conditions of the experiment, the inclusions partly leak and form aureoles of daughter inclusions. Original inclusions had F = 75%, whereas after experiment T_H and F were as follows (Table 1):

Type of inclusion	Shape and size of inclusion	No. of inclusions	F, %	T_H, °C	Type of homogenization
Original	tubular, 0.1 x 0.05 mm	1	15 mean 10	356	in G
		3	10	358	in G
		1	5	360	in G
Daughter	oval, platy, acicular, 0.03 x 0.01 mm	2	45 mean 77	382	in L
		3	60	391	in L
		3	80	373	in G (sic.)
		4	90	335	in G
		4	90	375-380	in G

The above conditions may be comparable with contact metamorphism. Experiments related to P-T conditions of regional metamorphism were performed at 600-900°C and P total 5 and 10 kb whereas P of fluid either 0.1-0.2 of P total or P_{fl} - P total. Materials run were the above synthetic quartz a) with inclusions, b) without inclusions and c) natural quartz from Aldan quartzite bearing one-phase LCO_2, G and G/L inclusions; 6 runs for each kind of quartz. All G and G/L inclusions, both in natural and synthetic quartz did not leak, but LCO_2 inclusions (specific volume 1.05-1.25 cm^3/g) decrepitated in all runs. Thus, under conditions of amphibolite and granulite facies CO_2 should release from inclusions, but not water solutions. In inclusion-free quartz, inclusions with F = 0.2-0.3 formed at P_{fl} = 0.1-0.2 P total, and with F = 0.7-0.9 under P_{fl} = P total; when P_{fl} = const, F depends on T. (Abst. by A.K.)

DORONIN, A.Ya., 1977, On the connection between the crystallization temperature of sphalerite and the cadmium content in polymetallic ores: Geologiya i Geofizika, v. 18, p. 150-152 (in Russian; trans. in Soviet Geol. & Geophysics, v. 18, 1977, p. 123-135).

This paper describes the relationship between the homogenization (and some decrepitation) temperatures of inclusions in sphalerite and the logarithms of the contents of Cd not isomorphously present in the sphalerite of polymetallic ores. This correlation can be used as a geothermometer in ascertaining the average temperatures of formation of the ores in the polymetallic deposits of the Rudnyi Altai region. (Author's abstract)

DOROSHENKO, Yu.P. and PAVLUN', N.N., 1977, Thermobarogeochemical prospecting-evaluating criteria of tungsten ores (exemplified by Akchatau deposit) (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. I, p. 125-126 (in Russian; translation by A. Kozlowski). Authors at L'vov Univ.

Quartz-greisen W deposit Akchatau in Central Karakhstan formed during several stages: pneumatolytic-hydrothermal-molybdenite-quartz (T_H 440-520°C, P 1400-1000 atm), complex rare-metal and pyrite-wolframite-quartz (T_H 480-260°C, P 950-600 atm) and hydrothermal-sulfide-quartz (T_H 310-170°C, P 500-200 atm), fluorite-quartz (T_H 180-90°C) and zeolite-calcite (T_H 130-60°C). High-T hydrothermal solutions were strongly concentrated: up to 65 wt% of NaCl + KCl, being parent solutions of wolframite (435-350°C) and molybdenite (generation I 425-390°C, generation II 445-400°C); inclusions bear 1 to 12 dms (halite, sylvite etc.). CO_2 is the main gas, plus subordinate N_2 and CH_4. The above peculiarities may be used as prospecting criteria. (Abst. by A.K.)

DOROSHENKO, Yu.P., PIZNYUR, A.V. and TORCHINIUK, R.N., 1976, Conditions of formation of the Mo-W deposits of Kazakhstan (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 65 (in Russian; translation by A. Kozlowski).

Studied deposits are of the greisen type and they are connected with acid leucocratic granites of the Akchatau complex of the Lower Permian age. The following associations occur: molybdenite-quartz, and subsequently wolframite-pyrite-quartz, molybdenite-native bismuth-beryl-wolframite-quartz, polymetals-quartz, fluorite-quartz and carbonate-quartz, being in the early stage of pneumatolytic-hydrothermal, and in the late one - strictly of hydrothermal origin.

During the early stage (460-340°C, 1800-900 atm), after the pneumatolytic event, hydrotherms were of concentration over 26.5 % NaCl, with lesser F, K and Li. This stage gave main part of commercial mineralization. Strict hydrotherms (320-60°C, 800-100 atm) were enriched in CO_2, separating during boiling, especially during origin of the polymetal association. (Authors' abst.).

DOWNS, W.F., RIMSTIDT, J.D. and BARNES, H.L., 1977, Hydrothermal experiments on Salton Sea geothermal brines (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 955. Authors at Department of Geosciences, The Pennsylvania State University, University Park, Pennsylvania 16802.

A simple controlled-environment system has been developed for field evaluation of the mineralogies and kinetics of scale deposition from geothermal brines. The system consists of a replaceable helical coil of copper tubing suspended in a constant-temperature environment within a pressure vessel. The temperature of the bath is controlled by mixing a portion of the geothermal brine with irrigation water. Another portion of the geothermal brine flows through the coil where it is thermally quenched. Pressures within the coil and the surrounding bath are controlled by restricting fluid flow downstream.

Geothermal fluid from Magmamax No. 1 well (U.S. Bureau of Mines Test Facility, Imperial Valley, Calif.) entered at 320±10 psig, 225±5°C and was quenched in a series of 4-hour experiments to temperatures at 25° intervals between 75° and 225°C. Brine compositions, in ppm, were 114,000 Cl^-, 5,300 HCO_3^-, 48 H_2S, 245 SiO_2, 49 Pb, 255 Zn, and 17 Cu. Maximum rates of precipitation occurred at quench temperatures between 125°C and 175°C, and little formed at lower temperatures, due to the short residence time (0.93 sec.) in the coil compared to reaction rates. Not surprisingly, the hydrothermal reactions are kinetically rapid and formed ore-grade scale. The mineralogy varied with quench temperature,being more complex at 200-225°C. Dominant are sulfides: galena plus minor copper-iron sulfides and copper sulfosalts, within a matrix of calcite and aragonite. Calculated solubilities for these solutions show (1) galena to become saturated due to cooling as observed, and (2) sphalerite to be grossly supersaturated with respect to chloride complexing although this phase was not found. No cause has been found for precipitation of the carbonates. (Authors' abstract)

DUFFIELD, W.A., GIBSON, E.K., Jr. and HEIKEN, G.H., 1977, Some characteristics of Pele's hair; Jour. Research U.S. Geol. Survey, v. 5, no. 1, p. 93-101. First author at USGS, Menlo Park, CA.

Pele's hair is a filamentous variety of brown sideromelane glass that forms during eruption of basaltic lava. Strands of Pele's hair form from droplets of lava that are spun or stretched into filaments during quenching, and others may form as chilled streamers of lava. Common elongate vesicles, sometimes twisted, indicate extreme stretching and twisting during hair formation. Hair diameter ranges from about 1 to 300 micrometers. Refractive index of hairs decreases with hair diameter and is most probably a function of the process of formation rather than chemical composition. Masses of Pele's hair form natural spun-glass filters that trap small particles and serve as sites for sublimate deposition. Such deposition may begin even while hair is falling to the ground through an eruption fume cloud. Sublimates include carbonates, sulfates, sulfur, and less commonly hydrocarbons, thus complicating the interpretation of volatiles in Pele's hair in terms of original magmatic constituents. Vesicles, which provide the most nearly pure samples of magmatic volatiles, contain mostly H_2O and CO_2. (Authors' abstract)

DUFFY, C.J., and GREENWOOD, H.J., 1977, Phase equilibria in the system $MgO-MgF_2-SiO_2-H_2O$ (abst.): Geol. Assoc. Canada-Min. Assoc. Canada Program with Abstracts, v. 2, p. 16.

DUNGAN, M.A., 1977, Evidence for magma mixing at mid-ocean ridges, part II: the compositions of residual glasses and glass melt inclusions in basalts from legs 45 and 46 (DSDP) (abst.): Papers presented 20-23 Sept., 1977, Basaltic Volcanism Study Project, Lunar Sci. Inst., Houston. Author at Lunar Science Institute, Houston, TX 77058.

Reconstructed glass compositions of low Ti and Na melt inclusions in olivines correspond very closely to compositions of primitive ocean floor tholeiites inferred to be mantle-derived melts. Taken together with the highly forsteritic olivine phenocrysts also present in these rocks, these melt inclusions establish the participation of unfractionated magma in the mixing event responsible for the phyric basalts. (from the author's abstract). (Melt inclusions are also compared with residual glasses. E.R.)

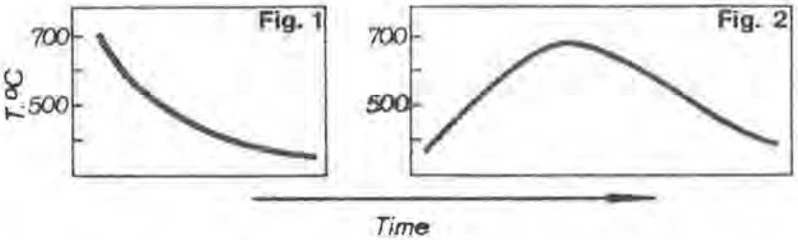
DURNEY, D.W., and RAMSEY, J.G., 1973, Incremental strains measured by syntectonic crystal growths, pp. 67-96 in Gravity and Tectonics, ed. by K.A. DeJong and R. Scholten: New York, J. Wiley & Sons, 502 pp.

Pertinent to the study of fluid inclusion origins in metamorphic quartz veins. (E.R.)

DYMKIN, A.M., 1977, Two types of sequence of stages of metasomatism in iron ore deposits (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. I, p. 77-78 (in Russian; translation by A. Kozlowski). Author at Inst. Geol. Geoph. of Siberian Branch of Acad. Sci. USSR, Novosibirsk.

In the contact aureoles formation of minerals occurs as result of retrograde metasomatism (Fig. 1): hornfels T_H >700°C, skarn T_H 700-550°C, magnetite ores T_D 580-380°C, aposkarn and post-ore metasomatites T_H <500°C. When deposits are formed under action of infiltrating solutions out from the contact, metasomatism develops two stages--

progressive and retrograde ores (Fig. 2). At T_H ∿400°C scapolitization appears, at 550-700; skarns, at 580-380-ores; at T <500-aposkarn and post-ore associations. (Abst. by A.K.)



DZHUMAILO, V.I., VASILENKO, V.N., and RYLOV, V.G., 1976, Conditions of formation of the noble metal mineralization in the Cu-sulfide ores (occurring) between Laba and Teberda Rivers, in Thermobarogeochemistry of mineral formation, N.P. Ermakov, ed.: Rostov, Rostov Univ. Press, p. 86-90 (in Russian).

Full paper corresponding to abstract in Fluid Inclusion Research volume 6, p. 41, 1973.

(Title changed here from that used earlier.)

EADINGTON, P.J., 1977a, A study of fluid inclusions and their significance in minerals from hydrothermal ore deposits, New England, New South Wales: Ph.D. dissertation, Univ. of Newcastle, Australia, 235 pp.

The techniques of fluid inclusion research have been applied to the study of late-magmatic rocks and hydrothermal ore deposits of the New England Fold Belt in northern New South Wales. This was done to determine the roles of temperature and salinity of the hydrothermal fluids in the formation of the ore deposits and the relationships of the hydrothermal fluids to magmatic activity.

Fluid inclusion studies revealed a close relationship between the salinity of the hydrothermal fluid and the type of ore deposit, while temperature has a less direct correlation with mineral associations. There is a variable connection with magmatic activity.

The highest formation temperatures were recorded for the pegmatitic Bismuth deposit where topaz, fluorite and beryl were deposited in the range 450°C to 55°C. The hydrothermal fluid, a Na, K, Ca, Fe, F, Cl brine with a salt content of 60 wt. %, was derived directly from a crystallizing magma.

(Inclusions in topaz, quartz, beryl and fluorite from this deposit all have same dm assemblage. The following was identified in the fluorite: amarantite ($Fe(SO_4)(OH)_6 \cdot 3H_2O$), halite, sylvite, fluorides, chlorocalcite ($KCaCl_3$), $FeCl_2 \cdot 2H_2O$, wolframite, and a magnetic opaque mineral (from p. 227). Dawsonite and liquid CO_2 were found in other samples. ER)

The cassiterite veins were deposited in the range 280°C to 450°C from brines with a salt content of 30-40 wt. %, and the base-metal sulphide veins were deposited in the range 250°C to 350°C from brines with a salt content of 5-10 wt. %. The cassiterite and the base-metal sulphide brines were progressively more dilute than the magmatic brine.

Vein deposits containing adularia were deposited from bicarbonate rather than chloride brines, with a salt content of 2-4 wt. %. These brines may have been connate waters.

The cassiterite and pegmatitic brines, having a density of 1.1 to

1.2 g/cm^3, would have tended to lie beneath, and separate from, dilute ground waters. The low-salinity base-metal sulphide brines have a density of 0.7-0.9 g/cm^3 and would have been susceptible to entrainment in a system of convecting groundwaters.

Monotonically falling time-temperature plots for the pegmatitic deposits indicate formation immediately following crystallization of their igneous host rocks with the hydrothermal brines having their temperature controlled by the surrounding rocks. Time-temperature plots which display a maximum indicate formation of the vein deposits after crystallization and cooling of the host rocks. In this case the brines heated the surrounding rocks.

The fluid inclusion temperatures fall within the limits defined by other indicators of temperature, such as sulphide invariant points and the melting of native bismuth.

A temperature of 600°C to 650°C has been determined for the crystallization, from a water-saturated, high-fluorine melt, of the igneous quartz-topaz rock (silexite) near Torrington. The associated tungsten deposits are shown to occur in recrystallized and silicified silexite with the wolframite derived by redistribution and concentration of wolframite which was originally widely disseminated in the fresh rock. (Author's abstract)

EADINGTON, P.J., 1977b, Evolution of hydrothermal brines associated with the Mole Granite, Glen Innes, N.S.W. (abst.): Abstracts of Second Australian Geological Convention, Monash Univ., 2-4 Feb., 1977, p. 38. Author at CSIRO Division of Mineralogy.
(National Library of Australia card number and ISBN- 0 86910 072 6).

The Mole Granite is mineralized with magmatic-pegmatitic deposits of tungsten and bismuth and hydrothermal deposits of cassiterite and basemetal sulphides.

The hydrothermal brines which effected mineralization evolved from a chloride type with a high salt content (50-60 wt. %), through chloride brines with moderate salt content, to a carbonate type with low salt content (3 wt. %).

The high-salinity chloride brine is found in fluid inclusions in magmatic and pegmatitic minerals. It has a high density (1.1-1.2 g/cm^3) and the observation that the salinity remained constant through a wide range of temperature suggests that the brine remained separate from low-salinity groundwaters.

The low-salinity brines are found in inclusions in hydrothermal deposits. These brines (density 0.7-0.8 g/cm^3), not having the density contrast to resist mixing, could be expected to be entrained in a system of convecting groundwater. The carbonate brines are associated with the minerals quartz and adularia, and temperatures (250-300°C) are similar to those in modern geothermal systems such as Wairakei, N.Z. It is envisaged that such a geothermal system was the last stage of hydrothermal activity. (Author's abstract)

EBY, G.N., 1977, Petrogenesis of Mount Johnson, an alkaline Monteregian intrusive (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 962-963. Author at Department of Earth Sciences, University of Lowell, Lowell, Massachusetts 01854.

Trace element and major element data support the hypothesis that the rocks of the transition zone and the pulaskite represent a pair of immiscible liquids. (From the author's abstract)

EGGLER, D.H., 1977a The principle of the zone of invariant vapor composition (ZIVC), with an example in the system $CaO-MgO-SiO_2-CO_2-H_2O$ (abst.): Amer, Geophys. Union, Trans., EOS, v. 58, no. 6, p. 521.

A ZIVC is defined as the region in P-T-X space in which a volatile-bearing mineral coexists with a multicomponent vapor and with its breakdown products in a reaction relation that buffers the vapor composition. (From the author's abstract).

EGGLER, David H., 1977b The principle of the zone of invariant vapor composition: an example in the system $CaO-MgO-SiO_2-CO_2-H_2O$ and implications for the mantle solidus: Carnegie Inst. Wash. Yearbook 76 for 1976-1977, p. 428-435.

EGGLER, D.H. and HOLLOWAY, J.R., 1977, Partial melting of peridotite in the presence of H_2O and CO_2: Principles and review, <u>in</u> "Magma Genesis; Proceedings of the American Geophysical Union, Chapman Conference on Partial Melting in the Earth's Upper Mantle", Oreg. Dept. Geol. Miner. Ind. Bull. 96, p. 15-36.

The principal volatile species in the upper mantle, H_2O and CO_2, have been observed, in experimental studies, to have large opposing effects upon composition of partial melts of peridotite. Hydrous liquids are more silica-saturated than liquids produced in the absence of volatiles, whereas CO_2-saturated liquids are less silica-saturated. These studies have been conducted using relatively large amounts of volatiles. Volatiles are thought to be present in the mantle, however, in small amounts (<0.5 wt. %). For such small volatile contents, subsolidus peridotite mineral assemblages containing hydrous or carbonate minerals exist in zones of invariant vapor composition (ZIVC). Because vapor is, isobarically and isothermally, invariant in composition, isobaric melting of peridotite occurs at the same temperature, forming the same liquid composition, regardless of the ratio of CO_2 to H_2O in the peridotite source region.

Isobaric T-X_{CO_2} sections at 15 and 30 kbar for a total $H_2O + CO_2$ content of $0.\overline{1}$ $\overline{\text{wt}}$. %, constructed using principles derived from simple systems, are presented as examples of ZIVC-type melting. Amphibole perioditite (+ vapor) at 15 kbar melts at about 1100°C to a nephelinitic liquid. Andesitic liquid can be produced only if CO_2 is absent. Dolomite-phlogopite peridotite (with or without vapor) at 30 kbar melts at about 1025°C to a melilititic liquid. The presence of CO_2 is critical to the development of such primary alkaline magmas. The amount of liquid produced of either nephelinitic or melilititic composition would be small (<5%), and would be produced within about 50°C of the solidus temperature. For higher degrees of melting, the amounts of volatiles present would be insufficient to saturate the melt, and hence the effects of those volatiles would diminish, until, at temperatures 300°-500°C above the solidus, nearly volatile-free theoleiitic melts would be produced. Authors' abstract.

EGGLER, D.H., MYSEN, B.O., and HOLLOWAY, J.R., 1977, The solubility of CO in silicate melts at high pressures (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 964. First author at Geophysical Laboratory, Carnegie Institution of Washington, Washington, D.C. 20008.

The solubilities of $CO-CO_2$ fluids, in equilibrium with graphite, in silicate melts from 16-30 kb and 1450°-1700°C have been determined. Charges consisted of silicates (albite, diopside, and larnite$_{72.5}$ forsterite$_{27.5}$), graphite containing ^{14}C, and palladium oxide as an oxygen source; molar C:O contents were ∿1:1. The quenched, optically transparent, glasses were analyzed for total C by autoradiography. At the conditions investigated, the CO content of the fluid ranges from 30 to 50 mol %, as calculated with Modified Redlich-Kwong thermodynamic functions. The solubilities of these $CO-CO_2$ fluids (total C as CO_2) were found to be greater than the solubilities of pure CO_2 at each P and T; solubilities at 20 kb, 1700°C, were (total C as CO_2): albite, 2.5 wt %; diopside, 6.6%, larnite$_{72.5}$forsterite$_{27.5}$, 26%. The increased solubility of $CO-CO_2$ fluid, relative to CO_2 fluid, is consistent with the interpretations that CO is more soluble in the melt than CO_2 and that the $CO/(CO+CO_2)$ content of the melt would be greater than the $CO/(CO+CO_2)$ content of the coexisting fluid. These interpretations are reinforced by experiments showing that the liquidus temperature of the composition $Di_{60}Fo_{40}$ at 17.5 kb is more depressed by a $CO-CO_2$ fluid than by CO_2 fluid. The remarkably high $CO-CO_2$ solubility in the larnite-forsterite liquid is suggestive that CO reacts preferentially with nonbridging oxygens. Because IR spectra of the glasses show only the CO_3^{2-} absorption band, it is proposed that the solution reaction may be: $CO + 2\ (O^-) = (CO_3)^{2-}$. (Authors' abstract)

EGGLER, D.H., MYSEN, B.O., HOLLOWAY, J.R., and HOERING, T.C., 1977, Fluids in the system C-O in equilibrium with graphite at high pressures: fluid species, solubilities in silicate melts, and effects on silicate phase relations: Carnegie Inst. Wash. Yearbook 76 for 1976-1977, p. 448-454.

EINAUDI, Marco T., 1977, Environment of ore deposition at Cerro de Pasco, Peru: Economic Geology, v. 72, p. 893-924.

The massive sulfide replacement body in carbonate wall rocks east of the Cerro de Pasco volcanic neck contains an early association of pyrrhotite and FeS-rich sphalerite altered by late fluids to pyrite-marcasite and FeS-poor sphalerite. Rapid sulfide deposition from an ore fluid that fluctuated widely in sulfidation-oxidation state is suggested by: (1) intricate reversals and broad range in X^{sl}_{FeS}; (2) lack of detailed correlation on a local scale between X^{sl}_{FeS} and iron-sulfide association; (3) evidence from sulfur isotope data for disequilibrium sulfide associations; and (4) superposition and telescoping of mineral stages. (From the author's abstract)

ELDERS, W.A., 1977, Rock-water interaction and temperature distribution in the Salton Sea geothermal field, Imperial Valley, California, USA (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 965.

ELLIS, A.J., 1977, Chemical and isotopic techniques in geothermal investigations: Geothermics, v. 5, p. 3-12. Author at Chem. Div., D.S.I.R., Petone, New Zealand.

A review is given of current thinking on the origin of chemical constituents in geothermal fluids, focussing attention on the more "soluble" elements such as Cl, Br, I, Li, Cs, As and B, and the dissolved gases. Mineral and solution equilibria are evaluated in order to derive underground temperatures, water pH and P_{CO_2} from the analysis of steam and water flows, natural or from geothermal wells. Isotopic exchange equilibria involving H, C, O, or S, provide additional geothermometers which may often be applied when chemical methods are complicated by steam separation or mixing processes.

The isotopic make-up of water (H, D, T, ^{16}O, ^{18}O) serves to identify water sources, water ages, and mixing processes in geothermal systems, and to delineate trends with time during the operation of a geothermal field. Chemical and isotope analyses also indicate the occurrence of changes in underground temperature, degree of rock/water interaction, and the tendency for mineral deposition. (Author's abstract)

ELLIS, A.J. and MAHON, W.A.J., 1977, Chemistry and Geothermal Systems: New York, Academic Press, 392 pp.

ELLIS, D.E. and WYLLIE, P.J., 1977, A model of phase relations in the system $MgO-SiO_2-H_2O-CO_2$ and prediction of the compositions of liquids coexisting with forsterite and enstatite (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 966.

EL SHATOURY, H.M., TAKENOUCHI, S., and IMAI, H., 1977, Nature and temperature of ore-forming fluids at Toyoha mine in the light of fluid inclusions in mineralized veins and quartz porphyry, in Problems of Ore Deposition, Fourth IAGOD Symposium, Varna, 1974, vol. 2: Sofia, Pub. House Bulgarian Acad. Sciences, p. 196-202.

See same authors, 1975a, Fluid Inclusion Research--Proceedings of COFFI, v. 8, p. 56 (1975).

ENJOJI, M., 1977, Fluid inclusions in minerals from Japanese contact metasomatic deposits, in Volume for Prof. T. Miyazawa, published by his students (5000 yen), pp. B49-B64 (in Japanese).

Summarizes the literature data on T_D and T_H from many deposits (9 T_H values >500°C), and numerous photomicrographs of inclusions from the Kamaisi, Yaguki, Tsumo, Kamioka, and Chichibu mines in Japan. (E.R.)

EPPLER, W.F., 1976a Inclusions in emerald from Burbar, Colombia: Goldschmiedeztg., v. 74, p. 64 (in German).

Emeralds of Burbar contain unidentified transparent rhombic inclusions with n > emerald that are unknown in emeralds from other deposits. Contrary to other Colombian emeralds there are no 3-phase, but 2-phase-inclusions.
(Abstract from Zent. f. Min., 1977, pt. 1, Jahr. 76/2, p. 277; trans. by H.A. Stalder.)

EPPLER, W.F., 1976b Negative crystals in ruby from Burma: The Jour. of Gemmology, v. 15, no. 1, p. 1-5.

Negative crystal cavities, up to 1.4 mm in length, were found which gave a strong(?) odor of H_2S when crushed (i.e., H_2S "must be present in a predominant amount" (p. 5)). (ER)

ERMAKOV, N.P., 1976a The twenty-fifth anniversary of thermobarogeochemistry and plans of its development in the last quarter of the XX century, 16 pp., Moscow (in Russian).

Brochure was edited by Sci. Council on Ore Formation of the Acad. Sci. of the USSR and Soviet Section of the COFFI as materials for the 5th All-Union Meeting on Thermobarogeochemistry of the Earth's Crust and Ore Formation, in Ufa (September 20-23, 1976). The author describes history of studies of G/L inclusions in Soviet Union in following periods: a) before 1950; b) forming of thermobarogeochemistry in 1950's; c) development of thermobarogeochemistry and all-union meetings in 1960's. The ways of further development and practical application of thermobarogeochemistry and certain imperfections of methods are outlined, as well as plans of organization and methodic improvement of future studies. (Abst. by A.K.)

ERMAKOV, N.P., 1976b, Homogenization and decrepitation temperatures of inclusions in knowledge of dynamics of processes of deep mineral formation, in Thermobarogeochemistry of mineral formation, N.P. Ermakov, ed.: Rostov, Rostov. Univ. Press, p. 5-13 (in Russian).

Full paper corresponding to abstract in Fluid Inclusion Research volume 6, p. 43-44, 1973.

ERMAKOV, N.P., 1976c Granite pegmatites and silexites in the light of thermobarogeochemical data (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 114 (in Russian; translation by A. Kozlowski).

1. Pegmatites and silexites are divided into remnant, sometimes chamber-bearing bodies in situ in granite massifs and in veins, the products of migration of rock-forming melts along fractures in rocks.

2. On the basis of fluid inclusions, three stages of formation were distinguished: magmatic, pneumatolytic and hydrothermal.

3. Except for ceramic pegmatites, only the last two stages form commercial deposits of rare-metal veins and muscovite pegmatites, and in chamber pegmatites, form piezooptic and precious minerals.

4. Granite pegmatites, usually zonal, coarse-crystalline bodies with granophyric structure of the early zone, have composition similar to parent intrusions. Pegmatite forms from melts and solutions, highly saturated by mineralizers, and silicate solutions-melts in places of their accumulation or after injection into fractures.

5. Silexites - essentially quartz, coarse-grained aggregates of late pegmatitic zone or vein bodies formed by injection of ultracid melt-solution, free of ore components. During rapid cooling quartz from such veins, at inversion point, becomes granulated raw material for production of high-quality quartz glass, due to absence of G/L inclusions. (Author's abst.)

ERMAKOV, N.P. (ed.), 1976d Thermobarogeochemistry of mineral formation: Rostov, Rostov, Univ. Press, 168 pp. (in Russian).

This little book contains 17 papers stemming from the Sept. 24-30 1973 meeting at Rostov-on-Don (the Fourth All-Union Conference on Thermobarometry). These are cited individually by author in this volume. With one exception, abstracts of all these will be found in volumes 6 and 7 of Fluid Inclusion Research, although many titles and authors have changed somewhat. The exception is a paper by Yu. G. Maiskiy, which was not listed in the original volume of abstracts from the meeting but is given in this volume. (ER)

ERWOOD, R.J. and KESLER, S.E., 1977, Supersaline, hypothermal main-stage mineralizing solutions, Naica chimney-manto deposit, Chihuahua, Mexico (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 969. First author at University of Toronto, Toronto, Ontario M5S 1A1.

Naica is a chimney-manto, limestone replacement, skarn-sulfide deposit typical of those that have produced much of Latin America's lead, zinc and silver. Many such deposits, including Naica, are not near known intrusive bodies and controversy persists over the importance of magmatic fluids in their origin. Fluid inclusions in fluorite deposited throughout sulfide mineralization at Naica provide the first direct observations of main-stage fluids in these deposits. The inclusions can be divided into: A) Liquid + Vapor (119°-379°C homogenization temperatures); B) L + V + Halite (237°-369°C; salinities of 31-45% equiv. wt. NaCl with less than 7% KCl); C) L + V + H + Sylvite (277°-490°C; 40-60% e.w. NaCl with 22-31% KCl); D) L + V + H + S (565°-684°C; ∿40% e.w. NaCl with ∿25% KCl). Types A, D and lower salinity B inclusions homogenize by vapor disappearance. Higher salinity type B and type C inclusions homogenize by halite disappearance indicating that these fluids were at or near halite saturation when trapped. Evidence for boiling is seen in type A and lower salinity type B inclusions but is less clear-cut in other type B and types C and D inclusions. We interpret these observations to indicate that main-stage mineralization at Naica was accomplished by a mixture of early (?) high temperature solutions (types C and D) that are very similar to the probable magmatic-hydrothermal solutions observed in the core of some porphyry copper deposits and later (?), lower temperature solutions (types A and B) that are not compositionally gradational with the higher temperature solutions and that are probably of mixed magmatic-meteoric origin. (Authors' abstract)

ETMINAN, Hachem, 1977, The porphyry copper of Sar Cheshmeh (Iran): Role of the fluid phases in the mechanisms of alteration and mineralization: PhD dissertation, Univ. Nancy, Sciences de la Terre, Memoire 34, 249 pp. (in French with English abstract).

Petrographic, mineralogic, geochemical, and fluid inclusion studies were made to establish the chemical and thermodynamic conditions for the transport and deposition of the copper and to develop a genetic model which can be used in prospecting for such deposits. There are six chapters:

1) A brief summary of the geologic setting of the Sar Cheshmech deposit. The deposit occurs in a stock of a granodioritic porphyry of late Tertiary age intruded into an immense andesitic volcano-sedimentary complex of Eocene age that has subsequently been faulted and folded.

2) A petrographic description of the enclosing andesites, the quartz diorite, and the porphyritic intrusive bodies.

3) Description of the different stages of alteration and mineralization, based on a detailed study of the succession of newly-formed mineral phases since these transformations can furnish very precious information concerning the physico-chemical conditions of the deposition of the ore minerals. In the andesite three different zones are observed which are concentric to the central porphyry. The internal zone closest to the porphyry is characterized by a strong biotitic alteration with a thickness from 50 to 400 m at the 2400 m level). This zone passes

progressively into the next zone whose external limit corresponds approximately to the cut-off grade of 0.40 % Cu. This intermediate zone is characterized by a weak biotitic alteration. Its thickness at the 2400 m level varies from 50 to 150 m. The external zone is very thick (greater than 1 km at the 2400 m level) and at the periphery grades into unaltered andesites. All of the porphyry is affected by a potassic alteration that is expressed by the newly formed potassic feldspars and biotite. A late phyllitic alteration characterized by the association chlorite-muscovite-pyrite is superimposed on the potassic alteration in both the porphyry and the biotized andesites.

Because the propylitic alteration is not superimposed on the two preceding alterations it is difficult to establish its chronologic relation with the other two alterations simply on the basis of a petrographic study. A clear spatial relation between the zones of the most important mineralization and the principal zones of alteration was noted. The limit of the economically exploitable ore (0.40 % Cu) follows, with few exceptions, the limit of the intermediate alteration zone of the andesites. Thus most of the reserves are found in the zones affected by an intense potassic alteration. Outside of these zones the grade falls abruptly. The highest grade (> 1.4 % Cu) is restricted to the internal alteration zone of the andesites in immediate proximity to the contact with porphry. From the study of the mineralization and the alteration one can conclude that most of the chalcopyrite and molybdenite mineralization was the result of the same hydrothermal phenomenon which resulted in the potassic alteration. It is also clear that if chalcopyrite was additionally deposited in the later stages of alteration (sericitic and to an even less extent, propylitic), this chalcopyrite is very subordinate to pyrite, the most important sulfide associated with these later alterations.

4) A geochemical characterization of the different petrographic units and their later evolution. The sequence was: a sharp drop in Na and Ca and an increase in K accompanying the biotitic alteration, an increase in Na accompnaying the propylitic alteration, and finally a decrease in Na and Ca as well as Mg and Ti during the sericitic alteration.

5) Fluid inclusions. This constitutes the most important part of the work. A study of these fluid inclusions trapped in phenocrysts of the porphyries has furnished extremely rich information on the evolution of the chemical composition and thermodynamic character of the mineralizing fluids.

The fluids corresponding to the potassic alteration, and observed in the type A veins, show a systematic coexistence of a vapor and a liquid which is very rich in dissolved species (up to 55% by weight NaCl), with a high concentration of copper (up to 5000 ppm), and a high temperature of homogenization (from approximately 350 to more than 650°C). The maximum fluid pressure varies from 1100-1200 bars at 650°C to around 160-200 bars at 350-370°C.

The fluids corresponding to the phyllitic alteration, represented by the type B veins, shows again evidence of fluid unmixing at the beginning of this stage of alteration. The homogenization temperatures vary from 400 to 260°C.

The fluids associated with the propylitic alteration are represented by type C and type D veins. These fluids consist essentially of a liquid of low to moderate salinity (between 2 and 15%) with homogenization temperatures between 280 and 180°C.

6) A comparison of the data for the alteration and mineralization and the results of the fluid inclusion studies. It is considered that the potassic alteration and thus also the most important mineralization took place at moderate to high temperatures (350-650°C) and low pressures (200-1200 bars). The phyllitic alteration, essentially characterized as a hydrogen metasomatism, occurred at moderate temperatures (300 to 350°C) and very low pressures (approximately 150 to 200 bars). The propylitic alteration characterized, above all, by an important contribution of CO_2 and H_2O, occurred at moderate temperatures (300-400°C) and a rather high fluid pressure (probably greater than 1000 bars).

Following a discussion of the conditions of genesis of the porphyry copper type of deposits in the context of the "orthomagmatic" and convective models, a model for the genesis of the Sar Cheshmeh deposit is proposed. In this model it is considered that shortly after the intrusion of the porphyry there was a very intense fracturing event producing a drop, very probably adiabatic, of the fluid pressure. The deposit of the copper is most likely related to the resulting boiling which produced a partitioning of the dissolved species between the two fluid phases and thus a very drastic change in the overall equilibrium conditions.

The results obtained in the present work once again affirm the growing interest in the study of fluid inclusions as a tool in prospecting for deposits such as porphyry copper and in particular for the evaluation of the prospects in the first stages of exploration. (From the author's abstract).

EVANS, A.M., 1977, Conference report - current research on fluid inclusions and on mineral deposits: Jour. Geol. Soc. Lond., v. 134, p. 315-397.

This is a 3-page summary of a conference held in Durham 13-17 December, 1976, followed by 11 pages of abstracts of the many papers presented. These abstracts will all be found in Fluid Inclusion Research -- Proceedings of COFFI, v. 9, 1976, and hence are not repeated here. A few changes in second authorship are ignored. Many of these abstracts were also published in Trans. IMM Sect. B. Of particular interest were the efforts and emphasis on getting fluid inclusion studies into the geological curricula in European universities. (ER)

EVANS, Tony, 1977, The nature and genesis of mineral deposits, a conference report: The British Geologist, v. 3, no. 1, p. 8-9.

Covers material similar to that in previous abstract (ER)

EWERS, G.R., 1977, Experimental hot water-rock interactions and their significance to natural hydrothermal systems in New Zealand: Geoch. Cosmo. Acta, v. 41, p. 143-150. Author at Dept. Geol., Univ. Melbourne, Parkville, Australia.

A study has been made of the interaction of a New Zealand greywacke and hot water at temperatures up to 500°C. Comparisons are drawn between the trace element content of the reaction solutions and the composition of New Zealand thermal waters with particular reference to the Broadlands geothermal field.

The experiments have demonstrated that hot water can extract significant quantities of As, Sb, Se and S at temperatures below the maximum temperatures recorded for the major geothermal fields in New Zealand.

The amount of Tl and Co leached up to 500°C was below the limits of detection and data could not be obtained for Au, Ag, Te and Bi. (Author's abstract)

EWERS, G.R. and KEAYS, R.R., 1977, Volatile and precious metal zoning in the Broadlands geothermal field, New Zealand: Ec. Geol., v. 72, p. 1337-1354.

Au, Ag, As, Sb, Tl, Se, Te, Co, and Bi have been determined by neutron activation analysis in samples from two deep diamond drill holes, hot-spring sinters, and precipitates from discharge waters from the Broadlands, New Zealand, geothermal field. Ore-grade amounts of Au and Ag are being deposited from the dilute hydrothermal waters at the surface, whereas erratically distributed sulfides (mainly pyrite with minor galena, sphalerite, and chalcopyrite) make up to 10 percent of the hydrothermally altered volcanic rocks at depth. Bore temperatures in BR 16 (the main hole studied) range from 280°C at 1,400 meters depth to 60°C at 80 meters depth. The data confirm the existence of a crude metalliferous zoning with As, Sb, Au, and Tl enriched in near-surface regions while Ag, Se, Te, Bi, Pb, Zn, Cu, and Co are concentrated mainly at depth.

Deposition of Tl is occurring solely in response to decreasing solution temperatures while the other elements are being precipitated through the combined effects of decreasing temperatures and boiling within permeable zones. It is concluded that they are being transported as thio complexes which become unstable due to loss of H_2S, CO_2, and/or NH_3 during boiling. Trace elements may have been coprecipitated with major element sulfides through adsorption and incorporation into sulfide lattices. Solution/wall-rock interactions and oxidation processes appear to be unimportant depositional mechanisms at Broadlands, while the possibility that dilution has caused deposition cannot be properly evaluated.

Tl enrichment halos are predicted around many base metal deposits. These could be more pervasive and uniform than those formed by other metals because Tl would have been deposited mainly in response to decreases in temperature away from hydrothermal vents, etc. Since Tl substitutes for K in potash-rich silicates, it may also survive metamorphic effects better than other volatile metals which might also form primary dispersion halos around ore deposits. (Authors' abstract)

FAIZIYEV, A.R., ISKANDEROV, F. Sh., ALIDODOV, B.A. and KISELEV, V.I., 1976, Temperatures of formation of Kukhi-Lal (SW Pamirs) (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 71 (in Russian; translation by A. Kozlowski).

Skarns are developed in the contact of magnesite marbles with gneiss-migmatite complex (granulite and amphibole metamorphic facies).

Tremolite, diopside and forsterite bear the highest amount of inclusions; clinohumite and spinel bear inclusions occasionally. Inclusions are faceted. One may distinguish P solid inclusions, P inclusions of solutions-melts (crystallized) and S G/L inclusions. P inclusions have T_H 590-800°C, S inclusions - 380-450°C. (Authors' abst.)

(Continued on next page)

Mineral	T_D^*, °C	T_H, °C
Forsterite	635	740-800
Violet spinel	660	750-780
Pink spinel	640	650-770
Diopside	610	680-710
Clinohumite	620	600-680
Tremolite	560	600-650

*Decrepitometer D-1; T_D = beginning of decrepitation

FATTAKHUTDINOV, S.G., KONYUKHOV, I.A., KHAYRETDINOV, I.A. and ASBASHEV, R.Sh., 1976, On the genesis of the recent thermal waters in Yangan-Tau (Bashkiria) (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR Inst. of Geol., p. 149-150 (in Russian; translation by A. Kozlowski).

In Priural'ye at a depth of several tens of meters T reach 380-400°C. Extensive hydrothermal alterations of rocks were found. G/L inclusions in marble-like calcite, precipitated by source Kurgazak, are two-phase and they have T_H 220-250°C in liquid, i.e. pressure is close to 100 atm. Thus, calcite crystallized at the depth ∿1 km (hydrostatic conditions). (From the authors' abst.)

FAYZIYEV, A.R., 1976, Crystal morphology of fluorite from deposits and mineralization shows of Central Tadzhikistan, in Minerals and parageneses of minerals, editors P.M. Tatarinov and D.V. Rundkvist: Leningrad, Leningrad Division of "Nauka" Publishing House, p. 160-167 (in Russian).

Fluorite from flux deposits yielded following T_H: Verkhniy Bigar 122-170°C, Bigar 150-175°C, Diamalik 145-340°C, Kondara 180-280°C, Takob 150-250°C, Krasnye Kholmy 120-190°C, Ankuch 135-200°C, Mogov 105-192°C, Kal'tuch 118-160°C, Tunikharv 130-160°C, Azrek 105-190°C, Chapdara 70-90°C. Deposits of optical fluorite bear crystals with lower T_H: Kuli-Kalon 110-150°C, Kaznok 70-160°C, Dzhushkhar 90-168°C, Pushnevat 60-115°C; the lowest T_H were found in fluorite from the Hg-Sb deposits: Turk-Parida 48-88°C, Idzham 62-88°C, Tau-Tash 66-82°C. The habit of fluorite is not strongly influenced by T of crystallization. (Abst. by A.K.)

FEDORCHUK, V.P., 1976, Superheated fluids in hydrothermal formations (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 72-73 (in Russian; translation by A. Kozlowski).

(...) Pre-ore impregnation of wall rocks at Hg deposits appeared at 700-600°C, T_H of inclusions from the next stage - 400-300°C. First ore stage gave cinnabar and native mercury. Mercury sometimes is entrapped in fluid inclusions in cinnabar and gangue minerals. T_H of the mercury-bearing inclusions in quartz sometimes > 350°C, total salts $\leq$ 2 g/l. Seemingly, significant part of Hg is transported by superheated H_2O vapor. (From the author's abst.)

FEHN, U., CATHLES, L.M., and HOLLAND, H.D., 1977, Hydrothermal convection at mid-ocean ridges (abst.): Amer. Geophys. Union, Trans., EOS, v. 58, no. 6, p. 514.

FENN, P.M., 1977a, The nucleation and growth of albite from the melt in the presence of excess SiO_2 (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 973-974.

FENN, P.M., 1977b, The nucleation and growth of alkali feldspars from hydrous melts: Canadian Mineralogist, v. 15, p. 135-161.

FIELD, C.W., BRISKEY, J.A., and MOORE, W.J., 1977, Sulfur isotope fractionation in disseminated pyrite adjacent to some lead-zinc veins, in U.S. Mine, Bingham, Utah (abst.); Geol. Assoc. Canada-Min. Assoc. Canada Program with Abstracts, v. 2, p. 18.

FILER, Jon, 1977, A study and comparison of fluid inclusions from blue and white quartz from a banded gneiss in the Dowingtown Quadrangle, southeastern Pennsylvania: Senior Research Thesis, Dept. of Geology, Bryn Mawr College, Bryn Mawr, Pa.

Both blue quartz and white quartz are present in an outcrop of banded gneiss in the Downingtown Quadrangle, southeastern Pennsylvania. This gneiss has been affected by two periods of metamorphism, a granulite grade event followed by an amphibolite grade event. A study of fluid inclusions in these quartzes was undertaken. This study showed that similar inclusions occur in both types of quartz: one set with melting points between -25° and -30°C, and a clearly secondary set with melting points near 0°C. In addition, the white quartz contains inclusions with a cube of halite and a melting point near -39°C; the blue quartz has a group of inclusions with melting points between -5° and -10°C. Homogenization temperatures for the saline brines average 40° lower than those for the less saline fluids. Extrapolated isochores intersect at 400°C and 3 Kb. It is possible that all the inclusions observed developed during a stage of retrograde alteration of the host rocks. (Author's abstract)

FISHER, I.S., 1977, Distribution of Mississippian geodes and geodal minerals in Kentucky: Econ. Geol., v. 72, p. 864-869.

A review of geode mineralogy, occurrence, and formation conditions, based in part on the fluid inclusion evidence. (ER)

FLEET, M.E., 1977, Origin of disseminated copper-nickel sulfide ore at Frood, Sudbury, Ontario: Econ. Geol., v. 72, p. 1449-1456.

The data are inconsistent with direct formation from immiscible sulfidedroplets in quartz diorite magma. (From the author's abstract)

FLEET, M.E., MacRAE, N.D., and HERZBERG, C.T., 1977, Partition of nickel between olivine and sulfide: a test for immiscible sulfide liquids: Contrib. Mineral. Petrol., v. 65, p. 191-197. Authors at Dept. Geol., Univ. of W. Ontario, London, Ont. N6A 5B7, Canada.

The partition of Ni between olivine, crystallized from basalt liquids, and iron-nickel monosulfide has been determined experimentally at 1160 and 1050°C using alumina crucibles in sealed silica glass tubes. The work suggests that an immiscible sulfide liquid may not be a normal product of upper mantle magmatic processes. Similarly, it appears unlikely that sulfide liquid immiscibility had any role in the genesis of nickel sulfide ores. (From the authors' abstract)

FLYNN, T., 1977, Filter-pressed partial melts: an experimental formation of migmatites (abst.): Amer. Geophys. Union, Trans., EOS, v. 58, no. 6, p. 520-521.

Silicate melts in the system Al_2O_3-SiO_2-MgO-K_2O-Na_2O-Cl were equilibrated with 4N aqueous chloride solutions and residual crystalline phases at temperatures between 675°C and 725°C and total pressures of 2 to 4 kbs. for a period of one month.

The composition of the aqueous solution was determined for all temperatures and pressures. NaCl is the dominant chloride: KCl and $MgCl_2$ follow in abundance respectively. The composition of the melt is largely a function of the initial parent rock composition. (From the author's abstract)

FOMENKO, V. Yu. and TERESHCHENKO, S.I., 1976, Conditions of alteration of rocks from the Taratash region of the Urals, on the basis of gas-liquid inclusions (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 124-125 (in Russian; translation by A. Kozlowski).

Inclusions were studied in quartz and garnet from ferriferous quartzites, ferriferous-silicate schists and migmatites at the southeast range of the Ufa block. Quartz bears: 1) G/L inclusions, T_H 540-418, 418-310, 310-165°C, usually in L, rarer in G; 2) polyphase inclusions with halite, G dissolves at 222-182°C, halite at 336-254°C; 3) rare inclusions filled with essentially CO_2, T_H 25-30°C; 4) rare H_2O-CO_2 inclusions with T_H 427-278°C (G dissolves at 28-25°C). Garnets bear essentially G and CO_2 (L+G) with T_H 25-21°C. Rocks were formed during several stages. P inclusions have simple (H_2O or H_2O-CO_2) composition and highest T_H. Some kinds of inclusions bear concentrated solutions (over 40% of total salts), connected with late processes (granitization and diabase dike injection). From the density of CO_2, pressures varied from 1700 to 1500 b. (Authors' abst.)

FOO, B.N., 1977, Mineral paragenesis, fluid inclusion studies and geochemistry of the Sungei Lembing tin lodes, west Malaysia (abst.): Inst. Mining and Met., Trans., Sect. B, v. 86, p. B163.

Homogenization temperature determinations made on cassiterite, post-cassiterite quartz and calcite from the Hantu lode revealed a progressive cooling trend with time from 272°C to 180°C to 148°C to <70°C. Repeated opening of the lode caused the cassiterite ore fluid to boil sporadically, and allowed emplacement of streaky quartz veins. Homogenization temperatures of the Sungei Lembing cassiterite (Hantu and Willinks lodes) were compared with cassiterites from lodes in other west Malaysian fields. Three ranges of homogenization temperatures were recognized, and can be grouped according to mode of occurrence as follows: 200-300°C for the hydrothermal lodes and pipes in shale and granite; 300-330°C for the greisens; and 360-500°C for the skarns.

Such variations may well be useful for determination of the type of primary tin lode from which an alluvial cassiterite was derived, and may thus provide a guide for selection of target areas in which to prospect for primary tin lodes. (From the author's abstract)

FOORD, E.E., 1976, Mineralogy and petrogenesis of layered pegmatite-aplite dikes in the Mesa Grande District, San Diego County, California, Ph.D. disser., Stanford U..

The Himalaya pegmatite-aplite dike system, in the Mesa Grande district of San Diego County, California, is world-famous for its past yield of gem-quality tourmaline and mineral specimens of exceptional value. It also is of special scientific interest as a complex product of crystallization in a system comprising silicate melt and aqueous vapor.

Properties and compositional zonation were determined in detail for major and minor minerals from each rock unit, with much use of electron microprobe techniques.

Studies of three types of fluid inclusions indicate low salinities, in general less than five wt. percent equivalent NaCl for the aqueous fluid that existed during pocket formation. Filling and/or homogenization temperatures ranging from 300°C to 270°C probably correspond to temperatures that existed during later development of pocket minerals.

The genetic model here favored for the dike system involves initial emplacement, at a depth not greater than 6 Km, of silicate melt with lesser fractions of coexisting crystals and aqueous vapor. Crystallization of non-layered aplite and the overlying layered aplite sequence was mainly from the melt. Vapor played an important role in formation of the hangingwall graphic pegmatite, some of which crystallized simultaneously with the layered aplite and some of which was probably formed later. The pocket pegmatite represents subsequent interactions of crystalline silicates and an aqueous vapor phase. Pocket zeolites and secondary minerals were formed still later from hydrothermal solutions at lower temperatures and pressures. Pocket clay finally was developed under open-system conditions. (From the author's abstract)

FOORD, E.E., 1977, Morphology and growth characteristics of pegmatite pocket tourmaline (abst.): in Program and Abstracts, Third M.S.A.-F.M. Symposium, Crystal Growth and Habit, Tucson, Arizona, Feb. 13-14, 1977 (unpaginated).

FORD, J.H. and GREEN, D.C., 1977, An oxygen- and hydrogen-isotope study of the Panguna porphyry-copper deposit, Bougainville: Journal of the Geological Society of Australia, v. 24, pt. 2, p. 63-106.

FORESTER, R.W. and TAYLOR, H.P., Jr., 1977, $^{18}O/^{16}O$, D/H, and $^{13}C/^{12}C$ studies of the Tertiary igneous complex of Skye, Scotland: Am. Jour. of Sci., v. 277, p. 136-177.

The average integrated water/rock ratio for the Skye hydrothermal system is approximately unity; at least 2000 km^3 of heated meteoric waters were cycled through these rocks. (From the authors' abstract)

FOSTER, R.P., 1977, Solubility of scheelite in hydrothermal chloride solutions: Chemical Geology, v. 20, no. 1, p. 27-44.

FOURNIER, R.O., 1977*a*, Constraints on the circulation of meteoric water in hydrothermal systems imposed by the solubility of quartz (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 979. Author at U.S. Geological Survey, Menlo Park, California 94025.

Hydrologic models of hydrothermal systems that are dominated by meteoric water and that have high-temperature heat sources located at relatively shallow depths (2-10 km) must consider variations in the solubility of quartz at high temperatures and high pressures, experimentally determined by George Kennedy and reported in 1950. Solubility maxima are attained from 330°C to about 480°C at pressures of 128 to about 715 bars. These pressures would be attained at depths of about 1 1/4 to 7 1/2 km where hydrostatic pressure is fixed by cold, dilute meteoric water flowing into the system. Under these conditions dilute water heated at a depth of 2 km ($\simeq$ 200 bars) will dissolve quartz until about 800 mg silica per kg solution is attained at about 340°C. Further heating at that depth will cause quartz to precipitate. At a given depth, then, decreased permeability owing to quartz precipitation should limit the temperature attained by dilute water circulating into the system. At 4 km 370°C can be attained before permeability is decreased and at 6 km about 400°C. A depth of circulation of about 7 1/2 km ($\simeq$ 750 bars) is required to circumvent the silica solubility maxima, thereby permitting meteoric water to interact with rocks at temperatures greater than 500°C.

The precipitation of quartz presents no problem for maintaining deep circulation cells where the maximum temperature attained by the solution is less than about 300°C. However, where higher solution temperatures are attained, the precipitation of quartz from a cooling solution is a major obstacle to maintaining convective circulation. A model based on upward convection at the side of a heat source, with heating of the solution as it rises, allows movement of hot (> 300°C) water over a greater vertical distance than would be possible if the highest temperature were at the deepest point of the convective flow. (Author's abstract)

FOURNIER, R.O., 1977b, Chemical geothermometers and mixing models for geothermal systems: Geothermics, v. 5, p. 41-50. Author at U.S. Geol. Survey, Menlo Park, CA 94025.

Qualitative chemical geothermometers utilize anomalous concentrations of various "indicator" elements in groundwaters, streams, soils, and soil gases to outline favorable places to explore for geothermal energy. Some of the qualitative methods, such as the delineation of mercury and helium anomalies in soil gases, do not require the presence of hot springs or fumaroles. However, these techniques may also outline fossil thermal areas that are now cold.

Quantitative chemical geothermometers and mixing models can provide information about present probable minimum subsurface temperatures. Interpretation is easiest where several hot or warm springs are present in a given area. At this time the most widely used quantitative chemical geothermometers are silica, Na/K, and Na-K-Ca. (Author's abstract)

FOURNIER, R.O. and ROWE, J.J., 1977, The solubility of amorphous silica in water at high temperatures and high pressures: Amer. Min., v. 62, p. 1052-1056. First author at U.S. Geological Survey, Menlo Park, CA 94025

FRANCK, E.U., 1973, Concentrated electrolyte solutions at high temperatures and pressures: Jour. Solution Chem., v. 2, no. 2/3, p. 339.

FRANTZ, J.D. and POPP, R., 1977a, Modification of the Ag + AgCl buffering technique for the determination of speciation in hydrothermal fluids: Carnegie Inst. Wash. Yearbook 76 for 1976-1977, p. 598-601.

FRANTZ, J.D. and POPP, R.K., 1977b- Determination of aqueous magnesium speciation in the system: $MgO-SiO_2-H_2O-HCl$ (abst.): Amer. Geophys. Union Trans., EOS, v. 58, p. 1243.

FRIDMAN, A.I., REMIZOVA, L.I., VOYTOV, G.I. and CHEREVICHNAYA, L.F., 1977, Natural gases from the Belorechenskoe barite deposit (N. Caucasus): Akad. Nauk SSSR Doklady, v. 233 no. 3, p. 470-472 (in Russian). Authors at the Moscow Geol.-Prospecting Inst., Moscow.

Hydrothermal Belorechenskoe deposit formed during three stages: quartz-dolomite, ankerite and barite-calcite; the latter formed at T from 100-85 to 75-60°C. Ankerite veins bear solid (kerite) and liquid bitumens. 47 specimens of wall-rocks and hydrothermal parageneses were analysed for gas content by gas chromatography. Samples (2g) were ground in a steel mill under argon. Gas composition is as follows:

Table 1. Average chemical composition of gases (in cm^3/kg of sample)

Rock	Number of samples	H_2	CO_2	N_2	Total Hydrocarbons (CH_4)
Amphibolite	2	0.760	2.50	33.00	0.202 (0.162)
Serpentinite	1	0.300	not found	not found	0.452 (0.428)
Gneiss altered hydrothermally	1	0.900	10.00	16.00	0.036 (0.028)
Granite-gneiss with veinlets of graphite and calcite	*	0.400	2.50	48.60	0.248 (0.223)
Microclinized gneiss with carbonate veinlets	3	0.760	10.00	15.50	0.132 (0.109)
Carbonate breccia from the contact of vein	2	0.210	8.00	34.00	0.073 (0.0044)**
Calcite with vein barite	3	0.560	3.30	30.00	0.175 (0.162)
Vein ankerite	*	0.520	8.30	7.30	0.128 (0.097)
Vein quartz	*	1.990	not determined	not determined	0.0365 (0.0361)

*number not specified by the author; **obviously a misprint, probably the value is 0.044 (A.K.)

Table 2. Chemical composition of hydrocarbons in inclusions (cm^3/kg)

Rock	CH_4	C_2H_8	C_2H_4	C_3H_8	C_3H_6	$C_4 + C_{>4}$
Microclinized granite with carbonate veinlets	0.0665	0.0095	0.009	0.0045	0.0035	not found
Ankerite from the lower wall of vein No. 19	0.636	0.064	0.062	0.031	0.026	0.021
Ankerite from the center of vein No. 19	0.574	0.0305	0.0405	0.071	0.084	not found
Hydrothermally altered amphibolite from the hanging side of vein No. 44	0.0165	0.0235	0.025	0.010	0.095	0.0035
Carbonate breccia from the footwall of vein No. 44	0.198	0.029	0.045	0.0115	0.0105	0.0060

Composition of gases varied during the hydrothermal process; especially distinct is the H_2-poor ankerite stage and H_2-rich final low-T calcite-barite stage, when hydrocarbons are represented almost exclusively by CH_4. (Abst. by A.K.)

FRIEDMAN, Irving and O'NEIL, J.R., 1977, Compilation of stable isotope fractionation factors of geochemical interest: U.S. Geol. Survey Prof. Paper 440 KK (12 pp. plus 49 figures)

Selected fractionation factors for D, O^{18}, C^{13}, and S^{34} have been compiled from the literature and plotted on a convenient linear temperature coordinate system. Elementary discussions of terminology and the problems of isotope standards are presented, together with equations relating the various standards used for reporting O^{18} values. Where data are available at only a few temperatures, the fractionations are given in tabular form. For each fractionation factor, a reference to the original work is given. (Authors' abstract)

FUGE, R., 1977, On the behaviour of fluorine and chlorine during magmatic differentiation: Contrib. Mineral. Petrol., v. 61, p. 245-249. Author at Geol. Dept., Univ. College of Wales, Aberystwyth, Dyfed, SY23 3DB, Wales, Great Britain

The behaviour of fluorine and chlorine during differentiation is considered in the light of halogen data for granites and separated biotites from the Dartmoor granite pluton of S.W. England, hornblende-bearing ultrabasic and basic rocks from a layered intrusion at Rhiw, N. Wales, and recent literature data on halogens in apatites from the Shokin Sag laccolith and the Skaergaard intrusion.

The data indicate that whereas fluorine concentrations are highest in the late stage differentiates, chlorine concentration is highest in the earlier differentiates. It is suggested that this behaviour of the two halogens is due to their relative affinities for silicate melts. Chlorine having a low solubility in silicate melts and a strong affinity for associated aqueous phases will tend to be concentrated in early formed hydrous minerals, leaving fluorine with its strong affinity for the melt to be enriched in the late-formed hydrous minerals. (Author's abstract)

GABROVSKA-ZIDAROVA, B., 1977, Vertical temperature zonality in the Mihalkovo ore field, in Problems of Ore Deposition, Fourth IAGOD Symposium, Varna, 1974, vol. 2: Sofia, Pub. House Bulgarian Acad. Sciences, p. 163-170. Author at Geological Institute, Sofia, Bulgaria.

T_H of inclusions in fluorite (115-180°C). They are lower and smaller in range in the lower horizons, and arelower in the outer parts of individual crystals. (ER)

GAGDASAROV, Yu.A., 1978, Melilite rocks and apomelilite metasomatities of the Bol'shetagninskiy massif (E. Sayan) and some problems of their genesis, in Minerals and parageneses of minerals; editors P.M. Tatarinov and D.V. Rundkvist: Leningrad, Leningrad Division of "Nauka" Publishing House, p. 46-55 (in Russian).

Late carbonatites rich in fluorite and sulfides, and bearing amphiboles, yielded T_H and T_D 150-450°C (A.K.).

GALIMOV, E.M., TUGARINOV, A.I. and NIKITIN, A.A., 1975, On the origin of whewellite in a hydrothermal uranium deposit: Geokhimiya, 1975, p. 676-683 (in Russian; translated in Geochem. Internat., v. 12, no. 3, p. 31-37, 1975). Authors at Vernadskiy Inst. Geochem. and Analytical Chem., Academy of Sciences USSR, Moscow.

The physicochemical conditions of formation of hydrothermal whewellite are discussed on the basis of investigation of isotopic composition of its carbon and of the carbon of associated calcite and carbonaceous matter. The carbon isotopic composition of hydrothermal whewellite (δC^{13} from -1.56 to -2.22%) is very different from that of diagenetic whewellite ($\delta C^{13} = +0.7\%$). On the basis of the concept of ordered distribution of carbon isotopes in the molecules of bioorganic compounds it is demonstrated that the investigated whewellite is a product of oxidation-reduction reactions, occurring in the hydrothermal solution with participation of organic matter. It is concluded that the deposition of ore involved reduction of hexavalent uranium and its precipitation as uraninite and oxidation of organic matter with formation of oxalic acid, followed by precipitation of calcium oxalate in the form of whewellite. (Authors' abstract)

GANEEV, I.G. and RUMYANTSEV, V.N., 1976a, Hydrothermal solutions under conditions of (thermal) gradient (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 155-156 (in Russian; translation by A. Kozlowski).

Natural hydrothermal systems under P (∿1500 bar, deposit type: Mo, W, Sn) are characterized by 1) convection movement of solutions, 2) absence of P gradients, 3) gradients of solution density due to T decrease under P = const, 4) spatial acid-alkaline differentiation caused by hydrolysis of salts and separation of volatiles toward the upper, cooler zone. The same generation of G/L in steep or vertical vein contains solution with regularly varying composition: higher pH of solution characterizes core of the vein, as well as lower density and lower concentration of gases. (From the authors' abst.)

GANEEV, I.G. and RUMYANTSEV, V.N., 1976b, Role of density of solution during hydrothermal growth of quartz (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 157 (in Russian; translation by A. Kozlowski).

Crystallization of quartz from 0.5 M NaOH solution was studied in T interval 310-450°C. Quartz does not crystallize when F of autoclave <57%. This is true not only at T = 380°C, as was found by N.I. Sheftal, but also over the entire T interval studied F>57% causes an increase in the speed of growth, and the effect of density increases when T is higher. Hence, natural mineral-formation in closed veins, i.e., under conditions of T gradient, as in an autoclave, should appear from solutions of high density. This agrees also with statistical results of studies of G/L inclusions. (Authors' abst.)

GANSTER, M.W., 1977, Evidence for the localized accumulation of hydrothermal fluids at the Henderson molybdenum deposit, Empire, Colorado (abst.): Econ. Geol., v. 72, no. 4, p. 728-729.

See Fluid Inclusion Research -- Proceeding of COFFI, v. 9, p. 44 (ER)

GARCIA-IGLESIAS, Jesus and TOURAY, Jean-Claude, 1977, A fluorite-calcite-quartz paragenesis with liquid and gaseous organic inclusions at La Cabaña, Berbes, Asturias fluorspar district, Spain: Econ. Geol., v, 72, p. 298-303.

Primary inclusions of two types of liquid hydrocarbons, gaseous hydrocarbons, and liquid water solutions were found. T_H ranges from 40-170°C, with liquid hydrocarbon inclusions in fluorite showing T_H averaging ∿70° below the cogenetic water solutions (T_{Frz} -20 to -40°). (ER)

GAREEV, E.Z., 1976, Inclusions of melt in phenocrysts from porphyry of the Chebach'ye copper-sulfide deposit (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 127-128 (in Russian; translation by A. Kozlowski).

Porphyry is an intrusion with variable composition and complicated structure.Cu-sulfide ores are connected with this rock. Inclusions were studied in quartz of subvolcanic rocks, except S G/L inclusions in healed cracks. Two types were distinguished: a) recrystallized, occurring in all grains of quartz, b) amorphous glass, very rare. Inclusions are arranged in zones, parallel to faces of crystal. In crystallized inclusions at 650-700°C the filling begins to melt, and at 970 it is completely melted (melt + G), T_H 950-1130°C. (...) (Author's abst.)

GEGUZIN, Ya.Ye and DZYUBA, A.S., 1977, Precipitation of gas and formation and trapping of gas bubbles at the crystallization front of a melt: Kristallografiya, v. 22, no. 2, p. 348-353 (in Russian; see translations).

GERLACH, T.M., 1977, Analysis of recent volcanic gas collection data from basaltic volcanoes: Surtsey, Mount Etna, Erta Ale (abst.): Amer. Geophys. Union Trans., EOS, v. 58, p. 1250.

GIBBARD, H., Jr. and GOSSMANN, A.F., 1974, Freezing points of electrolyte mixtures. I. Mixtures of sodium chloride and magnesium chloride in water: Jour. Solution Chem., v. 3, no. 5, p. 385.

The freezing points of aqueous mixtures of sodium chloride and magnesium chloride have been measured in the range of ionic strengths from 0.1 to 3.5 mole-kg^{-1}. (From the authors' abstract)

GIBBARD, H.F. and FONG, S., 1975, Freezing points and related properties of electrolyte solutions. III. The systems NaCl-$CaCl_2$-H_2O and NaCl-$BaCl_2$-H_2O: Jour. Solution Chem., v. 4, no. 10, p. 863.

The freezing temperatures of aqueous calcium chloride and barium chloride and their mixtures with sodium chloride were measured at equivalent molalities of 0.1 to 1.5 mole-kg^{-1}. (From the authors' abstract.)

GIBSHER, N.A., 1976, Forming of hydrothermal polymetallic deposits of Rudnyi Altai, occurring in volcanogene-sedimentary rocks (data of studies of fluid inclusions): in Genetic studies in mineralogy, Yu.A. Dolgov et al., eds.: Novosibirsk, Inst. Geol. and Geophy. Sib. Branch Acad. Sci. USSR, p. 90-93 (in Russian).

Following deposits were studied by means of fluid inclusions: Vavilovskoe Cu-pyrrhotite, Zyryanovskoe and Tishinskoe pyrite-polymetallic and Rubtskovskoe barite-polymetallic. In each deposit three stages were distinguished: I - pre-ore, II - ore and III - post-ore ones. P were determined by use of L CO_2 inclusions. The data are summarized in Table 19. (Abst. by A.K.)

Deposit, studied minerals	Stage	Max. T_H, °C Lower horizon	Upper horizon	No. of determinations	T_{FRZ}, °C	T of eutectics, °C	No. of determinations	Ions in water leachate	Concentration, wt. %	Composition of gas phase, vol.% [d] H_2S, SO_2, SO_3	CO_2	CO	H_2	N_2+rare gases	No. of determinations	P, atm	Nature of mineral-forming solutions
Vavilonskoe*																	
quartz-anthophyllite	I	550	500	34	-10to-12	-50	14	Ca,K,Mg, HCO_3,Cl	15	18-20	53-61	0	9-12	12-15	7		Pneumatolytic-hydrothermal
quartz	II	380	300	110	-18to-20	-42to-46	40	K,Ca,Mg, HCO_3,Cl, SO_4	30	27-58	12-37	0	14-25	9-16	9	800-1000	
Zyryanovskoe																	
quartz	I	420	420	53	-20	-50	8	Ca,Mg,Na, SO_4,HCO_3 Cl		23-54	25-48	13-30	7-12	0	7		
sphalerite	II	280	280	85	-15	-55	15	Ca,Na,Mg, SO_4,HCO_3	35-40	0	0-32	0-39	0-22	46-87	20		Hydrothermal
quartz		280	300	97	-15	-30	11			0							
carbonate		260	280	42	-15	-40	9			0	23-35	0-12	14-40	40-80	11		
quartz	III	300	270	67	-10	-37	13	Ca,Na,Mg, HCO_3,SO_4	35	35-81	8-77	0-11	3-14	3-23	4	1000	
carbonate[a]		270	230	38	-12	-30	9										
barite		200	200	25	-8	-30	11										
Tishinskoe																	
quartz[b]	I	380	330	85	-7	-40	8	K,Ca,Mg, HCO_3,Cl	15-17	41	20	0	13	16	7		
quartz	II	370	280	104	-5	-37	3	Ca,K,Na, Mg,SO_4, HCO_3	20-25	0-19	6-45	0-10	15-25	30-78	17		Hydrothermal
sphalerite		370	280	49	-3	-33	7										
quartz	III	260	200	58	-2	-23	7			70	30	0	0	0	22	600-800	
carbonate		260	200	64	-2	-25	10										
Rubtsovskoe*																	
quartz	I	300		15													
sphalerite	II	270	270	138	0to-2	-10	20	K,Na,Ca, Mg,Cl, SO_4,HCO_3	5-6	27-54	30-46	5-9	4-7	0-10	200	50-60	Colloidal-hydrothermal
quartz[c]		270	270	36	-2 to -3	-10	13										
barite		200	200	68	-1to-2	-10	8										

*Stage III not studied; a/Includes 8-14% hydrocarbons; b/Includes 10% hydrocarbons; c/ Includes 15-20% hydrocarbons;
d/ No O_2 found in any sample.

GIBSHER, N.A., 1977, Physico-chemical condition of formation of certain pyrite-polymetallic deposits of the Rudnyi Altai (gas-liquid inclusion data) (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. II, p. 67-68 (in Russian; translation by A. Kozlowski). Author at Inst. Geol. Geophys. of Siberian Branch of Acad. Sci. U.S.S.R., Novosibirsk.

Essentially the same data as in previous paper.

GIGASHVILI, G.M. and KALISH, V.P., 1977, Inclusions of hydrocarbons in minerals as indices of conditions of migration of oil-bearing fluids: Akad. Nauk Ukrainskoi RSR Dopovidi, Ser. B, no. 6, p. 493-497 (in Ukrainian with Engl. abst.). Authors at Inst. Geol. Geochemistry of Natural Fuels Acad. Sci. Ukr. SSR, L'vov.

Hydrocarbons were found in boulders of diabase porphyrites from the Middle Jurassic strata from the Ifigenia Cape on the Crimea Peninsula, in mineralized fractures and anygdules and geodes that have been cut by those fractures. Amygdules and geodes have an external zone of calcite and internal one of chalcedony; those cut by veinlets bear quartz formed from dissolved chalcedony. Three forms of occurrence of hydrocarbons were found: 1) light oil in cavities of amygdules and geodes, 2) patches of bitumen on the walls of amygdules and geodes, 3) inclusions in quartz and calcite. On opening, most of light oil evaporates and the condensed remainder reveals UV-luminescence (white or creamy-yellow, typical for paraffin-naphthene oils). Condensate contains 61.37 wt.% paraffins, including 22.99 wt.% n-paraffins and 38.38 wt.% iso-paraffins, napthene hydrocarbons — 12.45 wt.%, aromatic — 5.70 wt.% and tar-like substance — 20.48 wt.%, element composition, wt.%: C 86.16, H 11.96, ash 0.0, S, N, O — 1.88 (the balance), C/H = 7.2, typical for light oil, $\delta C^{13} = -2.32\%$ PDB. In quartz crystals eight types of inclusions of hydrocarbons and water solutions were found; size of inclusions ranges from 0.00 n to 0.0n mm: 1) G/L inclusions, F 80-86%, near contact with chalcedony, T_H in L 280-240°C, L luminesces in pale blue-grayish color — assumed to be inclusions of water solutions with small admixture of hydrocarbons; 2) G/L inclusions of hydrocarbons, F 85-90%, T_H in L +106 to +115°C, luminescence strong, blue-milky, on cooling new L_1 appears in G, T_H of G + L, = -81°C, thus L_1 should be L methane (critical T -82.3°C), hence from PTV properties pressure in volume L_1 +G at T_H = +110°C should be ≥ 330 atm. Since volume of the whole inclusion is seven times larger, $P \approx 46$ atm, if CH_4 approximates an ideal gas. Inclusions of types 1 and 2 are syngenetic, thus P at +260°C (mean T_H of inclusions of type 1) equals $\approx$ 80 atm. 3) Inclusions of hydrocarbons with various F, from 1 to 80 vol% of L, the latter homogenize in L at +102 to +110°C, luminescence of L milky-bluish with yellowish tint. In G inclusions on freezing L_1 condenses, T_H of L_1 + G either in G -79 to -82°C or in L_1 -80°C, sometimes in critical fluid at -75°C. In the latter inclusions volume of L_1 at -180°C equals 35% of initial volume of G; thus it is methane with admixture of heavier hydrocarbons. Differences of T_H indicate distinct changes of P. Interval of P varies from 160 atm (isochore 11.1 cm^3/g used) to 514 atm (isochore 4.4 cm^3/g). 4) P and S inclusions of hydrocarbons, L ~85%, T_H in L +75 to +85°C, luminescence strong, bluish-milky with yellowish tint. 5) P and S inclusions, L ~30%, luminescence bluish-milky, T_H in

G-like phase (sic.) at +74°C, on freezing dividing into L_1 and G phases. G bubble dissolves in L_1 phase at -106°C; it is probably methane of high density. T_H = -106°C for methane indicates an isochore of 3.1 cm^3/g. During complete homogenization (+74°C) P equals 340 atm. 6) Inclusions of hydrocarbons similar to type 5, but in addition to L and supercritical (Lsc) methane phases, also brown tar-like substance appears. T_H of $L + Lsc \rightarrow Lsc = +64°C$, on freezing $Lsc \rightarrow L_1 + G$, T_H = 99°C in L_1, P at +64°C = 300 atm. 7) Intercrystalline inclusions of light yellow-brownish oil, F variable, mainly L one-phase inclusions, luminescence yellowish-white, G phase appears mainly due to leakage. 8) S G/L inclusions of hydrocarbons, F $\sim$ 98%, T_H in L +41 to +60°C, luminescence deep yellow. G analysis yielded composition: CH_4 23, C_2H_6 12, C_3H_8 22, C_4H_{10} 9, C_5H_{12} 7, CO_2 3, N_2 3, H_2 14 (vol.%; by mass spectrometry). Probably aqueous-hydrocarbon solutions migrated in heterogenous state, occasionally boiling to form light (methane) and heavy (oil) fractions of hydrocarbons, T of fluid varied from +280 to 40°C, P occasionally was higher than 500 atm. (Abst. by A.K.)

GINZBURG, A.I., (ed.), 1976, Contributions to Genetic Mineralogy: Moscow, "Nauka" Pub. House, 151 pp (in Russian).

Includes 14 papers on typomorphism, paragenesis, experimental studies, and ontogeny of minerals. (AK)

GITTINS, J., FAWCETT, J.J., RUCKLIDGE, J.C. and BROOKS, K.C., 1977, Kalsilite, leucite, nepheline and potash feldspar in the Batbjerg intrusion, East Greenland; Natural examples of phase relations in the system $NaAlSiO_4$-$KAlSiO_4$-SiO_2-H_2O.(abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 989-990. First three authors at Department of Geology, University of Toronto, Canada, M5S 1A1.

GLEBOVITSKIY, V.A., editor, 1977, Thermometry and barometry of metamorphic rocks: Leningrad, Leningrad Division of the "Nauka" Publishing House, p. 208 pp. (in Russian).

The book, by twelve authors in the Institute of Geology and Geochronology of Precambrian of the Acad. Sci. USSR, includes descriptions and discussions of several methods of evaluating P-T conditions. The first chapter describes mineral facies as criteria for P and T of metamorphism. The second covers the distribution of elements in the coexisting minerals as a function of P-T. Thermometers and barometers based on distribution of isomorphous elements in mineral structures are presented in the third chapter, including experimental studies. Chapter four characterizes the linear discriminant functions as criteria of determination of thermodynamic parameters of crystallization of rocks (mineral pairs: orthopyroxene-clinopyroxene, clinopyroxene-hornblende, garnet-biotite, garnet-clinopyroxene). Methods involving fluid inclusions are given in Chapter 5. Interpretations of P-T_H determinations and solution composition are based on the example of the metamorphic Tsagan-Oluevskiy massif in E Transbaikalia, Central and SW Pamirs. The determined T and P for granites reach 900°C and 2.2 kb. The last (sixth) chapter, includes description of the use of dispersed elements for evaluation of thermodynamic conditions of metamorphism. (Abst. by A.K.)

GLEBOVITSKII, V.A., DRUGOVA, G.M., MOSKOVCHENKO, N.I., NIKITINA, L.P., PRIYATKINA, L.A., SEDOVA, I.S., 1977, The principles of mineralogical baro- and thermometry of metamorphic rocks: Proceedings of the USSR Academy of Sciences, Geol. Series, 1977, no. 9, p. 18-28 (in Russian).

GLUK, D.S., BAZAROVA, S.B., and TRUFANOVA, L.G., 1977, Phase relations in the system "Granite-H_2O" with addition of CsF, CsCl, Cs_2CO_3, RbCl and Rb_2CO_3 at 450-550°C and 1000 kg/cm: Ezhegodnik Sibirsk Inst. Geokhim. (Yearbook Siberian Inst. Geochemistry) for 1976, p. 170-175 (publ. 1977; in Russian with English abstracts.)

In the system granite-H_2O, in the presence of 1-2 wt.% of Cs or Rb, a mineral with a pollucite lattice forms. In systems with chlorides the biotite field widens. The temperature of silicate melt appearance in the presence of 0.5 wt.% Cs or Rb in the system is 450°C. (Authors' abstract).

GODBEER, W.C. and WILKINS,R.W.T., 1977, The water content of a synthetic quartz: Amer. Min., v. 62, p. 831-832. Authors at CSIRO Div. Min., North Ryde, N.S.W., Australia.

New water determinations are reported on X_0, a synthetic quartz which has been widely used for deformation studies. The infrared (0.059 wt.% H_2O) and classical (0.046 ± .002 wt.% H_2O) values are lower than that recently reported using the ion beam spectrochemical analyzer (IBSCA) technique by a factor of about 50. (Authors' abstract)

GOFF, F.E. and DONNELLY, J.M., 1977, Applications of thermal water chemistry in the Geysers-Clear Lake geothermal area, California (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 992.

GONCHAROV, V.I., SIDOROV, A.A., KRYLOVA, V.V. and GIMALETDINOVA, D.S., 1976, Composition of hydrotherms of anomalous type deposits (from the Lower Priamur'ye) (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 182 (in Russian; translation by A. Kozlowski).

Water leachates from quartz prove that the major constituents in early and late high-temperature stages are comparable: (Authors' abst.)

Stage	Associations	Composition of solutions and concentration of components,%	Total salt content, mg/100g	H_2O in sample wt. %	Concentration of the inclusion fluids, g/l
Early high-temperature	Quartz-adularia-hydromica	$\frac{HCO_3 53, Cl 15, SO_4 17}{K 37, Ca 36}$	31.70	0.75	42.3
	Quartz-chlorite-pyrite	$\frac{Cl\ 51, HCO_3 27, SO_4 21}{Na 41, K 28, Ca 25}$	83.08	0.65	127.8
Moderate temperature	Gold-chlorite-tetrahedrite	sic.			
	Quartz-carbonate-epidote	$\frac{SO_4 37, HCO_3 33}{Ca 41, Mg 25}$	16.24	0.51	31.8

(Continued on next page)

Moderate temperature	Quartz-rhodonite-carbonate	$\frac{\mathrm{HCO_3 70, SO_4 21}}{\mathrm{K29, Na26, Ca26}}$	23.88	0.84	28.4
	Gold-sphalerite-telluride	sic.			
Late high-temperature	Quartz-tourmaline	$\frac{\mathrm{HCO_3 58, SO_4 24}}{\mathrm{K56, Ca27, NaI4}}$	15.87	0.58	27.4
	Andradite-pyrite-chlorite	$\frac{\mathrm{HCO_3 61, SO_4 20, Cl\ 17}}{\mathrm{Ca49, Mg37}}$	31.39	0.39	80.5

GONCHAROV, V.I., SIDOROV, A.A., and LITVIN, O.N., 1976, Gas composition of hydrotherms of volcanogenic deposits (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 180-181 (in Russian; translation by A. Kozlowski).

Deposits of the NE part of the USSR were divided into two groups: I. those formed during T decrease and II. formed during T increase. Gases were analyzed in individual inclusions (see Table). H_2O and CO were found only in several samples from gold-argentite and gold-sulfoantimonite types of deposits. Hydrocarbons are absent. In the deposits of the anomalous type the content of HF + H_2S + SO_2 + NH_3 + HCl increases from early to late stages, and O_2 and CO are high only in initial and final stages. In the "normal" deposits the O_2/N_2 ratio is almost atmospheric: 0.25-0.35; in anomalous ones it varies strongly. Deposits with only silver are not comparable with the above types. (Authors' abst.)

Type of deposit		Mineral	T_H	Content of gases, % (vol.? A.K.)				
				$HF+H_2S+SO_2+NH_3+HCl$	CO_2	O_2	CO	N_2+rare gases
Normal (I)	Gold-sphalerite-galena	Quartz 1	325	3-6	68	6	0	26
		Quartz 2	260	0	47-86	2-11	0	13-42
		Quartz 3	240	0	62-67	7	0	26-29
		Calcite 1	290	0	68	6	0	25
		Calcite 2	245	0-2	42-69	6-18	0-10	25-32
	Gold-argenite	Calcite 2	275	0	57	9	0	34
		Quartz 5	315	0	69	6	0	25
		Quartz 6	360	2-45	21-46	18-39	0-10	8-24
Anomalous (II)	Gold-sulfoantimonite	Quartz	230	0-2	36-52	0-11	0-6	35-58
		Calcite	240	4-7	48-63	3-7	0	23-44
		Quartz	290	3-7	51-66	2-5	0-11	11-43
	Essentially silver	Quartz 1	350	2-3	31-50	0-31	0-10	34-58
		Quartz 2	375	0-6	24-46	7-13	0	58-63
		Quartz 4	360	0	25	4-11	0	64-69
		Quartz 5	380	0	36-58	0-16	0	41-54

Note: Ore-producing associations are underlined.

GONCHAROV, V.I. and VORONTSOVA, L.A., 1976, Hydrothermal solution compositions for some Yakutia tin deposits: Geokhimiya, 1976, no. 9, p. 1319-1326 (in Russian; translated in Geochem. Intern., v. 13, no. 5, p. 27-33).

Tin deposits of the pegmatite and cassiterite-quartz associations are produced from hydrothermal solutions of sodium chloride composition; deposits in the cassiterite-silicate-sulfide association are produced by calcium-magnesium bicarbonate-chloride solutions. The gas phases in these solutions show a marked tendency for the content of acid components to increase with the homogenization temperatures of the inclusions. Carbon dioxide often constitutes almost half of the gas phase in the inclusions of the cassiterite-quartz and cassiterite-silicate-sulfide associations, whereas for deposits of pegmatite type the level is less than 40%. There is no characteristic tendency for the CO_2 concentration to increase with the total salt content. (Authors' abstract)

GOODELL, P.C., 1977, Sulfide whiskers precipitated from connate waters (abst.): Geol. Soc. Amer, Abstracts with Programs, v. 9, p. 21.

Sulfide mineral whiskers are reported from numerous localities in sedimentary rocks in the interior lowlands of the central U.S. Such sulfides most often occur in quartz geodes or within coarse crystalline calcite in breccia zones. The sulfides are millerite whiskers or pyrite. Description of these crystals and their environments of formation has been undertaken in an effort to interpret their origin and to elucidate certain aspects of connate water behavior.

Fluid inclusion filling temperatures of quartz and calcite coexisting with the sulfides have been determined as follows: Halls, Gap, Kentucky, 170-210°C; Monroe Co., Indiana, 90-140°C; San Saba, Texas, 110-130°C. These temperatures are consistent with a connate water origin for the mineralizing solutions. Whisker morphology is suggestive of growth from supersaturation conditions. The documentation of supersaturated connate waters has important implications with respect to the origin of Mississippi Valley type lead-zinc deposits. (From the author's abstract)

GORBATYUK, O.I., SVERKUNOVA, T.V. and KURYAKOVA, O.P., 1976, Certain peculiarities of native gold and conditions of formation of Askol'd and Fashidon deposits (Primor'ye), in Genetic types and regularities of distribution of deposits of gold in the Far East (Materials of Conference on Gold Potential of the Amur area and adjacent regions, Blaysveshchensk, May 1971), editor V.G. Moiseenko, Novosibirsk, Siberian Branch of "Nauka" Publishing House, p. 78-81 (in Russian). Authors at the Far-East Geol. Inst. of Far-East Sci. Center of Acad. Sci. USSR, Vladivostok.

Kirovskoe deposit consists of four stages: 1) quartz-magnetite 300-250°C, 2) quartz-bismuthinite 250-200°C, 3) galena-sphalerite with quartz 220-190°C, 4) sulfantimonite with chalcedony-like quartz 200-160°C. Inclusion fillings in native gold from three deposits were also analyzed by the water leachate method. (The data are presented in a table, with 15 components listed in "g per 1000g H_2O", which we do not give here since there are apparently serious typographical errors, the data are stated with up to seven significant numbers, anions are nearly 10 times cations, and total ions are up to 20 times total H_2O. AK/ER)

GORDEEVA, V.I., 1976, Certain aspects of the genesis of apogranites: in Genetic studies in mineralogy, Yu.A. Dolgov et al., eds.: Novosibirsk, Inst. Geol. and Geophy. Sib. Branch Acad. Sci. USSR, p. 102-106 (in Russian).

Zinnwaldite- (or lepidolite-) amazonite-albite granites form apical parts of massif of leucocratic and biotite granites. Quartz of biotite granite bears besides S melt and S G/L inclusions, P melt crystallized inclusions, T_H 800-1020°C (G + 3 or more dms + sometimes up to 0.2 vol.% of L), G consists of "acid G" (17.0-18.5 vol. %) and CO_2 (83.0-81.5 vol. %). Zinnwaldite-amazonite-albite apogranite formed at 640-710°C from initially L, and later G solutions, main components H_2O and CO_2 (to 68.2 vol.%) and salt NaCl (up to 26%), P at T_H was 1350 atm. Zinnwaldite-albite-amazonite apogranite formed at 410-620°C from L and G solutions, G phase: $H_2O + CO_2$ up to 65 vol.%, H_2 up to 15 vol.%, N_2+rare G up to 20 vol.%, NaCl prevails among salts, P at 620°C - 1000 atm. Zinnwaldite (cryophyllite)-amazonite-albite apogranites formed at 400-520°C from L and G solutions of essentially NaCl + gas: H_2O, CO_2 - 36.4 vol.%, P at 520°C ∿600 atm. Quartz-amazonite veins formed at 260-350°C from L solutions of mainly NaCl + gases: H_2O, H_2 up to 10 vol.%, N_2+rare G up to 26.4 vol.%, P at T_H - 150-60 atm. Riebeckite-albite apogranites crystallized at 410-480°C.

P melt crystallized inclusions in quartz of biotite granite underlying lepidolite-amazonite-albite apogranite yielded T_H 850-1100°C; P melt-solution inclusions in quartz of the porphyry-type two-mica granite, bearing G, L and dms in vol. ratio 10:5:85, have T_H 800-850°C. (Abst. by A.K.)

GORDEEVA, V.I., AKIMTSEV, V.A. and SURZHKO, A.S., 1976, Conditions of crystallization of beryl in apogranite (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 115-116 (in Russian; translation by A. Kozlowski).

1. P inclusions of solutions-melts were studied in beryl from greisens and topaz-quartz-beryl veinlets.

2. Composition of inclusions: G 10-20, L CO_2 15-40, L H_2O 20-40, dms 20-65 vol.%, T_H 740-520°C.

3. P (dms omitted) 4500 ± 500 atm, density of homogeneous, highest -T inclusion 1.75 g/cm^3.

4. P in various crystals ranges from 4500 to 2500 (± 500) atm.

5. Water leachates bear Li, Na, K, Nb, Ta, F, Cl, HCO_3 and SO_4 (...) (Authors' abst.)

GORDEEVA, V.I. and SENINA, V.A., 1976, Primary inclusions in quartz from the bottom structural zones of apogranite (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 111 (in Russian; translation by A. Kozlowski).

1. Zonal, rare-metal-bearing (unspecified, A.K.) granite massif was studied.

2. In quartz from biotite granite wall rock inclusions were found: a) P crystalline; b) P crystallized, T_H 1110-850°C, G 5-10, dms 95-90 vol.%; c) S G/L.

3. In quartz from bottom biotite-muscovite granite there occur inclusions: a) P crystalline; b) P inclusions of solutions-melts, T_H

850-800°C, G 10 L 5, four dms 85 vol.%; c) G/L.

4. Minerals of the third from the bottom, muscovite zone bear inclusions of solutions-melts: G 10, L 10-15, four dms 80-75 vol.%, T_H 800-730°C.

5. P during formation of two-mica and muscovite zones (on the basis of CO_2 density and P of salt solution) were 1000-500 atm.

6. In the upper zones: lepidolite-albite, amazonite-albite and amazonite-albite plus lepidolite, T_H of P melt and solution-melt inclusions 1100-730°C; P 1000-500 atm; during T decrease water and CO_2 contents increased. (Authors' abst.)

GOVOROV, I.N., 1977, Thermodynamics of ionic mineral equilibria and mineralogeny of hydrothermal deposits: Moscow, "Nauka" Publish. House, 239 pp (in Russian).

Consists of two parts: Thermodynamics of ionic mineral systems under hydrothermal conditions; and Mineralogeny of hydrothermal deposits. Includes data tables as Appendices. (AK)

GOVOROV, I.N. and BLAGODARYEVA, N.S., 1977, Physico-chemical conditions of formation of the tungsten-tin deposits of quartz-greisen and silicate-sulfide groups (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Sib. Branch, v. I, p. 119-120 (in Russian; translation by A. Kozlowski). First author at the Far-East Geol. Inst. of the Far-East Sci. Center of Acad. Sci. USSR, Vladivostok.

Post-granitic mica-quartz greisens formed at 500-300°C from acid solutions (pH 4 to 1); ore minerals (cassiterite, wolframite, Nb-Ta minerals) precipitated at 350-250°C from solutions of pH ∿4. Mica-albite greisens formed at 550-400°C, pH of solutions 2.5-4. Migrating toward surface, the solutions cooled and neutralized: at 280-250°C quartz crystallized. Albite-topaz-fluorite greisens bear inclusions yielding T 500-375°C; pH 3-4.5. Ore-bearing zones formed at 375-275°C; pH 4.5-5. Big quartz greisen veins formed from solutions of pH 5-3 at T 350-200°C. Silicate-sulfide deposits formed at T 550-400°C (tourmalinites, boron compounds activity ∿0.01 m), 500-250°C (quartz-cassiterite), pH 7-4. (abst. by A.K.)

GOVOROV, I.N., BLAGODAREVA, N.S., KOKORINA, L.P., GRIGOR'IEVA, O.F. and GORBACH, L.I., 1976, Pneumatolytic and hydrothermal mineral-formation in magmatogenic deposits (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 69 (in Russian; translation by A. Kozlowski).

Strictly pneumatolytic minerals form only at the earliest and the most high-T stage of post-magmatic process. Albitization coincides with the beginning of condensation of G fluids, and development of the rare-metal albitites and greisens - with transition from supercritical to hydrothermal solutions. During formation of skarn-sulfide, tin-sulfide, cassiterite-quartz etc. deposits of this type, pneumatolysis is local and connected with fracturing. In large open voids, separation of supercritical fluids with various degree of contrast is possible, to form an aqueous vapor fraction in front zone (in the direction of motion) and concentrated hydrothermal solution in the rear. The weakly mineralized front phase formed pre-ore metasomatites (skarns, greisens, propylites), whereas ore precipitated from the concentrated solutions. (Author's abstract.)

GRABEZHEV, A.I., 1977, On conditions of formation of rare-metal and gold ore hydrothermal deposits (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Sib. Branch, v. 1, p. 121-122 (in Russian; translation by A. Kozlowski). Author at Inst. Geol. Geochem. of the Urals Sci. Center of Acad. Sci. USSR, Sverdlovsk.

The deposit occurs in slaty-carbonate rocks and intruded alaskite granite. It was formed in skarn, feldspathic, greisen, sulfide and quartz-carbonate-fluorite stages. Cassiterite, wolframite, and chrysoberyl are ore minerals.

Pyroxene-garnet-vesuvianite skarns formed at $T_{(H)}$ 500-450°C, albitites at 370-350°C, greisens in granites at 330-310°C, rare-metal veins and apocarbonate greisens and greisenoids at 300-280°C, post-ore quartz-carbonate-fluorite metasomatites at 250-230°C. Solutions varied strongly in composition, being of Cl, Na, HCO_3 type, concentration was 2-3% (Abst. by A.K.)

GRAF, D.L. and ANDERSON, D.E., 1977, Concentration dependence of activation free energies in electrolyte diffusion (abst.): Amer. Geophys. Union, Trans., EOS, v. 58, no. 6, p. 539.

GRANOVSKAYA, N.V., 1976, Statistical analysis of the volume of fluid inclusions and its significance in studies of ontogeny of mineral systems (abst): Problems of genetic information in mineralogy (Proceedings of the All-Union Mineralogical Seminar), Syktyvkar, June 1-4, 1976: Syktyvkar, Acad. Sci. USSR, Komi Div., p. 72-73 (in Russian; translation by A. Kozlowski). Author at the Rostov State Univ., Rostov.

Morphology, dimensions and number of inclusions per unit volume (F) are very important sources of information on ontogeny of mineral systems. Those parameters were determined for granites, pegmatites and hydrothermal veins of N. Caucasus, Kazakhstan and Donbass.

Minerals formed under extremely non-equilibrium conditions bear the highest amounts of inclusions. The smaller the supersaturation of mineral-forming solutions and the slower the precipitation, the greater the dimensions of the inclusions. Content of inclusions sharply increases in hydrothermally altered and greisenized granitoids, veins, etc. (From the author's abst.)

Location	Mean number of inclusions per $1 mm^3$ of rock ($x10^3$)	Mean size of inclusions (μm)	Mean content of inclusions in rock (vol.%)
	Granitoid massifs of N. Caucasus		
Urushtenskiy	180-290	2	0.3-0.4
Dakhovskiy	180	2	0.3
Pshishkiy	90-180	2	0.25
Kti-Teberda	300-400	1.4	0.4

(Continued on next page)

Location	Mean number of inclusions per $1mm^3$ of rock ($x10^3$)	Mean size of inclusions (μm)	Mean content of inclusions in rock (vol.%)
Granite from Zgidskoe polymetallic deposit	400-600	1.3	0.6
	Pegmatites		
N. Caucasus	200-390	2.5-3	0.5-0.7
Kazakhstan	20-50	10 (up to 200)	2-5
	Veins		
Hydrothermal quartz from the coal deposits in Donbass	400	3	2-3
Rock-crystal-bearing quartz veins in Donbass	550-700	3	5

GRANT, M.A., 1977, Broadlands-a gas-dominated geothermal field: Geothermics, v. 6, p. 9-29. Author at Dept. Sci. Indust. Research, Wellington, New Zealand.

Broadlands geothermal field is a hot-water system containing a few percent of non-condensable gas (carbon dioxide). This small fraction of gas makes the field response markedly different from a conventional hot-water system like Wairakei. The gas pressures cause boiling at depths of about 2 km, so the bores exploit only the two-phase zone. (From the author's abstract)

GRECHISHNIKOV, N.P., KRAMAR, O.A., KUZNETSOVA, S.V., MAKIVCHUK, O.F., NIKOLAENKO, V.I., OBRIZANOV, V.N., and POPOV, N.I., 1977, Peculiarities of hypogene zoning in a certain deposit of sodium-uranium formation: Geologicheskiy Zhurnal, v. 37, no. 3, p. 61-69 (in Russian). Authors at Inst. Geochem. and Physics of Minerals, Acad. Sci. Ukrainian SSR, Kiev.

The deposit occurs in metasomatized granodiorites. Late albite in metasomatites bears G/L inclusions with 10-25 vol.% of G phase, sometimes with LCO_2. T_H in upper part of albitite body range from 270 to 130°C (28 determinations, mean 185°C), in lower part--from 400 to 140°C (40 determinations, mean 250°C). (Abst. by A.K.)

GREENWOOD, D.A. and SMITH, F.W., 1977, Fluorspar mining in the northern Pennines: Inst. Mining and Met., Trans., v. 87, p. B181-B190.

Within individual ore zones trace-element geochemistry and fluid inclusion T_H studies show that vein intersections acted as major channelways for ascending mineralizing solutions. (From the authors' abstract)

GREW, P.C., 1977, Mineralization in microfractures by stress corrosion cracking (abst.): Econ. Geol., v. 72, no. 4, p. 729.

See Fluid Inclusion Research -- Proceedings of COFFI, v. 9, p. 51 (ER)

GRIB, Ye.N., 1976, Temperatures of crystallization of extrusive lavas of the post-caldera stage of the Uzon-Geyzernaya depression (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 99-100 (in Russian; translation by A. Kozlowski).

Extrusions are polyphase and with continuous transitions from dacite (Belaya, Ostanets) to liparite compositions (Sosedka, Geyzernaya, Kruglaya). In the final stage of formation of the Geyzernaya extrusion, a boulder lava flow of andesite-dacite composition formed. Similar dikes formed at the extrusion Ostanets. Plagioclase from lavas bears glass or crystallized melt inclusions, sometimes also polyphase inclusions with plagioclase, magnetite and pyroxene in the glass. Moreover purely G inclusions were found as faceted vacuoles, about 40 μm long, occasionally bearing a droplet of melt, some liquid either existing at room T or appearing at 68.5°C (sic.). At 450°C L evaporates. In acid lavas early plagioclase crystallized under deep conditions at T 1340-1300°C (dacite from Ostanets), but the external zones formed at 1290-1250°C. In liparite flows of the Geyzernaya and Kruylaya extrusions, T of plagioclase formation are 1290-1240 and 1190-1140°C; T decreases over a 20°C range from the bottom flows to the upper ones. Last andesite-dacite flow of the Geyzernaya extrusion has T_H 1250-1200°C (P inclusions) and 1180-1140°C (PS inclusions). (Author's abst.)

GRIGORCHUK, G.Yu., 1976, On some links of geological and physico-chemical conditions of hydrothermal mineral formation (using certain ore deposits of the East Transbaikalia as examples): Proceedings of the USSR Acad. Sci., Geol. Ser., no. 9, p. 88-102 (in Russian). Author at L'vov State Univ., L'vov, Ukrainian SSR.

Ore formations are connected with Mesozoic rocks: grantoids, dikes of diabases, lamprophyres etc., and terrigenic-volcanogenic sediments. T conditions of origin were as follows (T_H, °C):

		Blocks of the Krasnoyarovo-Zolinskoe ore field			
	Stage of development	N. Alenuyskiy	S. Alenuyskiy	Borovskiy	Masyukovskiy
1.	Quartz-tourmaline				
a)	early: sericite-pyrite-tourmaline-quartz	440-380, in G 365-320, in L			
b)	late: K-spar-albite-pyrite-quartz-tourmaline	380-370, in G 320-290, in L	380-370, in G 320-290, in L		
2.	Quartz-magnetite				450-330, in L
3.	Molybdenite-quartz				
a)	early: molybdenite-K-spar-quartz	490-390, in G 385-380, in L		490-390 in G 385-380 in L	
b)	middle: molybdenite-sericite-quartz	380-340, in L		380-340 in L	
c)	late: molybdenite-K-spar-quartz	330-300, in L			
4.	Quartz-arsenopyrite-pyrite				
a)	early: sericite-quartz-pyrite-arsenopyrite	310-250 in L			
b)	late: K-spar-carbonate-arsenopyrite-pyrite	250-200, in L			
5.	Quartz-polymetallic				
a)	early: sericite-quartz-sphalerite-galena	330-240, in L		310-265 in L	320-260, in L
b)	late: chlorite-quartz-carbonate-sphalerite-galena	230-200, in L	230-210, in L		320-200, in L
6.	Gold-pyrite-quartz			300-220 in L	390-220, in L
7.	Quartz-carbonate	180-80, in L	150-100, in L		140-80, in L

In the Kluchevskoe ore field (molybdenite, chalcopyrite, pyrite, gold, antimonite) T_H ranges from 550 to 180°C and P from 2200 to 1000 atm. (Abst. by A.K.)

GRIGORCHUK, G.Yu., 1977, Space-and-time evolution of certain physico-chemical parameters of formation of hydrothermal ores (exemplified by the deposits of Transbaikalia) (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. I, p. 151-152 (in Russian; translation by A. Kozlowski). Author at the L'vov Univ., Ukrainian SSR.

Block structure and numerous stages of mineral-formation are the most important features of these deposits. Several paragenetic associations formed from solutions of various alkalinity, that may be arranged into two typical sequences (see table).

Table. Temperature regime of formation of mineral parageneses of some stages (°C)

Stage of Mineral formation	First sequence			Second sequence	
	Mineral parageneses				
	Early	Middle	Late	Early	Late
	Kluchevskoe ore field				
Molybdenite-quartz	550-440 (II) 430-425 (I)	440-390 (II) 380-340 (I)	330-290 (II)		
Gold-quartz-pyrite-chalcopyrite	430-400 (II) 400-380 (I)	370-320 (I)	310-260 (I)		
Gold-polymetallic	320-300 (I)	300-260 (I)	250-210 (I)		
	Aprelkovskoe ore field				
Gold-quartz-pyrite-arsenopyrite	390-320 (I)	320-280 (I)	270-250 (I)		
Gold-quartz-bismuthinite				380-330 (I)	330-270 (I)
Gold-polymetallic				320-290 (I)	280-230 (I)
	Krasnoyarovo-Zolinskoe ore field				
Molybdenite-quartz	490-390 (I) 385-380 (I)	380-340 (I)	330-300 (I)		
Quartz-polymetallic				330-240 (I)	230-200 (I)

NOTE: (I)- homogenization in L, (II) - homogenization in G. (Abst. by A.K.)

GÜBELIN, E., 1977a, Inclusions in fluorite: Lapis, 1977, p. 2, 5, 16-19 (in German).

Typical inclusions are illustrated in colour, including green crystals of chlorite, secondary liquid inclusions, 3-phase inclusions and euhedral pyrite crystals. (Abst. from J. Gemmol.)

GUBELIN, E.J., 1977b, Further notes on mono- and bi-phase inclusions in amethyst and topaz: The Jour. Gemmology, v. 15, no. 16, p. 289-294.

Inclusions in an amethyst of unknown origin and a blue topaz from the St. Anne's Mine, Miami, Rhodesia were studied by microthermometry. Phase changes among the numerous daughter minerals are described and some are thought to be sulfates. (ER)

GUGUSHVILI, V.I. and AKHVLEDIANI, R.A., 1977, Dynamics of post-volcanic process exemplified by development of propylitization and hydrothermal mineralization in Adzharo-Trialet Paleogene complex, in: Hydrothermal process in the areas of tectonic-magmatic activity, p. 247-254, "Nauka" Publ. House, Moscow (in Russian).

Minerals of hydrothermal associations, formed from ascending solutions on a background of propylitization, yielded T_H 350°C (ranges 260-440°C), measured in quartz. (A.K.)

GUILBERT, J.M., 1977, Porphyry ore deposit classification problems (abst.): Geol. Assoc. Canada-Min. Assoc. Canada Program with Abstracts, v. 2, p. 22.

GUNOW, A.J. and MUNOZ, J.L., 1977, Evidence for high fluorine activity in magmatic and hydrothermal fluids at the Henderson molybdenite deposit, Colorado (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 1000. Authors at Department of Geological Sciences, University of Colorado, Boulder, Colorado 80309.

Anomalously high fluorine values have been found in biotite, muscovite, sericite, and garnet associated with the various intrusive, mineralization and alteration sequences at the Henderson molybdenite deposit in Clear Creek Co., Colorado. Twelve-element microprobe analyses of primary biotite in the Tertiary rhyolite intrusive phases indicate 3-6 wt. % F, 0.21-0.41 mole fraction Mg (Xmg). Hydrothermal vein biotite associated with MoS_2 mineralization contain 5-7.5% F, 0.5-0.6 Xmg. Sericite from the pervasive quartz-sericite-pyrite alteration halo contains 0.4-2.0% F.

Due to the strong preference of F for Mg-biotite, direct comparison of F percentages as indicators of relative changes in F activities is valid only for biotites having similar Xmg. Outside the pervasive alteration zones, Xmg for primary biotite within the host Urad porphyry is remarkably uniform (Xmg = .23±.02). Fluorine in these bioties is highest adjacent to mineralization. Within the ore body and in the pervasive alteration zones the Xmg and F values in both primary and hydrothermal biotite are more variable and require application of previously calibrated F-OH exchange equilibria to properly evaluate relative F activities.

Mn-garnet containing up to 3.5% F has also been found as a common constituent of greisen-type alteration at Henderson. Fluorine has not previously been recognized as a possible garnet component.

The unusually high F values in both the mica and garnet establish that F was an important constituent of the fluid phases throughout the magmatic, mineralization and alteration stages at Henderson. (Authors' abstract)

GUROV, Ye.P., GUROVA, Ye.P., and KHRENOV, A.Ya., 1976, Decrepitophonic prospecting for fluorite in the Eastern Priazov'ye, (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 138 (in Russian; translation by A. Kozlowski).

Fluorites from Pokrovo-Kireevskoe deposit occur in limestones of Lower Carboniferous as lenses and semistratabound ores, under overlying Mesozoic and Cenozoic deposits. Fluorite bodies are surrounded by large impregnation aureoles, where intensity of decrepitation is 10-20 times higher than background. Decrepitophonic activity of ore itself (carbonates + CaF_2) is 300-400 times, +carbonates + CaF_2 + feldspars, 100-200 times higher than background. Aureole is most distinct above ore body. Composition of wall-rocks has no influence on intensity of decrepitation. Dikes and bodies of malignites, keratophyres and orthopyres do not form aureoles of hydrothermal impregnation. (From the authors' abst.)

HAAPALA, I., 1977, Petrography and geochemistry of the Eurajoki stock, a rapakivi-granite complex with greisen-type mineralization in southwestern Finland: Geological Survey of Finland, Bulletin 286. 128 pp.

Greisen-type Sn, Be, W, and sulfide mineralization occurs in various parts of the stock. Fluid inclusons were studied in the greisen minerals. T_H cassiterite - 300-380°C; quartz 310-355; beryl from central veinlets 370-390°C (all in liquid). Some in beryl also homogenize in gas at 380-400°C. T_{Frz} cassiterite -7.9 to -7.35°C; in beryl -7.3 to -4.4°C. Some small unidentified dms found, one isotropic one in cassiterite has n = liquid, hence may be cryolite, hieratite (K_2SiFe), or cryolithionite. Some liquid CO_2 seen. (ER)

HAAS, J.R., Jr., and POTTER, R.W. II, Jr., 1977, Model for predicting thermodynamic properties of complex brines (abst.): Geological Research 1977, U.S. Geol. Survey Prof. Paper 1050, p. 182.

Methods for calculating the vapor pressure and volumetric properties of complex brines have been developed. The vapor pressure may be calculated from the boiling point and freezing point of the solution while the volumetric properties may be calculated from the volumetric properties of the binary components. These parameters may in turn be used to erect a PVTX grid from which the thermodynamic properties may be extracted.

If the brine has a freezing point, a boiling point, and volumetric properties similar to a solution with known thermodynamic properties, the thermodynamic properties of the known solution can be used to represent those of the geothermal brine. NaCl solutions are the only ones whose thermodynamic properties are known in the P-T range of geothermal interest. Experimental studies confirmed that most synthetic brines in the system Na-K-Ca-Mg-Cl-SO_4-Br have boiling and freezing points that correspond to more concentrated NaCl solutions. The volumetric properties were found to be essentially the same (i.e., the density was ±0.001 g/cm^3 to ±0.007 g/cm^3 of the NaCl solution). Hence, from the freezing point depression and boiling point elevation of the brine, one can estimate the thermodynamic properties by using the measured NaCl equivalents and Haas' equation of state. (Authors' abstract)

HAGNI, R.D. and WEI, C.-S., 1977, Ore microscopy and fluid inclusion geothermometry of sphalerite from the Tri-state zinc lead district, Missouri, Kansas, and Oklahoma (abst.): Geol. Assoc. Canada-Min. Assoc. Canada Program with Abstracts, v. 2, p. 22. Authors at Dept. of Geology and Geophysics, University of Missouri-Rolla, Rolla, Missouri, 65401.

Fluid inclusions in successively deposited generations of sphalerite from the Tri-State district have been examined for geothermometry as a function of time. Ore microscopic examination of Tri-State ore shows that sphalerite has been deposited during five periods. The main period of vug-filling sphalerite has been studied most intensively and as many as 83 fluid inclusions have been examined in a single crystal. These sphalerite crystals are commonly zoned, and their filling temperatures exhibit a general pattern of declining temperature from their cores outward, from about 135°C down to 90°C. The decline is not a steady one, but rather it is characterized by fluctuations commonly about 15-20°C.

Earlier deposited yellow disseminated sphalerite was formed in a narrow temperature interval, 120 to 85°C, a range lower than that of the earliest main stage sphalerite. Small, reddish brown sphalerite, deposited after main stage sphalerite, appears to have formed at about the same or slightly higher temperature than the late portions of the zoned sphalerite crystals. It is concluded that the Tri-State deposits were formed from ore-bearing fluids which gradually declined in temperature but that fluctuations in temperatures of deposition occurred between generations of sphalerite and throughout a single period of sphalerite deposition. The fluctuating character of the ore-forming fluid may be the result of multiphase introduction of the ore fluid or of mixing with a cooler fluid. (Authors' abstract)

HAJASH, Andrew, 1977, Experimental seawater/basalt interactions: effects of water/rock ratio and temperature gradient (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 1002.

HALLS, C., RANKIN, A., FERRIDAY, I.L., BLAIN, C.F., BRISTOW, C.M. and GRONOW, C., 1977, A tourmalinized hydrothermal intrusion breccia at Wheal Remfry in the western part of the St. Austell pluton, Cornwall (abst.): Inst. Mining and Met., Trans., Sect. B, v. 86, p. B163.

A study of kaolin mine. Cogenetic fluid inclusions from phenocrysts and hydrothermal quartz show that explosive brecciation took place at temperatures in excess of 300-400°C, in the presence of a highly saline fluid (36-46 eq. wt. % NaCl, sp.gr. 1.2-1.4), which was progressively boiled and diluted: three-phase inclusions of intermediate salinity and monophase vapour and aqueous inclusions were produced. Minimum depths of formation calculated from inclusion data were of the order of 1-1.5 km.

The Remfry breccia strongly resembles tourmalinized hydrothermal breccias associated with the tin-bearing subvolcanic eruptives of the eastern Cordillera in Bolivia, and provides evidence of the explosive release of volatiles during the transition from the magmatic to hydrothermal stages of evolution of the megacrystic lithium mica-granite that composes the western portion of the composite St. Austell pluton. (From the authors' abstract)

HASELTON, H.T., Jr., SHARP, W.E., and NEWTON, R.C., 1977, Decarbonation reactions and derived CO_2 fugacities at high pressures and temperatures (abst.): Amer. Geophys. Union Trans., EOS, v. 58, p. 1243.

HAYASE, Kitaro, MAS, G.R., and BENGOCHEA, A.L., 1977, Synthesis of barium-strontium sulphate solid solution and some considerations on the genesis of barite-celestite deposits in Neuquen Province, Argentina: J. Japan Assoc. Min. Petr. Econ. Geol., v. 72, p. 93-102. (in English)

Many barite-celestite deposits are found in Neuquen province, Argentina. Some of them are of vein-type traversing stratified rocks. Others have bedded shapes, roughly concordant with stratification and formed by selective replacement of limestone seams by barite and celestite. Measured homogenization temperature of liquid inclusions in barite and celestite (114-157°C), their chemical compositions, wall-rock alterations, the associated sulphide minerals and the results of the present synthesis experiments suggest that these deposits were formed under the following conditions: (1) Some of the ore deposits were formed by hydrothermal solutions poor in strontium at rather high temperatures; (2) Some others were formed by hydrothermal solutions rich in strontium at rather high temperatures; and (3) the rest of the deposits were formed by hydrothermal solutions rich in strontium at rather low temperatures. (From the authors' abstract).

HELZ, R.T., 1977, Determination of the P-T dependence of the first appearance of FeS-rich liquid in natural basalts to 20 kb (abst.): Amer. Geophys. Union, Trans., EOS, v. 58, no. 6, p. 523.

HEMMINGSEN, E.A., 1977, Spontaneous formation of bubbles in gas-supersaturated water: Nature, v. 267, p. 141-142.

Of interest to the problem of nucleation of vapor bubbles in previously homogeneous inclusions. (ER)

HESS, P.C., 1977, Structure of silicate melts: Canadian Mineralogist, v. 15, p. 162-178.

HEWITT, J.M., 1976, Recent research in structural geology, rare earth geochemistry and ore genesis: Commonwealth Comm. on Mineral Resources and Geology, Liaison Report CGLO LR 125, 31 pp.

A report on several geological meetings in the U.K. A tectonics meeting included a discussion of infrared work (presumably that of M.E. Jones of Imperial College) on hydroxyl groups in natural and synthetic quartz, and their effects on strength. Fluid inclusions form only in synthetic quartz on heating, by precipitation of molecular water, turning the samples opalescent, but the similarity of this result to natural milky quartz suggests a similar solid state origin. On deforming sandstones, work-hardening due to pinning of dislocations by "bubbles" occurs. (E.R.)

HIBBARD, M.J., 1977 A reinterpretation of myrmekite and its significance in the magmatic-hydrothermal boundary problem (abst.); Geol. Soc. Amer. Abstracts with Programs, v. 9, p. 435.

A century of dispute over the origin of myrmekite can be largely attributed to one simple textural relation that has been repeatedly misinterpreted, namely the replacement interpretation of myrmekitic oligoclase-quartz intergrowths which have "protrusive" form in alkali feldspar. A sequence of crystallization, including late-stage development of myrmekite, is here proposed for the Sands Springs porphyritic quartz monzonite (Nevada), in which the "protrusive" character of myrmekite is interpreted as no more a replacement phenomena than would be a feldspar crystal protruding into a miarolitic cavity. The origin of most, if not all, myrmekite (sensus stricto) is thought to lie with a rather simple model of rapid simultaneous crystallization of oligoclase and quartz (yielding myrmekite) as overgrowth on earlier plagioclase crystals, attendant to local pressure quenches resulting from partial escape of a separating aqueous phase from a late-magmatic aqueous-rich fluid that then proceeds to crystallize, quasi-hydrothermally, alkali feldspar after, and around, the just prior-formed, myrmekite. The location of such a late-magmatic aqueous-rich fluid determines the location of myrmekite. If it remains essentially in situ then myrmekite coexists with silicate phases crystallized before aqueous saturation as well as with quasi-hydrothermal alkali feldspar. If it escapes the system, myrmekite can associate with aplite-pegmatites, hydrothermal veins, or even occur in metamorphic wall rock. Myrmekite can thus be used as an indicator of the nature of fluid in many geologic situations, and of the "timing" of aqueous phase saturation relative to changing crystal/melt ratios in crystallizing magmas. (Author's abstract)

HOAGLAND, J.R., 1977, Petrology and geochemistry of hydrothermal alteration in Borehole Mesa 6-2, East Mesa geothermal area, Imperial Valley, California (abst.): Econ. Geol., v. 72, no. 4, p. 730.

HOEFS, J. and STALDER, H.A., 1977, The carbon isotope composition of CO_2-bearing inclusions in fissure quartz from the central Alps: Schweiz. mineral. petrogr. Mitt. v. 57, p. 329-347. First author at Geochem. Inst. der Univ., Goldschmidtstrasse 1, D-34 Göttingen, Germany.

The carbon isotopic compositions of CO_2 - liberated by thermal decrepitation - from Alpine fissure quartzes has been determined mass-spectrometrically. The $\delta^{13}C$-values of the CO_2 vary between -2.0 and -9.6 $^{\circ}/_{\circ\circ}$ (PDB). Besides CO_2 considerable quantities of hydrocarbons have been found in many cases. This finding, however, has not been confirmed by microthermometric analyses. The $\delta^{13}C$-values of the total carbon in the fluid inclusions (CO_2+hydrocarbons) vary between -10.1 and -23.7$^{\circ}/_{\circ\circ}$. It is concluded that the CO_2 is either of juvenile origin or represents a mixture of decarbonization-CO_2 and CO_2 derived from the carbonaceous matter of the surrounding rocks. The latter assumption seems to be justified especially in those cases where the total carbon in the fluid phase has relatively light δ-values.

During the crystallization of the fissure quartzes an enrichment in ^{12}C is observed in the later (younger) fluids which correlates with decreasing CO_2-contents and increasing hydrocarbon contents. This phenomenon is especially pronounced in the "Fensterquarz" representing crystals from the latest fluids. (Authors' abstract)

HOLLOWAY, J.R., 1977a, The effect of fluorine on dehydration equilibria (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 1021.

HOLLOWAY, J.R., 1977b, Fugacity and activity of molecular species in supercritical fluids: Thermodynamics in Geology, D.G. Fraser (ed.), D. Reidel Publ. Co., p. 161-181.

HOPKINS, D.M., 1977, An improved ion-selective electrode method for the rapid determination of fluorine in rocks and soils: Jour. Research U.S. Geol. Survey, v. 5, no. 5, p. 589-593.

HUANG, Chi-I, 1977, Fluid inclusion study of well cuttings from Magmamax #2 drillhole, Salton Sea geothermal area, California (abst.): Econ. Geol., v. 72, no. 4, p. 730.

Abundant fluid inclusions occur in hydrothermal calcite, anhydrite, and quartz selected from cuttings from depths of 590 to 1,220 m, Magmamax #2 drillhole, Salton Sea geothermal area. At room temperature, most inclusions contain vapor and liquid phases with vapor/liquid volume ratios of about 0.1. Inclusions were heated in a gas-medium heating chamber until homogenization. Pressure-uncorrected filling temperatures are generally within 30°C of the drillhole temperatures, the latter being lower in most cases. A single crystal of quartz from about 591 m depth shows a systematic change in the filling temperatures of 10 inclusions from 230±6°C (cf. drillhole temperature of 235°C) to 261±6°C over a distance of 0.1 mm. These measurements indicate that the reservoir has probably cooled down by at least 25°C.

For geothermal resource study, fluid inclusion geothermometry provides a useful supplement or alternative to the measured drillhole temperatures which may not always be the same as pre-drilling temperatures. (Authors' abstract)

HULSTON, J.R., 1977, Isotope work applied to geothermal systems at the Institute of Nuclear Sciences, New Zealand. Author at Inst. Nuclear Sci., D.S.I.R., Lower Hutt, New Zealand.

A number of isotope techniques are being applied to the study of the New Zealand geothermal areas. Stable isotope equilibria have been used to estimate temperature profiles underground. Present results indicate that the hydrogen-water and sulphate-water (^{18}O) equilibria represent temperatures close to the surface, while the $^{13}CO_2$-$^{12}CH_4$ and $H^{34}SO_4^-$-$H_2{}^{32}S$ equilibria are much slower to re-establish and probably represent temperatures at greater depth. Dating by natural radioactive carbon-14 and tritium techniques have so far only been able to show that the water circulation times are greater than 20 yr. Hydrogen and oxygen-18 measurements indicate that the geothermal waters originate mainly from local groundwaters but may have undergone varying oxygen shifts by reaction with rocks in the system. Ore bodies in the Tertiary volcanics of New Zealand are being studied as indicators of past geothermal conditions. (Author's abstract)

HYVÄRINEN, L., KINNUNEN, K., and MÄKELÄ, M., 1977, The geochemistry, fluid inclusions, sulfur isotopes and origin of the Hammaslahti copper ore deposit, Finland: Geological Survey of Finland, Bulletin 293, 23 pages and 14 figures. First author at Geological Survey of Finland, SF-02150 Espoo 15, Finland.

The origin of the Hammaslahti copper ore deposit was investigated through a geochemical study of the Cu, Ni, Co, silicate iron, Zn and Pb distributions in the ore proper and in the adjoining clastic, nonvolcanic sedimentary rocks. A total of 27 fluid inclusion examinations were carried out on gangue minerals from the ore proper and from its host rocks. The isotope composition of sulfide sulfur was determined in 34 samples.

The ore is surrounded by distinct negative aureoles of Cu and Co, and by a positive Ni aureole.

Fluid inclusion studies indicated a minimum formation temperature of 310°C and H_2O, H_2S, CO_2 and Se as the main chemical components of the ore-forming fluids.

The overall range of the $\delta^{34}S$ values is from +1.4 to +14.2 o/oo; the arithmetic mean being +5.5 o/oo. The sulfides of the ore proper exhibit a mean $\delta^{34}S$ of +3.8 o/oo with a standard deviation of 0.8, whereas those from host rocks outside the ore show a mean $\delta^{34}S$ of +6.3 o/oo with a standard deviation of 2.6.

The results favor the conclusion that once-disseminated synsedimentary sulfides were remobilized to form the ore. (Authors' abstract.) The inclusion temperatures were for T_D of small (2-10 μm) inclusions with moderately high pressure CO_2; the Se was found as a trace in sublimates from decrepitation runs. (ER)

ICHIKUNI, Masami, 1977, H_2S concentration in the Kuroko-forming solution estimated from chemical composition of electrum: Mining Geol. (Japan), v. 27, p. 331-333 (in Japanese with English abstract).

The partition of silver between solution and electrum was used to estimate H_2S concentration in the Kuroko-forming solution. The calculation was made for a 1 molal NaCl solution at 250°C. The Ag/Au ratio in the ore solution was assumed to be identical with their crustal abundance ratio. Electrum containing as much as 35% silver can be deposited from the solution with $a_{HS^-} = 10^{-4.5}$, which corresponds to 100 ppm as H_2S at pH 5. Gold is dissolved as thio-complex $Au(HS)_2^-$ in the ore solution. (Author's abstract)

IKORSKIY, S.V., 1976, Quantitative determination of water during thermobarographic analysis of inclusions in minerals (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 174-175 (in Russian; translation by A. Kozlowski).

Two runs were made in the thermobaric decrepitation apparatus with measurements of P of the released G. The first one, usual, the second with a water absorber between the furnace and recording system, eliminating the ambiguity of interpretation of "volatiles" in inclusions and to distinguishing water from G substance. (From the author's abst.)

IKORSKY, S.V., 1977, On the character of distribution and accumulation time of hydrocarbon gases in rocks of the Khibiny alkaline massif: Geokhimiya, 1977, no. 11, p. 1625-1634 (in Russian).

IKORSKIY, S.V., GAVRILENKO, B.V. and DANI, A.D., 1976, Gases in quartz veins during evaluation of gold ore capacity (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 146 (in Russian; translation by A. Kozlowski).

Gases and TPX characteristics of gold ore and barren quartz veins of Kola Peninsula were studied. Total gases in gold ore veins vary from 1.1 to 8.8 cm^3/kg: H_2 58.2%, CO_2 35.4%, CH_4 6%; a mixture of saturated and unsaturated hydrocarbons C_2-C_4 was found, and in individual samples iso- and n-pentanes were determined; H and CO were not found; pH>7. Increase of N_2 content is connected with increase of CH_4 and decrease of CO_2. If gas content increases (mainly as increase of CO_2, up to 80 cm^3/kg), pH decreases below 7. Ore-bearing and barren quartz veins may be also distinguished, using mean value of CH_4/C_2H_6 (229-294 for ore veins and 9-63 for barren veins). Gold ore-bearing veins have the same, stable type of gas release, recorded on decrepitation curves, and it distinguishes them from barren ones. (Authors' abst.)

IMAI, H., IIDA, K., and TAKENOUCHI, S., 1977, Fluid inclusion study in the quartz from the Ashio mine, Japan, in Problems of Ore Deposition, Fourth IAGOD Symposium, Varna, 1974, vol. 2: Sofia, Pub. House Bulgarian Acad. Sciences, p. 171-173. First author at Dept. of Mineral Development Engineering, Univ. of Tokyo, Japan.

Inclusions in the central Sn-W zone have T_H 310-240°C; intermediate Cu zone 350°-200°; marginal Zn zone 270-230°C. NaCl equiv. ranged from 0 to 9%. (ER)

INDUKAEV, Yu.V., 1977, Physico-chemical parameters of processes of mineral-formation in the deposits of skarn gold-ore type of Alae-Sayan (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Sib. Branch, v. II, p. 22-23 (in Russian; translation by A. Kozlowski). Author at the Tomsk Univ., USSR.

The mineral-forming system is characterized by a high concentration of Cl, Na, K and Mg; Na/K varies from 1:1 to 1.5:1; pH-alkaline; homogenization in G phase. T_D and T_H in spinel and fassaite equal 920-610°C. Pyroxene and garnet formed from solutions of alkalinity decreasing down to neutral, bearing Na, K, Ca, Mg, Mn, Fe, HCO_3, Cl, CO_2 and a small amount of SO_4 and NO_2^-(sic); Na/K ratio 1.1:1 to 5:1. Skarns formed at T 890-480°C.

Minerals of the hydrothermal stage crystallized at 400-80°C, mainly at 320-120°C; late quartz, carbonates etc.--at 150-80°C. Solutions forming aposkarns contained high amount of Na, K, Ca, Mg, Fe, HCO_3, Cl, F, CO_2, NO_2, NH_4, lower of SO_4; Na/K varied from 2.5:1 to 1:1; solutions were liquid. Amphiboles and serpentine formed at 430-150°C. Minerals of gold-sulfide stage formed from solutions of Na, Ca, K, Fe, Mg, Cu, Pb, Zn, As, Sb, Cd, Cl, H_2S, HCO_3, SO_4, NO_2^-, NH_4, causing contemporaneous listvenitization of skarns and berezitization of granitoids. Na/K ratio ranged from 1.8:1 to 1:1.5, ores formed at 390-120°C, 510-190 atm; main mass of Au precipitated at 250-150°C, together with late sulfides; solutions were of type: HCO_3>Cl, and Ca>Na+Mg, with a high content of CO_2. (From the author's abst.)

INT. ASSOC. HYDROLOG. SCIENCES, 1976, Symposium, Thermal and chemical problems of thermal waters, Grenoble, Aug.-Sept., 1975, Int. Assoc. Hydrolog. Sciences Pub. 119, 143 pp.

ISHAN-SHO, G.A., 1976, T-P-X conditions of formation of mercury-antimony type (deposits) from Southern Tyan'-Shan' (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 197 (in Russian; translation by A. Kozlowski).

1. Hg, Sb, Hg-Sb and polysulfide-Hg-Sb deposits of various age formed at T 360-40°C. T of ore formation was below 250°C; for Sb minerals - 250-100°C, for Hg minerals - 200-50°C. P ranged from 800 to 100 bar with strong fluctuations during ore-formation. Ore precipitation occurred under oxidizing conditions and decreasing pH.

2. Parameters T-P-X in various deposits are very similar. (Author's abst.)

ISHAN-SHO, G.A. and NOVIKOVA, T.I., 1976, Peculiarities of formation of deposits of the Zeravshan-Gissar mercury-antimony belt (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci USSR, Inst. of Geol., p. 197-198 (in Russian; translation by A. Kozlowski).

1. Subzones were distinguished that displayed the role of thermostatic structures (sic.) on the period of ore precipitation.

2. At Konchoch deposit (Karakul subzone), mercury type ore mineralization formed at 50°C and 530 bar. (...)

3. Deposits of the Magianskaya group (Magianskaya subzone) of

Sb-Hg type formed during a T drop over interval of 50°C and P drop over 660 bar. (...)

4. The Dzhizhikrut deposit (Revat-Dzhizhikrut subzone), of Hg-Sb type, formed during T drop over 100°C and P over 50 bar. Metacolloidal structures are typical. (From the authors' abst.)

ISHIHARA, S. and TERASHIMA, S., 1977, Chlorine and fluorine contents of granitoids as indicators for base metals and tin mineralizations: Mining Geology (Japan), v. 27, no. 143, p. 191-200 (in Japanese).

ISKANDAROV, Zh., MUSAEV, A., and KHAMRABAEV, I., 1976, Experimental modelling of processes of magmatogenic rock- and ore-formation: Tashkent, "Fan" Publish House, 119 pp (in Russian).

IVANOV, S.N., and TALANTSEV, A.S., (eds.), 1976, Problems in mineralogy and geothermobarometry: Sverdlovsk, Inst. Geol. and Geochem. Uralian Acad. Sci. (Trudy, v. 130), 148 pp. (in Russian).

IVANOVA, A.A. and MOSKALYUK, A.A., 1977, Peculiarities of composition of gas-liquid inclusions in fluorites from various mineral associations (abst.), in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Sib. Branch, v. II, p. 119-120 (in Russian; translation by A. Kozlowski). Authors at VSEGEI, Leningrad, U.S.S.R.

Commercial fluorite deposits of the south of the U.S.S.R. belong to several genetic associations: rare-metal-fluorite, Fe-rare-earth fluorite, polymetallic-fluorite, Sb-Hg-fluorite and fluorite. Fluorite from the Fe-rare-earth-fluorite deposits bears in inclusion solutions of Cl type (94-97% equiv. of total anions) and with Na>K (24-50% vs. 6-7%). Fluorite from pegmatitic and greisen deposits connected with leucocratic granites crystallized from $Cl-SO_4-HCO_3$ solutions of Na>K (30-31% vs. 2-7%). Fluorite deposits of E. Transbaikalia are characterized by HCO_3 composition (94-99% of total anions) and Na ≈ K (4-8% vs. 4-6%). Fluorite from Hg-Sb-fluorite deposit Kelyana crystallized from solution of HCO_3 type (33-70% equiv.) and bearing significant amounts of NH_4 (3-7%); Na>K (16-56% vs. 4-12%). (From the authors' abst.)

IVANOVA, G.F., 1976, Mineralogy and geochemistry of the tungsten ore mineralization in Mongolia. The Joint Soviet-Mongolian Scientific-Research Geological Expedition, Trudy, No. 15, Ed. V.L. Barsukov: Moscow, "Nauka" Press, 258 pp (in Russian). (Abstract by A.K.)

The book contains descriptions of geology, mineralogy and ores of following Mongolian Mesozoic tungsten deposits and groups of tungsten deposits: Baga-Gazry, Khara-Moritu, Yugodzyr', Tumen-Tsogto, Tsagan-Dabin, Borun-Tsogto, Chulun-Khuriete, Modoto, Salaa, Aryn-nur, Buryanty, Ikh-Naratinkhind, Ikh-Khayrkhan, and Ongon-Khayrkhan. Also, the wall rocks were characterized mineralogically, geochemically and petrographically. W deposits are connected with intrusion of four petrographic types: granodiorite-granite, standard (granite), Li-F granite and agpaitic. Au-rare metals, Sn-W, Mo-W, and Sn-polymetal types are the most general classification of ore associations. Ore deposits occur mainly in zones adjacent to contacts of intrusions, both in intrusive and cover rocks. Ores are connected with metasomatites of greisen type (greisens: topaz-muscovite-biotite, topaz-zinnwaldite, topaz, topaz-quartz, quartz-muscovite, beryl-muscovite, beryl-quartz, fluorite-quartz, greisenized granite-porphyry etc.), zones of brecciation, veins both in intrusions and in the enclosing rocks (consisting of quartz, fluorite, micas, beryl, etc.) and rarely with pegmatites (wolframite). Ore minerals are: wolframite, huebnerite, and cassiterite; scheelite is mainly the product of alteration of wolframite and huebnerite; sulfides--molybdenite, pyrite, marcasite, pyrrhotite, bismuthinite, sphalerite, galena, chalcopyrite, tetrahedrite, arsenopyrite, Bi sulfosalts of Pb; gangue minerals in addition to the listed above: carbonates--siderite, ankerite, calcite, rhodochrosite, feldspars, chlorite, sometimes gypsum. Ores have massive or disseminated textures. Greisens also concentrate Li, Rb, and Cs, presumably in micas.

Physico-chemical conditions of ore formation were determined by methods of fluid inclusion study, described elsewhere. Inclusions in minerals from ore parageneses are two-phase (G+L) or three-phase. The most common third phase is L CO_2, but sometimes it is a dm. A number of inclusions of types: G+L H_2O+L CO_2 + dms or G + LH_2O + dms occurred, especially in quartz and topaz; dms are halite, sylvite, and several unidentified transparent and ore minerals, total of dms usually ranges from 12.5 to 28% (vol.? A.K.). P-T conditions are as follows (from the author's Table 35, p. 170-175); in parentheses number of specimens studied:

Mineral	Type of deposit	T_H, °C	T_D, °C	P, bar	Remarks
Topaz	Sn-W	411-390 (1)			dms
		374-332 (2)			
		322-277 (1)			LCO_2
Quartz		400-313 (2)			dms
		310-267 (7)	220-180 (?)	1400-725 (4)	L CO_2
		316-211 (2)	370 (1)		T_D in another specimen than T_H.
Fluorite		290-205 (2)			dms
		280-110 (2)		650-320 (2)	L CO_2
		385-100 (5)			
Wolframite			370-120 (11)		
Cassiterite		368-294 (4)			
Topaz	Mo-W	374-363 (1)			
Beryl		289-260 (1)			L CO_2
		377-274 (6)			
Quartz		273 (1)			L CO_2
		390-296 (10)			
Fluorite		338-268 (2)			dms
		341-286 (3)		750-590 (2)	L CO_2
		360-102 (19)			
Ankerite		140-120 (1)			
Rhodochrosite		274-240 (1)			
Wolframite			330-280 (4)		
Beryl	W	322-289 (3)		800 (1)	L CO_2
		370-309 (2)			
Quartz		267-252 (1)			dms
		302-244 (8)	240 (1)	1050-520 (6)	L CO_2
		327-273 (3)			
Fluorite		270-192 (2)			dms
		306-252 (8)		1150-630 (3)	L CO_2
		348- 95 (18)			one specimen has T_H 53-45°C
Wolframite			320-160 (8)		

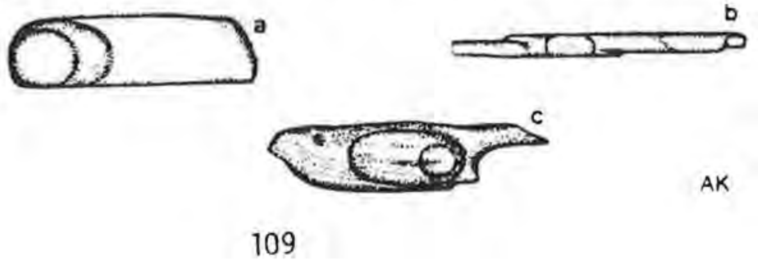
Mineral	Type of deposit	T_H, °C	T_D, °C	P, bar	Remarks
Huebnerite		318-206 (5)	300-260 (10)	720-600 (1)	only two pairs of T_H and T_D were measured in the same specimens
Pyrite			340-270 (2)		
Pyrite + pyrrhotite			240 (1)		
Sphalerite		288 (1)			
Quartz	Mo	348-331 (2)			
Fluorite	CaF_2	244-121 (10)			
Wolframite			330-300 (2)		

Above P-T results were compared with reference data on P-T conditions of origin of similar deposits in the E. Transbaikalia (Tab. 36, p. 182) and other W and Sn deposits (Tab. 37, p. 183-184).

Studies of chemical composition of fluid inclusions in ore-bearing quartz (Tab. 38, p. 186-189) by water leachate method revealed strong variations of concentrations (all in g/l): Na 2.58-67.36, K 0.71-51.81, Li 0.12-1.90; concentrations of Ca and Mg $\leq$ 2.8, Cl almost nil -- 117.38, F almost nil -- 52.31, HCO_3 almost nil -- 81.50 (result 148.8 was assumed by the author as uncertain); 33 analyses. SO_4 found in samples in range 5.0-40.2. The amount of water in quartz was from 0.3 to 0.35 wt%, presumably occurring in inclusions. Total salts ranged from 46.2 to 395.0 g/l (Tab. 40, p. 196). In water leachates from wolframites (10 analyses, Tab. 39, p. 190-192, concentrations in g/l) amounts of ions were found: Na 0.26-15.03, K 0.96-44.22, Li 0.05-0.21 (8 analyses), Ca 0.98-30.28, Mg 0.00-19.62, Cl 0.00-11.76, F 1.01-11.91, HCO_3 3.05-111.35; amount of water in wolframite 0.04-0.40 wt%. Chemical composition of fluid inclusions is discussed with the background of the reference data on other deposits (Tab. 41-44, p. 196-199). Determined concentrations of W in inclusions in quartz from wolframite- and beryl-bearing veins (by polarographic method, Tab. 45, p. 202; in water leachates? A.K.) range from $n \cdot 10^{-1}$ to $n \cdot 10^{-3}$ g/l (25 analyses). An attempt was made to evaluate factors, causing concentration of Nb and Ta in wolframites, including temperature of crystallization (Tab. 50, p. 218), as well as chemistry of parageneses and mineral forming solutions. Wolframites probably crystallized from weakly acid to neutral solutions, at S^{2-} concentrations from 10^{-5}-10^{-4} to 10^{-1}-10° mol/l. (Abst. by A.K.)

Plate XII

Plate XIII



IVANOVA, G.F., KHITAROV, D.N., LEVKINA, N.I., and MILOVSKY, G.A., 1976, Chemical composition of tungsten-bearing hydrothermal solutions from a study of gaseous-liquid inclusions.: Geokhimiya, 1976, p. 1308-1318. (in Russian; translation in Geochem. Internat., v. 13, no. 5, p. 17-26, 1976).

The peculiarities of the chemical composition of gaseous-liquid inclusions in quartz and wolframite are considered. By methods of cryometry and triple water extraction the chemical composition of the liquid phase of the inclusions was investigated. Two types of tungsten-bearing solutions were distinguished: highly-mineralized and moderately-mineralized. Some specific peculiarities of the compositions of solutions from which quartz and wolframite were deposited were demonstrated in the paper. (Authors' abstract)

IVANOVA, G.F., MOTORINA, Z.M. and NAUMOV, V.B., 1976, Sequence of mineral-formation in wolframite deposits (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 64-65 (in Russian; translation by A. Kozlowski).

1. Fifteen mineralogically similar deposits were studied; most of them formed during two stages: 1 - early (greisens or quartz veins with greisenized wells): topaz + quartz + zinnwaldite + cassiterite + ferberite, quartz + muscovite + beryl + molybdenite (+ wolframite), quartz + wolframite (or huebnerite) + cassiterite; 2 - late: sulfides, quartz + fluorite + carbonates. Association huebnerite + pyrite is intermediate between stages 1 and 2.

2. Minerals of the early stage crystallized from liquid CO_2 - rich solutions at T 400-250°C (usually 360-260°C) and P from 1400 to 250 bar (usually 110-600 bar). Association quartz + fluorite + carbonates crystallized at 200-100°C and 400-300 bar.

3. (...)

4. Above sequence appeared at the deposits of Zabaikal'ie, Kazakhstan, Mongolia etc. (From the authors' abst.).

IWASAKI, F., 1977, Line defects and etch tunnels in synthetic quartz: Journal of Crystal Growth, v. 39, no. 2, p. 291-298.

JACKSON, N.J., MOORE, J.McM., and RANKIN, A.H., 1977, Fluid inclusions and mineralization at Cligga Head, Cornwall, England: J. geol. Soc. Lond., v. 134, p. 343-349.

Thermometric and salinity data are presented for fluid inclusions populations in samples of hydrothermal vein material (quartz intergrown with wolframite, cassiterite, stannite, arsenopyrite, pyrite/chalcopyrite, hematite and limonite) and in metasomatic quartz overgrowths in granite, greisen and kaolinized granite. These data indicate that multistage high temperature (T_H 200-400°C) and single or multistage low temperature (T_H 70-150°C) hydrothermal events occurred within the Cligga Head granite stock and its environs. Although fluid inclusion salinities were low (2-12 equiv. wt.% NaCl) throughout the hydrothermal history of the stock, there is a general tendency for the salinity of the vein fluids to decrease with decreasing temperature. The homogenization temperature and salinity of the vein fluids of the wolframite-cassiterite mineralization are similar to those of another Cornish Sn-W deposit at St Michael's Mount. Low to moderate salinity fluids in the T_H range 300-400°C appear to be a characteristic of the cassiterite-wolframite mineralization in the Cornubian metallogenic province. (Authors' abstract)

JAHNS, R.H., 1977, Geologic features of the Little Three Pegmatites, Ramona District, California (abst.): in Program and Abstracts, Third M.S.A.-F.M. Symposium, Crystal Growth and Habit, Tucson, Arizona, Feb. 13-14, 1977 (unpaginated).

JEHL, Vincent, POTY, Bernard, and WEISBROD, Alain, 1977, Hydrothermal metamorphism of the oceanic crust in North Atlantic Ocean: Bull. Soc. geol. France, v. 19, no. 6, p. 1213-1221 (in English). Authors at Équipe de recherche sur les équilibres entre fluides et mineraux, C.R.P.G. C.O. 1, 54500 Vandoeuvre-lès-Nancy, et E.N.S.G., B.P. 452, 54001 Nancy Cedex.

Mineralogic and fluid inclusion studies have been carried out on dredged samples from North Atlantic Ocean. Associations of the newly formed minerals have been correlated with specific fluids which are essentially aqueous solutions with insignificant amounts of dissolved gases. Temperatures and pressures have been estimated for this metamorphism which seems to be the result of a convective circulation of sea water inside a fractured oceanic crust.(Authors' abstract)

JOHANNES, W. and SCHREYER, W., 1977, Distribution of H_2O and CO_2 between Mg-cordierite and fluid phase: Fortschritte der Mineralogie, v. 55, pt. 1, p. 64-65 (in German). First author at Hannover, Germany.

Russian authors (i.e., KIZUL et al., 1971) have been able to trace, besides H_2O (up to 1.50 weight-%) also CO_2 (up to 0.75 weight-%) in cordierites from rocks of the granulite facies. The calculated X_{CO_2} values of the analysed cordierites range between 0.05 and 0.34. This is particularly interesting in view of the presence of extremely CO_2-rich fluid inclusions, reported by TOURET (1971) in rocks of the granulite facies. In order to establish the relation between these two lines of evidence, hydrothermal experiments were made to determine the distribution of H_2O and CO_2 between phases in the system Mg-cordierite H_2O-CO_2.

Previously produced, synthetic, waterfree, finely pulverized Mg-cordierite was treated with a gas phase of the desired composition in gold capsules at ≤5kbs and ≤1000°C. The results obtained at P_{f1}-5kbs and 600°C are shown in Fig. 1. An invariable, strong preference of H_2O in cordierite can be seen. Relatively water-rich cordierite (X_{CO_2}=9.25) coexists, e.g., with a much lower water gas phase (X_{CO_2}=0.65). Even extremely CO_2-rich gaseous phases show at 5 kbs, 600°C, only maximum CO_2-contents in cordierite of ∿1.5 wt.%; this corresponds to 0.22 moles CO_2 per formula unit of cordierite. Compared with this, in the presence of a pure aqueous gas phase, about 2.0 wt.-% H_2O is taken in (= 0.66 mol. H_2O) under identical PT-conditions.

These preliminary experimental results offer an explanation of the occurrence in nature of CO_2-rich fluid inclusions and cordierites with relatively low CO_2/H_2O.

References:

Kizul, W.I., Lasebnik, J.D., Brownkin, A.A., and Zyknew, W.O.: Dok. Akad. Nauk SSSR, v. 200, no. 6, (1971)
Touret, J.: Lithos, v. 4, p. 423-436 (1971).

(Authors' abstract, translated by H.A. Stalder.) (Continued on next page)

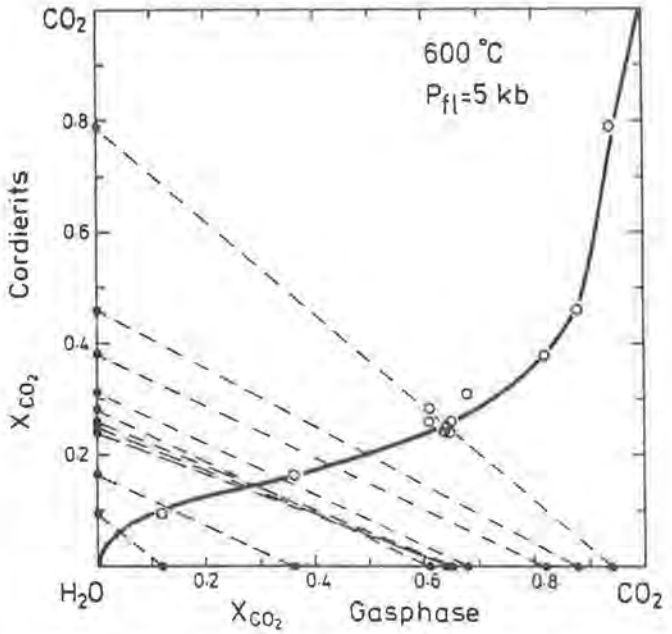


Fig. 1

X_{CO_2}-values of coexisting Mg-cordierites and gas-phases at P_{fl}=5 kbs, 600°C. Dashed lines connect the values of coexisting pairs, whose common geometrical point within the diagram is represented by the curved line.

JOHNSTON, D.A. and SCHMINCKE, H.-U., 1977, Triggering of explosive volcanic eruptions by mixing of basaltic and silicic magmas (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 1041. First author at University of Washington, Dept. of Geol. Sci., Seattle, WA 98105.

The 1976 eruption of Augustine Volcano, Alaska began soon after basaltic and silicic magmas were mixed, either by introduction of basalt from a deeper source into, or by two-phase convection (induced by local crystal concentration) within, a compositionally zoned crustal magma chamber. Heating of the cooler silicic magma, which melt inclusion data suggests was at or near water saturation, by hotter basaltic magma must have reduced water solubility in the cooler magma, thus rapidly increasing vapor pressure. This, or the volume increase produced by addition of new magma to the chamber, may have triggered the first explosive phase of the 1976 eruption.

The presence of euhedral or only slightly resorbed magnesian olivine (Fo86-81), out of equilibrium with the surrounding andesitic and dacitic glass, implies that the olivine-bearing basalt was mixed with the silicic magma no more than a few months prior to the eruption, judging from the known growth (=resorbtion) rates of olivine (from Donaldson, 1975).

Euhedral or slightly resorbed magnesian olivine phenocrysts are present in the andesitic to dacitic products of each of the three past historic eruptions of Augustine, and in some prehistoric deposits, possibly all. The absence of evidence for a decrease in the silica content of the eruptive products despite the evidence for frequent mixing of basic and silicic magmas suggests that new magma is not entering the chamber as frequently as mixing and eruption is occurring, that differentiation has kept pace with magma addition, or that the eruptions are composition controlled. (Authors' abstract)

JONES, M.B., FIELD, C.W., RYE, R.O., and OSATENKO, M.J., 1977, Possible sea water involvement in the Valley copper deposit - preliminary results of H, O, and S isotope data (abst.): Geol. Assoc. Canada-Min. Assoc. Canada Program with Abstracts, v. 2, p. 27.

JONES, S.J. and JOHARI, G.P., 1977, Effect of hydrostatic pressure on air bubbles in ice: in Isotopes and impurities in snow and ice, Proc. of Grenoble Symposium, Aug-Sept, 1975, IAHS-AISH Pub. no. 118, p. 23-28 (in English).

In order to understand the reason for the disappearance of air bubbles below 1100 m in the deep core obtained at Byrd station, Antarctica, we are stuyding the effect of hydrostatic pressure on air bubbles in ice. Samples of natural and artificial ice, approximately 10 mm cubes, are kept in a high pressure optical cell rated to 250 b and pictures of the sample are taken regularly. From enlarged prints the size of the bubbles is determined as a function of time. Our main conclusion is that bubbles initially close up rapidly due to the deformation of ice around the bubble and then continue to close up slowly due to the diffusion of air molecules into the ice lattice. No significant difference is found between clathrate and nonclathrate formation conditions. (Authors' abstract)

KALUGIN, I.A., 1977, Certain natural indices of peculiarities and redox conditions during metamorphism of iron ores (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. I, p. 81-82 (in Russian; translation by A. Kozlowski). Author at Inst. Geol. Geophys. of Siberian Branch of Acad. Sci. USSR, Novosibirsk.

Albitites occurring with iron ore formed metasomatically at (T_H) 400-560°C, K-spar metasomatites 400-540°C, skarn-magnetite ores 400-560°C, hydrosilicate-magnetite ores 400-530°C; this corresponds to greenschist and epidote-amphibolite facies. Similar parageneses in ferruginous quartzites yielded T_H ∿100°C lower than above, probably due to higher P values. (Abst. by A.K.)

KALYUZHNYI, V.A., 1976, Nature of the information in inclusions of fluids concerning the genesis of minerals (abst.): Problems of genetic information in mineralogy (Proceedings of the All-Union Mineralogical Seminar Syktyvkar, June 1-4, 1976: Syktyvkar, Acad. Sci. USSR, Komi Div., p. 69-70 (in Russian; translation by A. Kozlowski). Author at the Inst. Geol. Geochem. of Mineral Fuels of the Acad. Sci. Ukrainian SSR, L'vov.

1) An inclusion in a mineral is a cavity from an internal defect of the crystal lattice, filled in the process of crystallization with mineral-forming fluid or another substance. Inclusions are characterized by the peculiarities of the origin of the defects in the crystal, and by the nature of the filling substance. An inclusion, just as a mineral, has three essential stages of development: nucleation, formation, and alteration.

2) When inclusions are used as indicators of the genesis of minerals, the following most important problems should be solved: a) to which individual mineral or zones of growth or regeneration should the inclusion be related, i.e., what is the time and spatial connection of

inclusions with elements of growth of crystal (primary or secondary inclusions); b) what is genetic type of the inclusion filling and the syngenetically precipitated mineral, as well as whether the inclusion is allo- or authigenic; c) does the inclusion preserve the primary filling and in what way was the inclusion transformed during its existence.

These problems may be correctly solved only by extensive studies of syngenetic and sub-syngenetic groups of inclusions.

3) A general genetic classification of inclusions is a guide to the investigations, and the particular systematics of the inclusions in a given geological object is the final result of a thorough analysis of their genetic nature. Classification cannot be the key to mineral formation; the latter is established individually for each mineral, mineral associations and deposit.

4) Heterogeneous state (boiling) is the most usual condition for the mineral-forming fluid in the majority of deposits of low and moderate depth. It should be used to a maximum in thermobarometry. The comparison of inclusions in syngenetic groups permits distinguishing inclusions of homogeneous origin (especially of homogeneous trapping) among groups formed by boiling of solutions or by necking-down of vacuoles.

5) Composition T and P of the fluid at the moment of trapping are the PTX parameters of mineral-forming solution at that given point. After isolation of an inclusion those parameters, as well as the shape of the inclusion, change to various degrees.

6) The inclusion filling may remain essentially unchanged, if the following processes do not occur: a) diffusion of substance through crystal, b) precipitation of substance on the walls of vacuole, c) redistribution of substance during necking-down of inclusion, d) refilling of inclusions, e) redistribution of substance during change of the shape of inclusion, and f) decrepitation of inclusions due to natural overheating. Influence of the above processes may be very small or very significant. The processes may be distinguished very easily and may be important factors in obtaining more complete and better information on the conditions of mineral formation.

7) Composition of inclusions and ratios of phases under room conditions, carefully studied with use of methods of the exact sciences (physical, chemical, physico-chemical, etc.) and correct interpretation yield completely determined data on the parameters of endogene mineral-formation. (Author's abst.)

KALYUZHNYI, V.A., 1977, Discussion on the project of the mineralogical dictionary of the Carpatho-Balkan mountainous system, <u>in</u>: IGC - Carpatho-Balkan Geological Association, Materials of Commission of Mineralogy and Geochemistry, no. 3, p. 84-86 (in Russian). Author at Inst. Geol. Geochem. of Fuel Raw Materials of the Acad. Sci. Ukrainian SSR, L'vov.

Discussion of the importance of fluid inclusion studies for geological sciences. (A.K.)

KALYUZHNYI, Vl.A. and GIGASHVILI, G.M., 1976, New cryometric stage with liquid thermostating medium for studies of inclusions of fluids in minerals: Mineral. Sb., L'vov. Univ., v. 30, no. 1, p. 34-36 (in Russian with English abstract). Authors at Inst. Geol. Geochem. of Fuels of Acad. Sci. Ukrainian SSR, L'vov. (See Translation Section)

KALYUZHNYI, Vl. A. and VOZNYAK, D.K., 1965, Graphical method of determination of the temperature and pressure of homogenization of the closed system H_2O-CO_2 in application to liquid inclusions in minerals: Mineralogical Thermometry and Barometry, Izdat. "Nauka", Moscow, 1965, p. 88-92 (in Russian; see translations).

KALYUZHNYI, Vl.A., and ZHOVTULIA, B.D., 1977, On the conditions of quartz crystallization in Zarpatian acid volcanic rocks: Mineralog. Sbornik., v. 31, no. 1, p. 68-71 (in Russian).

It was established that crystallization of magmatic quartz in Zakarpatian acid volcanic rocks began at 1200-1300°C and finished at 960°C. The presence of syngenetic inclusions with different degrees of filling indicate boiling of the melt. Decrease of the content SiO_2 can be observed by the end of crystallization process. (Authors' abstract)

KAMILLI, R.J. and OHMOTO, Hiroshi, 1977, Paragenesis, zoning, fluid inclusion, and isotopic studies of the Finlandia Vein, Colqui District, Central Peru: Econ. Geol., v. 72, p. 950-982.

The Finlandia Pb-Zn-Ag-Au vein cuts andesitic Tertiary volcanic rocks and is unusual in that the Ag-Au mineralization is earlier and of a higher temperature than the Pb-Zn mineralization. Hypogene mineralization can be divided into 7 paragenetic stages: (I) quartz; (II) quartz + muscovite + tetrahedrite + silver sulfosalts + electrum + sphalerite + galena + pyrite + siderite; (III) quartz; (IV) sphalerite + galena; (V) quartz; (VI) sphalerite + galena; (VII) yellow-green sphalerite + galena + barite. Stage II muscovite yields a K-Ar age of 10.3 ± 0.5 m.y., which corresponds to the late Tertiary volcanism of the central Andes.

Uncorrected fluid inclusion filling temperatures are 270° ± 20°C for stage I, II, and III, 260 ± 20°C for IV, 240° ± 20°C for V, 180° ± 20°C for VI, and 200° to 140°C for VII. Sulfur isotope temperatures from sphalerite-galena pairs agree with these temperatures, implying that the deposit was quite shallow when formed and that little or no pressure correction is necessary for the fluid inclusion data.

The distribution and nature of the stage II mineralization is strongly controlled by elevation. The stage II Ag-Au bonanza ore shoots are restricted to a 130-meter vertical interval in the vein, where the ore is fine grained and contains at least 13 minerals. The fine-grained nature of the Ag-Au-rich stage II ore, its strong control by elevation, and the observation that primary fluid inclusions exhibit markedly variable liquid to vapor volume ratios all indicate that boiling was the controlling factor in the ore formation for this stage. Boiling of the hydrothermal fluid may also have been a factor in the deposition and localization of ore in a number of classic Ag-Au bonanza ore deposits and evidence of boiling may be a potential tool in exploration, especially for blind bonanza ore shoots.

Chemical and isotopic data from fluid inclusions suggest the existence of two distinct hydrothermal fluids throughout the course of mineralization. One was a meteoric water with $\delta D_{H_2O} \sim -100$ per mil, the other a sedimentary formation (connate?) water, with uniformly high salinity (6 to 13 equiv. wt. % NaCl) and δD_{H_2O} between -75 and -48 per mil. The principal stages of sphalerite and galena deposition

(IV and VI) are associated with the predominant presence of formation water, but meteoric water predominated during quartz and Ag-Au mineralization (stages, I, II, III, and V).

Both types of fluid evolved to higher values of $\delta^{18}O_{H_2O}$ with time, from ∿ -8.5 per mil during stage I to +2 per mil during stage VI and then a final drop to ∿ -1 per mil in stage VII. Increasing $\delta^{18}O_{H_2O}$ of both fluids and K/Na (from <0.06 to 0.214) ratios in the fluids of meteoric origin indicate that both fluids were reacting with increasing amounts of fresh rock at increasing temperatures while the temperature at the site of deposition was decreasing.

Fluid inclusion and mineralogical data indicate that stage II fluids had the following chemical composition (calculated for 270°C): $\log f_{S_2} = -10.2 \pm 0.6$, $pH = 5.1 \pm 0.4$, $f_{O_2} = -34.6 \pm 1.6$, $\log f_{CO_2} = 1.3 \pm 0.2$, and $\log m_{\Sigma S} = 2.5 \pm 1.0$. (Authors' abstract)

KANISHCHEVA, L.I. and ROMANENKO, I.M., 1977, Zonality of cassiterite from tin ore deposits of tourmaline type from Primor'ye: Akad. Nauk SSSR Doklady, v. 236 no. 6, p. 1457-1460 (in Russian). Authors at Far-East Geol. Inst. of Far-East Sci. Center Acad. Sci. USSR, Vladivostok.

Cassiterite crystallized at 350-210°C; includes also literature data on T and pH of cassiterite crystallization. (A.K.)

KAPUSTIN, Yu.L., 1976, Mineral microinclusions in rock-forming minerals of pegmatites, in Minerals and parageneses of rock-forming minerals, editors, P.M. Tatarinov and D.V. Rundkvist: Leningrad, Leningrad Division of "Nauka" Publishing House, p. 22-38 (in Russian).

Minute solid inclusions of rock-forming and rare-metal accesory minerals are commonly present in feldspars, micas, tourmaline, and quartz. Apatite, zircon and beryl mainly concentrate in plagioclase; in micas -- zircon, apatite, garnet, magnetite and niobates; in microcline -- micas, spodumene and beryl; and in quartz -- very tiny opaque minerals. Ta, Nb, Zr, rare earths, Th, U, and Sc occur in rock-forming minerals mainly in solid inclusions, but Sr, Ba, Cs and Rb -- as isomorphic admixture. (Author's abst., transl. by A.K.)

KARABANOV, V.A., KROL', O.F., NAYDENOV, B.M., POLYVYANNYI, E.Ya., and CHERNOV, V.I., 1977, Certain peculiarities of formation of scheelite stockwork (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. I, p. 129-130 (in Russian; translation by A. Kozlowski). Authors at Kazakh Inst. of Mineral Raw Materials.

Isotopic composition of Ar in fluid inclusions in quartz from Boguty scheelite deposit and Boguty and Syugatinskaya intrusions was studied. Ar was released from inclusions by heating. Boguty W deposit and Boguty intrusion have the same Ar isotopic composition, but sulfide associations are different in Ar composition, being close to subsurficial waters. (Abst. by A.K.)

KARAMYAN, K.A. and MADANYAN, O.G., 1977, Physico-chemical conditions of formation of the copper-molybdenum deposits in the Zangezur ore region (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. I, p. 153-154 (in Russian; translation by A. Kozlowski). Authors at the Inst. Geol. Sci. Acad. Sci. Armenian SSR.

Cu-Mo mineralization developed in Zangezur deposits in pegmatites, skarns, pneumatolytic and hydrothermal formations. Hydrothermal ores yielded T_H 420-60°C, including quartz-molybdenite, quartz-molybdenite-chalcopyrite and quartz-chalcopyrite associations (T_H 420-315°C) and quartz-pyrite and quartz-sphalerite-galena ones (T_H 300-220°C). The T decrease has a jump-like pattern. P (estimated from fluid inclusions) ranges from 1200 to 70 atm, and concentration of salts from 520 to 150 g/l (NaCl equiv.). Main salts are: NaCl, KCl, and subordinate $CaCl_2$ and $MgCl_2$; HCl is the main gas in the group of "acid gases." (Abst. by A.K.)

KARAPETYAN, A.I., 1977, Genetic groups of ore formations in the Pambak-Zangezur belt: Acad. Sci. Armenian SSR, Izvestia, Nauki o zemle (Earth Sci.), v. 30 no. 4-5, p. 122-133 (in Russian, Armenian summary). Author at Inst. Geol. Sci. Acad. Sci. Armenian SSR, Erevan.

Hydrothermal deposits of ores: Au, Te, Sb, As, Cu, Mo, Pb, Zn, Bi, Ag, and Hg, formed at T interval 500-450 to 100-80°C, but commercial ores crystallized at narrower T range 350-100°C. (A.K.)

KARPOV, G.A., 1976, Experimental studies of mineral formation in geothermal boreholes: Moscow, "Nauka" Pub. House, 171 pp. (in Russian).

Consists of two parts: 1) Hydrothermal alteration of rocks and minerals and chemical composition of thermal solutions (Pauzhetskoe, Bol'shebannoe, and Sredneparatunskoe deposits); and 2) Experimental studies of alteration of rocks and minerals. (A.K.)

KARPOV, G.A., 1977, Uzon caldera--an example of a recent ore-forming system, in: Hydrothermal process in the areas of tectonic-magmatic activity, p. 163-172, "Nauka" Publ. House, Moscow (in Russian).

KARSKIY, B.Ye. and FORTUNATOV, S.P., 1976, Decrepitometry in prospecting for mica-bearing pegmatites in the Karelo-Kola region (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 138-139 (in Russian; translation by A. Kozlowski).

Aureoles of silicification around mica pegmatites in gneiss and schist are 1-5 m wide, whereas higher decrepitation activity was found in a wider zone, from 20 to 30 m, with peaks at 120-340 and 340-540°C. Differentiated commercial pegmatites have both 340-540 and 120-340°C aureoles 25-30 m wide, but pegmatite dikes with non-commercial fine-grained muscovite have a 340-540°C aureole 10-15 m and a 120-340°C aureole 3-5 m wide; around pegmatitic veinlets and mica-free pegmatites aureoles are 5-10 m and none, respectively. Thus, low-T aureole is the main index of commercial mica content of pegmatites (120-340°C), as in pegmatites from Mama region. (Authors' abst.)

KARSKIY, B.Ye., FORTUNATOV, S.P. and ZORIN, B.I., 1976, On temperature zoning of mica-bearing pegmatites (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 116-117 (in

Russian; translation by A. Kozlowski).

1. Decrepitation curves are characteristic for varieties of pegmatites; for Mama and Karelo-Kola pegmatites they have three peaks.

2. In zones of pegmatites T_D decrease from 680°C to 620°C (fine-grained → granophyric → block → pegmatoid). T_D 540-480°C is typical for pneumatolytic pegmatites with apographic structure, quartz-muscovite complex and metasomatic quartz. T_D 400-300°C, found only in Mama pegmatites, is connected with P hydrothermal inclusions in drusy quartz and PS inclusions in early varieties of pegmatites. T_D 300-180°C characterizes PS inclusions in drusy quartz and pegmatites with apographic and pegmatoid structure.

3. Curves of decrepitation testify to discontinuities in origin of pegmatites (Authors' abst.)

KARSKII, B.Ye., ZORIN, B.I., FORTUNATOV, S.P., and ABRAMOV, A.V., 1977, Tourmaline from Mama mica-containing pegmatites: Izv. Vyssh. Uchebn. Zaved, Geol. Razved, v. 20, no. 9, p. 172-174 (in Russian). Authors at Mosk. Geologorazved. Inst. im. Ordzhonikidze, Moscow, USSR.

The tourmaline in the pegmatites occurs in several generations, which differ in crystal form, relation to the rock-forming minerals, composition, and characteristics of fluid inclusions. That in pegmatites with aplitic structure is fine-grained and associated with quartz. That in pegmatites with graphic structure occurs as short prismatic crystals and that in pegmatite with pegmatoidal structure occurs as larger, striated prismatic crystals. Long prismatic, striated tourmaline crystals result from quartz replacement. The schist country rocks have schorl crystals of moderate size. Chemical analyses of the tourmaline in the pegmatite varieties are tabulated. The decrepitation temps. of the fluid inclusions fluctuate from 250-740° and indicate formation of the pegmatites in 2 stages. (C.A., 1978, 88: 52998t)

KARWOWSKI, Lukasz, 1977, Geochemical conditions of greisenization in the Izerskie Mountains foothills (Lower Silesia): Archiwum Mineralogiczne, v. 33, no. 2, p. 83-148 plus 11 plates (in Polish with 7-page English summary and figure captions). Author at Uniw. Slaski, Inst. Geol., Sosnowiec, Poland.

Studies of greisen rocks of the Izerskie Mountains foothills and the physico-chemical conditions of their formation are discussed. On the basis of field work and mineralogical-geochemical studies in the author concludes the origin of the greisens is related to post-magmatic activity of the Karkonosze massif. Thermometric and barometric results indicate that the greisenization process should be associated with the activity of hydrothermal solutions within the range 450-300°C, at about 800 atm pressure, with moderately concentrated fluoride-chloride-carbonate solutions in an acid environment. Additionally, tungsten mineralization has been recognized within the greisen zone. (Author's abstract)

KARWOWSKI, L. and KOZŁOWSKI, A., 1977, Wolframite-cassiterite mineralization from Karkonosze-Izera area, W. Sudetes, Poland (fluid inclusion studies), in Problems of Ore Deposition, Fourth IAGOD Symposium, Varna, 1974, vol. 2: Sofia, Pub. House Bulgarian Acad. Sciences, p. 174-178.

See Kozlowski, Karwowski and Olszynski, 1975, Fluid Inclusion Research--Proceedings of COFFI, v. 8, p. 98 (1975).

KARZHAVIN, V.K., 1976, The kinetic characteristics of the degassing of minerals on heating: Geokhimiya, 1976, p. 1701-1713 (in Russian; translated in Geochem. Internat., v. 13, no. 6, p. 58-69, 1976). Author at Geol. Inst. Kola Branch of the Acad. Sci. USSR, Apatity.

Investigation of the composition of the gas phase and of the dynamics and kinetics of separation of gas from samples of apatite from different deposits and of nepheline from the Khibiny alkalic massif during stepwise heating in vacuum revealed certain quantitative and qualitative differences among the liberated volatiles. The composition of the separating gas phase does not change regularly with temperature; instead, there are two maxima of separation of gases (below and above 600°C). The principal component of the gas phase, water, separates almost completely at 400°C. The highest water content was found in pegmatitic nepheline (up to 0.57 wt. %) and the lowest, in apatite from a Lovozero alkalic pegmatite (0.0067 wt. %). Analyses of the gas phase separating from different fractions of nepheline from an apatite-nepheline rock made it possible to estimate the composition of the largest inclusions and suggested that the gas phase is present in the minerals not only in inclusions but also in dissolved state in the form of submicroscopic (molecular) bubbles in the crystals. (Author's abstract)

KARZHAVIN, V.K. and BELAVIN, Ye.A., 1977, Volatile phase of sample "Khibiny-General." Mathematic modeling of gas equilibria: Akad. Nauk SSSR, v. 236 no. 2, p. 446-449 (in Russian). Authors at Geol. Inst. of the Kola Div. Acad. Sci. USSR, Apatity.

Theoretical volatile concentrations of the system C-H-N-S-O, expressed as gases: H_2, N_2, S_2, O_2, CH_4, C_2H_6, C_3H_8, C_4H_{10}, CO, CO_2, COS, CS_2, H_2O, NH_3, N_2O, NO, SO_2, SO_3 in equilibrium with melt of the mean sample of Khibiny rock (so called "Khibiny-General"), were calculated for T 300-1500°C and P 1-5000 atm; pertinent to studies of G phase in fluid inclusions. (Abst. by A.K.)

KARZHAVIN, V.K., LUTTS, B.G. and PETERSIL'YE, I.A., 1976, Gases from deep-seated rocks (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 204 (in Russian; translation by A. Kozlowski).

Gases were determined in 9 samples from explosive pipes in Yakutia: garnet and garnet-spinel peridotites (cm^3/kg of rock), He 0.00029, H_2 0.48, CH_4 0.0086, N_2 0.14, CO_2 0.003); mantle eclogites, He 0.00012, H_2 0.77, CH_4 0.0031, N_2 0.21, CO_2 0.03. Gases were released from 10 g of 1-mm sample in quartz tu be on heating up to He 0.00012, H_2 0.77, CH_4 0.0031, N_2 0.21, CO_2 0.03. Gases were released from 10 g of 1-mm sample in quartz tube on heating up to 1200°C. Gases were analysed for T interval 400-1200°C. The maximum G evaluation from sample was at 700°C (up to 47 vol. % of total content). Amount of G in deep-seated rocks varies. Smaller part of G occurred in fluid inclusions and intergranular pores; the larger part that might be released only by the thermovacuum method, possibly

occurs occluded in the solid substance. Also the release of part of G due to chemical reactions is possible. (Authors' abst.)

KATZ, Amitai and MATTHEWS, Alan, 1977, The dolomitization of $CaCO_3$: an experimental study at 252-295°C: Geoch. Cosmo. Acta, v. 41, p. 297-308. Authors at Dept. Geol., The Hebrew Univ. of Jerusalem, Israel.

The results of experiments on the hydrothermal dolomitization of calcite (between 252 and 295°C) and aragonite (at 252°C) by a 2 M $CaCl_2$-$MgCl_2$ aqueous solution are reported and discussed. Scanning electron microscope photographs show that partial dissolution of dolomite crystals can yield highly porous masses that could result in the trapping of large numbers of inclusions, as are seen in many dolomites. (ER)

KAZIMIROVA, T.K., 1976, Inclusions of solutions-melts in spodumene from rare-metal pegmatites (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 115 (in Russian; translation by A. Kozlowski).

1. P solution-melt inclusions in spodumene from quartz-microcline and quartz-albite zones were studied.
2. Phase ratios: L CO_2 30-40, L H_2O 30-50, dms 20-30 vol.%.
3. L CO_2 dissolves in L H_2O at 370-330°C, T_H 560-480°C. (Author's abst.)

KAZITSYN, Yu.V., 1976, Trace elements and fluid inclusions in minerals of altered Cu-Mo bearing rocks, <u>in</u> Internat. Geol. Congress, 25th Session, Reports of Soviet Geologists (Tugarinov, A.I., et al., eds.), p. 274-284: Moscow, Izd. Nauk (in Russian with English summary).

This paper was not given at the 25th I.G.C. and the abstract is not present in the volume of abstracts of the 25th IGC. (E.R.)

KELLY, W.C. and WAGNER, G.A., 1977, Paleothermometry by combined application of fluid inclusion and fission track methods: N. Jb. Miner. Mh., H. 1, p. 1-15.

For the first time fluid inclusion and fission track studies are combined as complimentary paleothermometric techniques. They are applied to apatite from the hydrothermal tungsten veins of the Panasqueira mining district/Portugal. During the Hercynian orogeny the apatite was deposited at temperatures in or slightly above the range of 230-315°C at shallow depths of 1500 m or less. The temperatures fell to below 70°C in the waning stages of this mineralization. In post-Hercynian time either a single late Jurassic thermal event 152 Ma ago (above 150°C) or two such events 152 Ma and 79 Ma ago occurred, in which the late Cretaceous event could not have exceeded 150°C. The late, "Alpine" mineralization observed at Panasqueira is likely connected with one of these two events. The late Jurassic event may be related to the early rifting of the Atlantic.

KERRICH, Robert, 1976, Some effects of tectonic recrystallisation on fluid inclusions in vein quartz: Contrib. Mineral. Petrol., v. 59, p. 195-202. Author at Dept. Geol., Univ. of Western Ontario, London Ontario N6A 5B7, Canada

T_H data obtained from tectonic vein quartz varies according to the state of intracrystalline deformation. Strain free domains within grains exhibit abundant primary fluid inclusions, from which internally consistent temperatures are recorded. The onset of optical features associated with intracrystalline deformation by dislocation creep is accompanied by a decrease in the number of fluid inclusions and an increase of T_H. At higher states of strain tectonic recrystallization, evidenced by the formation of new subgrains, leads to the complete destruction of inclusion arrays. Empty cavities are swept out of the new grains during recrystallization, into subgrain walls.

Heterogeneous deformation of vein quartz at the intracrystalline level may be due in part to selective hydrolytic weakening in areas where fluid inclusions have leaked and thereby increased the structural water content. (Author's abstract)

KERRICH, Robert, 1977, Yellowknife gold mineralisation: the product of metamorphic degassing (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 1048-1049. Author at Univ. of Western Ontario, Department of Geology, Canada N6A 5B7.

Quartz-gold veins are located along conduits within a system of ductile shear zones transecting metabasalts in the Yellowknife greenstone belt. $\delta^{18}O$ values of main-stage vein quartz varies from $12^{\circ}/_{\circ\circ}$ to $16^{\circ}/_{\circ\circ}$. The calculated ^{18}O of fluids assumed to be in equilibrium with the vein quartz is ∿9%*, indicating a possible metamorphic origin. $\delta^{18}O$ values of quartz in the metabasalts increase from a background of ∿10%* to parity with the $\delta^{18}O$ of vein quartz adjacent to the vein alteration envelopes. This enrichment is due to oxygen exchange with the metamorphic fluids in the temperature range 300°C-400°C; and coincides with a strong iron reduction anomaly ($Fe^{2+}/\Sigma FE$ = 0/92 vs 0.75 background). Water/rock ratios computed on the basis of $^{18}O/^{16}O$ data and oxidation-reduction reactions are >3:1. The gold deposits appear to have formed by the focussing of a massive flux of reducing hydrothermal solutions (∿4 km^3) derived by metamorphic dehydration reactions over a source volume of >180 km^3, during episodes of extensive hydraulic fracturing. Steep geothermal gradients prevailing in the Archean would give rise to fast rates of metamorphic dehydration with concomitant hydraulic fracturing, and this may account for the dominant occurrence of hydrothermal gold deposits in Archean greenstone belts. Precious metal abundances in primary lithologies (Au 1-5 ppb, Ag 20-60 ppb, Pd 2-25 ppb) are typical of average abundances in igneous rocks, and therefore the Yellowknife volcanics are not intrinsically favourable to location of an ore deposit. These data support the premise that thermal and structural conditions promoting degassing of hot fluids in equilibrium with source rock over very large crustal volumes are the principal factors governing ore formation. (Author's abstract) *Sic. Probably misprint for o/oo

KERRICH, R., FYFE, W.S. and ALLISON, I., 1977, Iron reduction around gold-quartz veins, Yellowknife district, Northwest Territories, Canada: Economic Geology, v. 72, p. 657-663.

It is concluded that the observed reduction of iron in gold ore requires minimum water/rock ratios of about 3:1. Consideration of gangue mineral volumes leads to much higher water/rock ratios. (From the authors' abstract)

KERRICK, D.M., 1977, The genesis of zoned skarns in the Sierra Nevada, California: Jour. Petrol., v. 18, pt. 1, p. 144-181. Author at Dept. Geosci., The Penn. State Univ., Univ. Park, PA 16802.

Zoned skarns occur at plutonic-metamorphic contacts, in veins cutting marble, and at contacts between marble and interlayered amphibolite and biotite-rich rocks. For P=2 kb, fluid inclusions and P-T-X_{CO_2} stability relations of calc-silicate assemblages suggest T< 650°C and a H_2O-rich fluid (X_{CO_2} <0.1). Small-scale, Ca-rich endoskarns are common near exoskarns. Mass balance calculations suggest that: (a) the formation of exoskarn requires the influx of solute in an aqueous solution from uncontaminated magma in addition to material derived from the endoskarn, (b) some "limestone assimilation" is required to form endoskarns, and (c) skarn formation was essentially a constant-volume process. Applying chromatographic theory, compositional profiles of garnet and pyroxene across zoned skarns suggest that infiltration metasomatism was an important process, although diffusion metasomatism appears to have produced local compositional gradients at the infiltration "fronts." Fluid flow calculations show that thick exoskarns could readily form by intergranular infiltration of aqueous solutions. Reciprocal diffusional exchange is suggested as a dominant mechanism in the formation of zoned skarns formed at contacts between interlayered metamorphic lithologies. (Author's abstract)

The simple 2-phase inclusions contain no recognizable CO_2, and have T_H of 373-384°C; T_{FRZ} -2 to -5°C. Pressure correction is estimated to be 250°C. (E.R.)

KESLER, Stephen E., 1977, Geochemistry of manto fluorite deposits, Northern Coahuila, Mexico: Economic Geology, v. 72, pp. 204-218.

Economically important manto fluorite deposits in northern Coahuila, Mexico, are found at the contact between uppermost Lower Cretaceous Georgetown limestone and disconformably overlying Del Rio shale or Buda limestone in nine districts within a 5,000-km^2 area. The deposits formed by replacement followed by open-space filling and consist of fluorite with minor calcite and quartz and local celestite and supergene(?) gypsum. Sulfides are extremely rare in these deposits. Wall-rock alteration around the mantos involved fluoritization and locally intense silicification and formed halos about one foot wide. Primary inclusions in fluorite from these mantos contain liquid + vapor ± petroleum material ± an unidentified daughter crystal. Homogenization temperatures on nearly 300 such large, primary inclusions range from about 110° to 330° with a strong maximum at 150° ± 20°C. Salinities of these inclusion fluids range from 8 to 18 equiv wt % NaCl, and Na/K atomic ratios of inclusion leachates range from 2.5 to 3.14 with all leachates containing large amounts of calcium. Evidence for boiling is seen in many deposits.

The deposits are spatially associated with mid-Tertiary(?) rhyolite (anomalously high in fluorine), and some chimneys, veins, and contact deposits are immediately adjacent to these rhyolites. One such contact deposit contains fluorite with polyphase inclusions (salinity of over 40%) that homogenize in the 370° to 430°C range and have a Na/K atomic ratio of 1.14 (with abundant calcium). Sulfur from arsenopyrite in this deposit has an isotopic composition of + 0.8 per mil, whereas sulfate from manto celestite has sulfur as heavy as +13.2 per mil. Sulfur in gypsum and pyrite in the Del Rio shale have compositions of -18.8 and

-31.3 per mil, respectively.

Consideration of these data in their geologic context suggests that the manto deposits formed when a zone of formation water trapped below the Del Rio shale was intersected by rhyolite magmas, which contributed fluorine, heat, and possibly magmatic water and sulfur to the formation water zone. On a regional scale, the northern Coahuila fluorite district appears to be related to a zone of mid-Tertiary alkaline igneous rocks that extends from the Big Bend area to Tampico and includes another important Mexican fluorite district. These results lend credence to unexposed magmatic affiliations postulated for other fluorite districts in North America.

KHASANOV, A.Kh., 1977, Physico-chemical conditions of formation and age of near-vein metasomatites and epithermal ore mineralization of the Gissaro-Alay (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Sib. Branch, v. II. p. 139-140 (in Russian; translation by A. Kozlowski). Author at Tadzhik State University.

Hydrothermal Sb-Hg, polymetallic-fluorite, barite-calcite-radioactive, sulfide-celestite, and fluorite deposits of Gissaro-Alay and adjacent regions formed in several stages. Early metasomatites developed at 350-450°C at the depth 1500-1800 m. Ore bodies crystallized at 50-300°C and 100-350 atm from almost neutral solutions. (From the author's abst.)

KHAYRETDINOV, I.A., AVZYANOV, V.S., ANDRYANOVA, N.A., and PSHENICHNYI, G.N., 1976, Thermobarogeochemical conditions of formation of sulfide deposits of S. Urals, in Thermobarogeochemistry of mineral formation, N.P. Ermakov, ed.: Rostov, Rostov Univ. Press, p. 77-86 (in Russian).

Full paper corresponding to abstract in Fluid Inclusion Research volume 7, p. 99-100, 1974.

(Authors and title changed from the earlier version.)

KHETAGUROV, G.V., 1976, Results of thermometric and mineralogical-geochemical studies of ores of polymetal deposits of Central Caucasus, in Thermobarogeochemistry of mineral formation, N.P. Ermakov, ed.: Rostov, Rostov Univ. Press, p. 91-102 (in Russian).

Full paper corresponding to abstract in Fluid Inclusion Research volume 7, p. 100-101, 1974.

(Title changed from that used earlier.)

KHETCHIKOV, L.N., 1976, Inclusions of mineral-forming media in crystals, grown under various conditions (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR Inst. of Geol., p. 156-157 (in Russian; translation by A. Kozlowski).

1. Inclusions were studied in crystals grown from water solutions at low and elevated T under P = 1 atm as well as under high P, and from melts under P from 1 atm to high pressures.

2. In crystals grown at T up to 40°C, P = 1 atm, only L inclusions were found; those grown at T 40-80°C - mostly G/L inclusions with F>95%.

3. Crystals grown at T 150-400°C, P 50-2000 atm, bear mainly G/L inclusions with F≈F of autoclave. Crystals grown from G or L

solutions are easily discernible. Crystals are trapped*in inclusions when the salt concentration exceeds 40%. *I.e., solid inclusions (Ed.)

4. Crystals grown from melts, P 1 atm, 700-1700°C, bear syngenetic G and solidified inclusions (...). Melt immiscibility may be observed in inclusions.

5. Crystals grown from vapor phase above melt contain mostly G and glass-G inclusions with G vol. from 35 to 60%.

6. Synthetic diamonds (T>1000°C, P>40kb, crystallization from solution in melt): inclusions are similar to the medium of crystallization. Inclusions are different than in natural diamonds, likewise the different conditions of crystallization of kimberlites, when compared with synthetic conditions. (...) (From the author's abst.)

KHETCHIKOV, L.N., 1977, Inclusions of mineral-forming environment in the crystals grown under different conditions: Proc. of the USSR Acad. Sci., Geol. Ser., 1977, no. 6, p. 93-103 (in Russian).

This is the full paper covered in the preceding abstract. (ER)

KHITAROV, D.N. and ARMAN, O.P., 1976, Gases of the mineral-forming solutions forming rare-metal deposits of various types (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 204-205 (in Russian; translation by A. Kozlowski).

Composition of G in fluid inclusions was studied by use of improved chromatograph LKhM-8MD; the apparatus was calibrated to determine quantitatively H_2O, CO_2, CH_4 and H_2S. Following deposits were studied: quartz-vein Kara-Oba and Nura-Taldy, metasomatic fluorite-Be in carbonates (Transbaikalia), ore mineralizations of various metals in Gissar Mountain Chain, as well as of rare metals in central Kazakhstan and Kyzyl-Kum.

1. At the Kara-Oba deposit, early, high-T stages with topaz are characterized by high concentrations of CO_2 (18 mol/1000g H_2O) and CH_4 (22 mol/1000g H_2O). H_2S was noted. During subsequent stages concentrations of CO_2 and CH_4 decrease to 1 mol/1000 H_2O. In fluid inclusions of quartz-wolframite and quartz-molybdenite veins almost uniform concentrations of CO_4 (18-16 mol/1000g H_2O) and absence of CH_4 were ascertained. Fluid inclusions in quartz from all three main types of veins from Kara-Oba bear similar, low amounts of CO_4 ($\sim$1 mol/1000g H_2O). In fluid inclusions of quartz from quartz-wolframite veins CH_4 was found in concentration up to 1.6 mol/1000g H_2O; in quartz from composite veins with sulfides, 0.3 mol/1000g H_2O; and in quartz from quartz-molybdemite veins CH_4 was not found.

2. In fluid inclusions of the minerals of metasomatic Be deposit from Transbaikalia CO_2 and CH_4 are absent; in fluid inclusions in fluorites from the same ores concentrations of CO_4 reach 4 mol/1000g H_2O.

3. During mineral formation the concentration of CO_2 increased and CH_4 decreased. (Authors' abst.)

KHODAKOVSKIY, I.L., 1976, Calculation of pressure of chloride solutions from the homogenization temperature of inclusions bearing daughter minerals (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 172-173 (in Russian; translation by A. Kozlowski).

1. G/L inclusions often bear daughter minerals, usually NaCl and KCl, dissolving sometimes at T higher than T of dissolving of G phase. For the correct determination of P at T_H the data on P-V-T relations are necessary for highly concentrated salt solutions at high T and P.

2. For extrapolation of the experimental densities of the binary water electrolytes in the wide ranges of T, P and concentrations, an expression of the "apparent partial molal volume" is useful:

$$\varphi v = 1000/mdd^\circ(d^\circ - d) + M_2/d^\circ; \qquad (1)$$

where d and d° - densities of solution and solvent, in g/cm^3, m - concentration of solution in moles per 100g of H_2O, M_2 - molecular weight of the dissolved substance.

Relation between φv and ionic strength μ:

$$\varphi v = \varphi v^\circ + V/Z + Z-/\Delta\varphi + b\mu + c\mu^2 + \ldots; \qquad (2)$$

where $\Delta\ (D-X) = Sv/4BJ_1 + Wv/(4B)^2 J_2$;

and $J_1 = 1 - {}^2/_4\ B\sqrt{\mu} + 2\ \ln(1 + 4B\sqrt{\mu})/(4B)^2\mu$;

$J_2 = 1 - 4/(4B)^2\sqrt{\mu} - 2/(4B)^2\mu[1/1 + 4B\sqrt{\mu} + 3\ln(1 + 4B\sqrt{\mu}) - 1]$;

where Sv, Wv and B are theoretical coefficients depending only on T and P; V - number of moles of ions formed during dissociation of one mole of electrolyte, and Z+ and Z- are charges on ions.

3. From experimental data on the density of NaCl solutions, the indices for equation (2) were found, as well as their relation to T and P; this permitted extrapolation of the densities of NaCl solutions of any concentration - from 25 to 600°C and from 1 to 3000 bars.

4. Examples of calculations were presented. (Author's abst.)

KHOD'KOVA, S.V., 1977, The use of data on composition and homogenization temperature of microinclusions in salt crystals in solving problems of genesis: Litologiya i Poleznye Iskopaemye, 1977, no. 6, p. 140-143 (in Russian; translated in Lithalogy and Mineral Resources, v. 12, no. 6, p. 730-732, 1978).

The author attempts to prove that a previous article by Kovalevich (1975b, p. 96 in Fluid Inclusion Research--Proceedings of COFFI, v. 8, 1975) is completely without merit due to a failure to relate the inclusions studied to the various stages of lithogenesis. (ER)

KHOLIEF, M.M., 1975, Significance of inclusions in quartz of some Egyptian clastic sediments as a geologic criterion: Proc. Egypt. Acad. Sci., v. 28, p. 123-130 (in English). Author at Petroleum Research Inst., Nasr City 7th Region, Cairo, Egypt.

The author uses inclusions in quartz from Nubian sandstone to characterize its provenance. (ER)

KHOLIEF, M.M. and EL-BAZ, M.H., 1977, Mineralogy of Upper Eocene sandstones at Nile Valley, Egypt: Rapp. Comm. int. Mer Medit., v. 24, no. 72, p. 245-247.

Includes discussion of use of inclusions in provenance studies (ER).

KHOMICHEV, V.L. and KHOMICHEVA, Ye.S., 1977, Zonal temperature sequence of molybdenum deposits in Khakasiya (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci.

U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. I, p. 171-178 (in Russian; translation by A. Kozlowski).

Comparative studies of similar Cu-Mo deposits from the E slope of Kuznetskiy Alatau permitted their arrangement in a sequence from deeply to slightly eroded deposits. Erosion reached the deepest levels in Ipchul'skoe and Agaskyrskoe deposits. T data are as shown (T_H in °C):

			Deposits	
	Beyskoe	Sorskoe	Ipchul'skoe	Agaskyrskoe
Pegmatoid quartz of stock work		700-470 in G	680-440 in G or L	
Do. from veins		430-400 in L		420-340 in L, rarely G
Pyrite-K-spar-quartz veins of the I stage		470-390 in L or G	450-360 in L, rarely G	400-260 in L
Sulfide-quartz veins of the II stage	440-300 in L or G	400-280 in L	380-260 in L	360-220 in L
Quartz-molybdenite veins of the III stage		360-250 in L	320-235 in L	

KINSLAND, Gary L., 1977, Formation temperature of fluorite in the Lockport Dolomite in Upper New York State as indicated by fluid inclusion studies--with a discussion of heat sources: Economic Geology, v. 72, pp. 849-854.

Fluid inclusion geothermometry studies of fluorite crystals from Penfield Quarry in the Silurian Lockport Dolomite of upstate New York indicate that mineralizing fluids with temperatures in the range of 137 ± 5°C were at least in part responsible for the minerals found there. This temperature is higher than can be explained within the framework of present knowledge of the geology of upstate New York and of its geologic history. Some one or any combination of the following must be true: 1) The Lockport must have been buried more deeply than present reconstructions indicate, 2) mineralizing fluids from a remote heat source must have been introduced into the Lockport along unknown channels, 3) the geothermal gradient of the area must have been considerably higher than the present value, 4) a post- (or late-) Silurian intrusion must be present beneath the Lockport. **(Author's abstract)**

KIRCHER, Athanasius, 1678, Mundus Subterraneus, 3rd ed: Amsterdam, Jamssen (in Latin).

This slightly obscure early reference was submitted by Cecil Schneer. In it, the author illustrates and describes (vol. II, Lib. VIII, p. 80-81) inclusions with bubbles that are free to move by gravity.

KIRIKILITSA, S.I., MARCHENKO, E.Ya., and KON'KOV, G.G., 1977, Recognition in the Ukrainian apatite-bearing province of alkali rocks and carbonatites: Akad. Nauk Ukrainskoi RSR Dopovidi, ser. B, no. 1, p. 14-17 (in Ukrainian with Engl. abst.). Authors at Inst. of Mineral Resources, Kiev.

Carbonatite-alkaline Novopoltavskiy massif within the Ukrainian shield bears apatite and carbonate with the main range of T_D 430-440°C (assumed to be close to the main stage of carbonatite formation); subordinate peaks appear at 510 and 540°C as well as at 370°C. G/L inclusions in quartz from fenites have T_D 200-500°C, with peaks at 200, 260 and 430°C. Alkaline rocks formed at 775°C (T derived from the composition of nepheline). (Abst. by A.K.)

KIRKPATRICK, J., 1977, Measurement and calculation of crystal growth rates in silicate systems: Canadian Mineralogist, v. 15, p. 195.

KIRKPATRICK, R.J., 1977, Nucleation and growth of plagioclase, Makaopuhi and Alae lava lakes, Kilauea Volcano, Hawaii: Geol. Soc. of Amer. Bull., v. 88, p. 78-84. Author at Dept. of Geol. Sci., Harvard Univ., Cambridge, Mass. 02138.

The Hawaiian lava lakes offer an unparalleled opportunity to study the processes that occur during the crystallization of basaltic magma. This paper presents estimates of the rates of nucleation and growth of plagioclase in the Kilauea lava lakes, Makaopuhi and Alae, and a discussion of the processes that control the nucleation and growth. The observed growth rates perpendicular to (010) vary from 1.7 to 11.0 x 10^{-10} cm sec^{-1}. The nucleation rates vary from 6.8 x 10^{-3} to 2.0 cm^{-3} sec^{-1}. In general the rates increase with increasing crystallization at any point, decrease with increasing distance from the surface, and are higher in the shallower lake, Alae. For the most part, nucleation appears to occur heterogeneously on previously existing crystals. The growth appears to be controlled by the interface attachment kinetics and not by diffusion in the melt. The observed results are in qualitative agreement with theoretical predictions. (Author's abstract).

KIYOSU, Yasuhiro and NAKAI, Nobuyuki, 1977, Estimation of formation temperature for the Taishu, Toyoha and Kamioka Pb-Zn deposits on the basis of sulfur isotope temperature scale: The Journal of The Japanese Assoc. of Min., Petrol. and Econ. Geol., v. 72, no. 3, p. 103-108 (in Japanese with English abstract).

The $^{34}S/^{32}S$ ratios of coexisting sphalerite and galena from Taishu, Toyoha and Kamioka Pb-Zn ore deposits have been measured to estimate the temperature of formation of ore deposit. All of the sphalerite samples were enriched in ^{34}S compared with galena. Sulfur isotopic fractionation between sphalerite and galena ranges from 1.5 to 2.0 permil in the Taishu and Kamioka deposits, while in the Toyoha deposits ranges mostly from 2.5 to 3.0 permil. The fractionation of coexisting samples from early stage veins in Toyoha deposits is smaller than those from later stage veins. Using these isotopic fractionations and experimental temperature scale (Kiyosu, 1973), the temperature of formation is estimated to be 350° to 400°C in Kamioka deposits, 300° to 350°C in Taishu deposits and 200° to 250° in Toyoha deposits. These isotopic temperatures are slightly higher than filling temperatures determined from fluid inclusions of quartz and sphalerite. (Authors' abstract)

KLEMIN, V.P., 1976, Temperatures of formation of the sulfide ores of the S. Urals (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir

Section, Acad. Sci. USSR, Inst. of Geol., p. 87 (in Russian; translation by A. Kozlowski).

Ores occur in the contacts of subvolcanic rocks and tectonic zones. T_D of pyrites (Podol'skoe and Oktiabr'skoe deposits) equals 300-500°C, T_D of pyrite from pseudobreccia - 400-500°C. Rock with tectonic schistosity, away from the aureole of influence of the pre-ore intrusion, locally bear ores consisting of polymetallic sulfides and barite (deposits: Machskoe, Buribaiskoe, Tash-Tauskoe); T_D of pyrite 350-150°C. (From the author's abst.)

KLESHCHEV, G.V., BRYZGALOV, E.N. and CHERNYI, L.N., 1976, Methods of diffraction topography and hydrothermal etching in studies of the structure of crystals (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 158.

General characteristics of the methods are given and their high resolution is described. Studies of the growth of crystals, regularities of growth, distribution of dislocations, G/L and solid inclusions are exemplified by natural and synthetic crystals. (Authors' abst.)

KLEVTSOV, P.V. and LEMMLEIN, G.G., 1959, Determination of the minimum pressure of formation of quartz for the example of crystals from Pamir: Zapiski Vses. Mineralog. Obshch.v. 88, no. 6, p. 661-666 (in Russian; see translations).

KNAPP, R.B., 1977, Numerical simulation of the formation of quartz-filled veins in hydrothermal systems (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 1053.

The process of closing an open fracture by precipitation of quartz on the fracture walls is quantitatively examined, using differential equations which describe advective and diffusive transport, dissolution kinetics, equilibrium precipitation, and changing fracture aperature. (From the author's abstract)

KNIGHT, J.E., 1977, A thermochemical study of alunite, enargite, luzonite, and tennantite deposits: Econ. Geol., v. 72, p. 1321-1336.

Temperature dependent phase relationships and irreversible reactions between fluids and minerals in the systems K_2O-Al_2O_3-SiO_2-SO_3-H_2O and FeO-Cu_2O-H_2S-SO_3-As_2O_3-H_2O have been computed using thermodynamic data taken from the literature.(From the author's abstract)

KNIGHT, J.E. and NORTON, D.L., 1977, Hydrothermal alteration of hot plutons as a function of time, temperature, and pressure (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 1054.

Simulation of heat and mass transport processes with partial differential equations and numerical methods permits quantitative computation of conductive and convective heat transport and irreversible equilibrium mass transfer between mineral phases and circulating fluids. (From the authors' abstract)

KOBILEV, G.A. and TRUFANOV, V.N., 1977, Main stages of formation of lead-zinc deposits in the northern Caucasus: Akad. Nauk SSSR, Doklady, v. 234, p. 1156-1159 (in Russian).

Includes some melt inclusion homogenization temperatures of ≤1100°C, and vacuum decrepitation temperatures of over 600°C. (ER)

KOGARKO, L.N., 1977, Problems of genesis of agpaitic pegmatites: Moscow, "Nauka" Press, 294 pp. (in Russian).

KOGARKO, L.N. and ROMANCHEV, B.P., 1977, Temperature, pressure, redox conditions, and mineral equilibria in agpaitic nepheline syenites and apatite-nepheline rocks: Geokhimiya, 1977, no. 2, p. 199-216 (in Russian; translated in Geochem. Internat., v. 14, p. 113-128). Authors at Vernadskiy Inst. Geochem. and Anal. Chem., Acad. Sci. USSR, Moscow.

Thermodynamic data (redox conditions, temperature, and pressure) are presented for agpaitic nepheline syenites and their related apatite deposits; rock melting at various oxygen partial pressures has been used in conjunction with examination of mineral (and melt) inclusions. (Authors' abstract.)

KOKIN, A.V., SILICHEV, M.K. and ANDRYANOV, N.G., 1977, On results of vacuum decrepitation of gold from some placer and vein deposits in Verkhoyan'ye (abst.) <u>in</u> Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council On Ore Formation, Sib. Branch, v. II, p. 24-25 (in Russian; translation by A. Kozlowski). Authors at the Allakh-Yun' Geol.-Prosp. Expedition of Yakutian Territrial Geol. Office of Geol. Mining of Russian Socialist Federal Soviet Republic (RSFSR).

Seven sections were analysed, bearing 51 samples of gold from placer deposits and 21 samples from vein deposits. Results are given in the table below.

Sections, from S to N	T_D, °C	Maximum peak, °C
1	650-300	590
2	550-120	220
3	500-100	190
4	390- 50	275, 190, 75
5	650-125	650, 300, 180
6	650-390	490
7	650-190	210

1) Gold from deposits in situ in individual river basins (sections) are characterized by the same ranges of T_D. 2) From south to the north the regular change of T_D of gold was noted, depending on type of crystalline basement; the highest T_D are connected with the elevation of the basement. 3) Three groups of gold with various T_D were distinguished, both in placer deposits and in situ. (From the authors' abst.)

KOKORIN,A.M. and KOKORINA, D.K., 1976a Stages and zonation of mineralization of the typical hydrothermal deposits of the (Soviet) Far East (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir

Section, Acad. Sci. USSR, Inst. of Geol., p. 75 (in Russian; translation by A. Kozlowski).

Dalnegorsk* skarn-polymetallic deposits formed under pneumohydrothermal conditions during T_H decrease from >500 to 50°C. The final period of skarn formation was during the condensation of the gas-vapor phase into hydrotherms at 420-450°C. Sulfides crystallized at T_H 350-250°C; the mineral-forming process finished at 30-50°C with formation of the fluorite-calcite paragenesis. All mineral associations usually occur together in the ore bodies, which are developed over 400 m vertically. P driving ore formation was up to 300 atm.

Tin ore deposits of the cassiterite-silicate type of the Kavalerovskii region formed at T_H from ≈ 420 to 50°C; T_H during the commercial mineralization stage was 450-300°C, sulfide stage 350-200°C, late quartz-carbonate 200-50°C. The higher T_H values are found in the deeper levels and presumably pneumatolytic inclusions with still higher T_H may be found in the greater depths. Ores were found down to 1000 m below the surface. Pressure decreased from 350 to 50 atm. Deeper ores are poorer in sulfides and richer in cassiterite.

Lermontovskoe deposit in some places contains skarns, greisens with scheelite ores, and sulfide mineralization. Pneumatolytic greisens formed at ≈ 500-430°C, scheelite at 400-350°C, sulfides at 350-250°C and the late associations at 250-100°C. Ore-forming solutions were rich in CO_2; pressures varied from ≈ 1000 atm to 250-30 atm.

The sequence of parageneses at the deposits is as follows: skarns → greisens → sulfides → quartz → carbonates. (Author's abst.)

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*Formerly Tietiukhe

KOKORIN, A.M. and KOKORINA, D.K., 1976b Temperature criteria for the level of erosion (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 147 (in Russian; translation by A. Kozlowski).

Deposits of cassiterite-quartz formation have T_H 500-100°C (commercial paragenesis 450-400°C), cassiterite-silicate 450-50°C (450-350), cassiterite-sulfide 350-50 (350-300°C). Taking into account initial values, they may be arranged in such a way that the first and the third formations are comparable with the lower and upper levels of deposits of the second formation. "Commercial" T_H (450-300°C) are useful to determine the height of eroded rocks above deposits. Low T_H of cassiterite means small erosion of ore body. When vertical extent of mineralization equals ∿1000m, and decrease of T_H is about 100-150°C, T gradient may be evaluated as 10-15°C/100m. Pre-ore mineralization is connected with pneumatolytic solutions, cassiterite crystallization appears immediately after their change into hydrotherms. Evidences of transportation of ore elements in gaseous fluids were obtained. G was analysed by G chromatography.

Eight stages were distinguished in deposit I: 1) quartz-feldspar, 2) molybdenite-quartz, 3) wolframite-quartz (I), 4) late wolframite-quartz (II), 5) sulfide-quartz, 6) feldspar, 7) quartz-fluorite, 8) calcite-zeolite. Vein quartz of stages 2,3,4 and 7 bears high amount of CO_2 and in wolframite veins-high amount of H_2. Deposit II was formed during 7 stages: 1) quartz-greisen, 2) wolframite-quartz, 3) topaz, 4) muscovite-biotite, 5) tourmaline-quartz, 6) sulfide-quartz, 7) quartz-fluorite. There were found gases as follows (cm^3 per 1 kg of rock):

Stage	Total gases	H_2	CH_4	CO_2	O_2	N_2
1	17.22	9.38	0.098	6.09	0.32	1.03
2	35.56	20.59	0.116	13.58	0.24	0.93
7	1.35	0.76	0.00	0.32	0.04	0.27

CO is absent, C_2H_4 content varies from 0.0 to 0.46. At the deposit III in veins of wolframite-ore formation gases were revealed (same units): H_2 13.8-15.33, CH_4 0.11-0.13, CO_2 33.98-47.02, O_2 0.09-0.32, N_2 0.13-1.09, total gases 49.70-59.52. (Authors' abst.)

KOKSHAROV, V.A., 1976, Method of determination of composition of volatiles from minerals (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 173-174 (in Russian; translation by A. Kozlowski).

Gases are condensed at specific T and P in special apparatus (...). In G/L inclusions the volume percentages of H_2O, H_2SO_4, SO_2, NH_3, H_2S, CO_2, SiF_4, HCl, SiH_4 and total G were determined from T of condensation <-196°C. Experiments were made with inclusions in galena from the Ridder-Sokol'noe deposit: H_2O 24.7, SO_2 0.2, $H_2S + CO_2$ 58.8, $N_2 + H_2$ + noble gases 16.3 (in vol. %). (Author's abst.)

KOKSHAROV, V.A. and KUZEBNYI, V.S., 1977, On the regime of mineral-forming solutions at the Ridder-Sokol'noe deposit (abst); in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch v. II, p. 77 (in Russian; translation by A. Kozlowski). First author at Inst. Geol. Sci. of Acad. Sci. Kazakh SSR.

The deposit is typical of the polymetallic deposits in the Rudnyi Altai. Inclusions in galena, sphalerite, pyrite, quartz and carbonate from polymetallic ores and quartz-ore veins, formed at 325-270°C, yield following composition of gases (in vol. %): H_2O <20 to 30-45, $SO_2 < 10$, $H_2S + CO_2 (H_2S >> CO_2)$ from 37-45 to 50-85, not determined gases from 4-20 to 30-37 (the latter may include N_2, H_2 CO and rare gases). (A.K.)

KOLONIN, G.R. and KOSALS, Ya.A., 1977, Proposed physico-chemical model of rare-metal ore formation exemplified by the Dzhida ore field (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. I, p. 155-156 (in Russian; translation by A. Kozlowski). Authors at Inst. Geol. and Geophys. Siberian Branch Acad. Sci. USSR, Novosibirsk.

High T metasomatosis (early microclinization, early albitization, greisenization, and silicification) developed at 650-400°C. Mo-W mineralization formed from Na-K-Cl-HCO_3 solutions with increasing F, Ca and S^{2-} content at later stages, at T 400-350°C, P 1.5-2 kbar; T 440-300°C, P 1.5-0.5 kbar; T 360-160°C, P 1.5-2 kbar during subsequent stages of ore mineralization. Each stage of ore mineralization begins with the removal of Mo, Be and W from granite and then these elements were precipitated in stockworks and quartz veins. The mode of transport is discussed. (Abstract by A.K.)

KOLTUN, L.I., 1977, Temperature and composition of solutions in the process of formation of the Kadain polymetallic deposit (Eastern Transbaikalia) (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. II, p. 80-81 (in Russian; translation by A. Kozlowski). Author at the L'vov University.

Ores form veins and stockworks in strongly fractured carbonate rocks. Following associations were distinguished: pyrite-quartz, arsenopyrite-pyrite, ankerite-galena-sphlerite, carbonate-galena, sulfide-calcite, sulfide-quartz and calcite-dolomite. Ores were formed from hydrothermal solutions at T 310-70°C. Two earliest associations crystallized at 319-270°C (T_H in quartz). Main commercial ores come from ankerite-galena-sphalerite association (T_H in ankerite 235-180°C, in sphalerite 220-190°C, all P inclusions). Carbonate-galena and sulfide-calcite ores precipitated at 145-70°C (inclusions in calcite). Parent solutions bear following ions (in % - equiv.): Ca 77.05, Mg 13.1, Na 6.56, K 3.28, HCO_3 64.21, $HSiO_3$ 18.45, Cl 13.65, F 3.69. (From the author's abst.)

KOLTUN, L.I. and PIZNYUR, A.V., 1976, Studies of mineral-forming solutions for research and prospecting for ore bodies (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 133-134 (in Russian; translation by A. Kozlowski).

Although spatially separated, the deposits of Mo, Mo-Pb,Zn, Au, Pb-Zn, W and Sn in E. Transbaikalia have common stages of development. Quartz-molybdenite and quartz-tourmaline stages are early, polymetallic and other sulfides are intermediate, and quartz-carbonate are late. Similarity of stages is distinctly expressed by phase and chemical compositions of solutions: early - pneumatolytic-hydrothermal, rich in CO_2, NaCl and KCl, intermediate - hydrothermal rich in CO_2, late - low T hydrothermal, yielding carbonates. Change of composition of solutions from concentrated $Cl-Na-CO_2-H_2O$ through CO_2-H_2O to dilute ones, may be found also in one stage. Early stage is accompanied by potassium feldspar metasomatism, intermediate - sericitization, late - silicification and carbonatization. Data on thermobarogeochemistry of commercial stages of mineralization permit their successful evaluation.

At the Zhireken Mo deposit, parent solutions of commercial ores have high concentration of NaCl and narrow T ranges of molybdenite precipitation (420-370°C). (...) Method of visual search for G/L inclusions was used at the W-Mo Kounrad deposit (Central Kazakhstan) and it revealed blocks of Mo ore mineralization (...)(Authors' abst.)

KONKIN, V.D. and KUZNETSOVA, T.P., 1977, Thermobarogeochemistry of ores of the Kholodninskoe deposit (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. II, p. 82-83 (in Russian; translation by A. Kozlowski). Authors at the Central Sci.-Res. Geol.-Prosp. Inst. of Ministry of Geol. of the U.S.S.R., Moscow.

Kholodninskoe pyrite-polymetallic deposit occurs in the Olokitskiy side of geosyncline of the Riphean age, within the Baikal folded area built up of metamorphosed volcanogenic-sedimentary rocks. Ores formed during three stages: 1) hydrothermal-sedimentary, 2) progressive metamorphism, 3) retrograde metamorphism. Inclusions in quartz and sphalerite typical of stage 2 have T_H 530-650°C (i.e., T of amphibolite facies), those of stage 3 -- 280-400°C. (From the authors' abst.)

KONONOV, V.I. and POLYAK, B.G., 1977, Recent hydrothermal activity and peculiarities of volcanism of Iceland, in: Hydrothermal process in the areas of tectonic-magmatic activity, p. 21-31, "Nauka" Publ. House, Moscow (in Russian).

KONOVALOV, I.V., 1976, Metallogenic prognosis of gold ore mineralization (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 140 (in Russian; translation by A. Kozlowski).

Metamorphic-hydrothermal quartz-gold ore bodies were studied in the Lena region, in the ranges of Bodaybo synclinorium in Upper Proterozoic deposits. On the basis of the highest T_H in vein quartz, a map of paleoisograds of the synclinorium was made. T zoning of quartz vein fields roughly agrees with regional metamorphic zoning and depends on the position of deep cross cutting faults. Maximum T_H in quartz in sericite, biotite, garnet and staurolite zones of metamorphism: 400-310, 420-380, 430-410 and 450-430°C, respectively. Gold ore mineralization formed at T_H 380-360°C, other veins are barren. Six types of decrepitation curves of quartz were distinguished. Commercial ores are characterized by low-T peaks at 200-220°C and at 380-600°C. Hence, the most promising parts of the ore fields might be found. (Author's abst.)

KONOVALOVA, O.G., DOLGOV, Yu. A., SIMONOV, V.A. and STOGNIY, G.A., 1976, Inclusions in minerals of non-granitic pegmatites and massifs of basic and ultrabasic rocks in geosynclines; in Genetic studies in mineralogy, Yu. A. Dolgov et al., eds.: Novosibirsk, Inst. Geol. and Geophy. Sib. Branch Acad. Sci. USSR, p. 63-67 (in Russian)

Olivine from forsteritic dunites bears inclusions filled with G of low P, similar to atmospheric (G are mainly CO_2, sometimes S-bearing gases or N_2). Sometimes on the walls of vacuoles solid substance was observed that often melts at 500-750°C and redeposits inside vacuole. Solids are either aluminosilicates (by microprobe analysis) or organic carbon compounds (0.11 wt. % in bulk dunite), including light-yellow paraffin bitumen (0.004 wt. % in bulk dunite).

Hornblende from gabbro pegmatites in Stanovoy Crest (Kuznetskiy Alatau) bear tubular G/L inclusions with T_H 420-280°C and T_D 660°C. Quartz from those pegmatites has G/L inclusions with T_H 345-170°C. Cryometry of inclusions in amphiboles yielded $MgCl_2$ as main component, salinity 7 wt. %; in quartz - $CaCl_2$ (+$MgCl_2$), concentration 26 wt. %. By thermometry + cryometry method P at T_H in inclusions in amphiboles is 400 atm, in quartz - 30 atm. Thus, gabbro pegmatites formed from hydrothermal solutions.

Corundum from plumasites and kyshtymites of the Urals (deposits: Bomovskoe, Sysertshoe and mine 210 in Il'menskiy Reserve) bears numerous inclusions of L CO_2 with following characteristics: T_H 27-30°C, T_{FRZ} from -56.6 to -54.0°C, G phase by analysis of individual inclusions - CO_2 74-76 vol. %, N_2 + rare G 24-26 vol. %. Ruby from phlogopite plumasites of the massiv Ray - IZ (Polyarnyi Ural) bear rare G inclusions filled mainly by N_2 + rare gases (95.8 vol. %) plus admixture of CO_2 (4.2 vol. %). Amphibole, associating with ruby, bears G/L inclusions (T_H 260-280°C) and three-phase ones: G + L + silicate with T_H G + L 320-350°C. The latter neither dissolved nor melted solids up to decrepitation at 500-600°C. (Abst. by A.K.)

KONSTANTINOV, M.M., ANDRUSENKO, N.I. and MOSKALYUK, A.A., 1977, Peculiarities of composition of mineral-forming solutions for various types of gold-silver ore mineralization (abst.) <u>in</u> Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Sib. Branch, v. II, p. 26-27 (in Russian; translation by A. Kozlowski). First author at Central Sci.-Research Geol.-Prosp. Inst. of Geol. Ministry, Moscow.

Gold deposits were formed by SO_4-HCO_3-Cl solutions of low to moderate total salt concentration and neutral or weakly alkaline pH. Au-Te ores in areas of subalkaline basaltoid volcanism precipitated from Na- or Na-Ca-SO_4-HCO_3 solutions. Gold ores associated with andesite volcanism are characterized by Ca-rich solutions with SO_4:HCO_3:Cl varying from 1:1:10 to 1:10:1 and distinct changes of Na and K content. Au-Ag ores connected with liparite volcanism formed from solutions of SO_4:HCO_3:Cl ratios equal 5:1:1, poor in Na and variable in K and Ca; all data from water leachates of fluid inclusions. (From the authors' abst.)

KORCHEMAGIN, V.A., PANOV, B.S. and KUPENKO, V.I., 1977, Contribution to the problem of genesis of the mercury ores in Donbass (abst.) <u>in</u> Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Sib. Branch, v. II, p. 123-124 (in Russian; translation by A. Kozlowski). Authors at the Donetsk Polytechnical Inst., U.S.S.R.

Quartz samples from the most important parts of Donets basin were studied (Nikitovskoe ore field, Nagol'nyi and junction zone of Donbass and Priazovie crystalline massif). On the basis of T_H and experimental studies of the water-quartz system, including oxygen isotope fractionation, the authors found that quartz from Nikitovskoe crystallized from juvenile solutions, but other quartzes crystallized from essentially connate waters. (From the authors' abst.)

KORMUSHIN, V.A., 1976, Determination of the filling of inclusions and their volume (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976; Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 171-172 (in Russian; translation by A. Kozlowski).

On heating, G/L inclusions change ratio of L and G phases, depending on the thermal volume expansion of L and mineral. T_H is related to concentration of solution and the ratio of L to that of the vacuole. T_H of the isolated system is a linear function of the concentration of solutions, when the changes of composition are small.

Essential possibility of determination of the degree of filling of inclusion was ascertained as well as its volume. Diameter of G phase should be measured at three known T and calculation is made using equations:

1) Degree of filling, F

$F = V_1 [1 + \beta m\ (t_2 - t_1)] - V_2/V_1\ [1 + \beta \ell\ (t_2 - t_1)] - V_2$;

2) Volume of liquid phase, V

$V = V_1 [1 + \beta m\ (t_2 - t_1)] - V_2/(\beta\ell - \beta m)(t_2 - t_1)$;

where V_1 and V_2 - volumes of G phase of spherical shape at $T = t_1$ and t_2 respectively; thermal expansion indices: of mineral (βm), and of L phase in G/L inclusion (βℓ).

There was also proposed an equation for calculation of βℓ; from the relationship between T_H and concentration of solution of G/L inclusion, for the individual value of F, the concentration of L phase is found. (Author's abst.)

KORNILOV, V.F., 1976a Temperatures of formation of the mercury-antimony ores in the Kadamzhay-Chauvay ore region (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., P. 79-80 (in Russian; translation by A. Kozlowski).

Ore fields are zonal: Sb ores occur in the W part of the Aktash-Boordinskaia structure (Kadamzhay), Hg-Sb ores - in the E part (Chauvay), Hg ores - in the central part (Arpalykskoe and Alyshskoe deposits). Pre-ore jasperoid or fluorite-jasperoid mineralization formed at 300 ± 20°C (T_D of quartz), crystallization finished at 260-230°C and 330 ± 10 atm (inclusions in quartz of the Kadamzhay deposit) and 210-140°C (inclusions in fluorite of the 1st Chauvay ore field); composition of the water leachates is $HSiO_3$-HCO_3-Na-Ca, saturated with CO_2.

In the W part of the ore region, the main quartz-antimony stage appeared at 240-160°C, and the solutions were of $HSiO_3$-Cl-Na composition; same in the E part at 200-40°C. Quartz-fluorite-cinnabar-antimony-calcite-barite association is the analogue of the second ore stage at the Kadamzhay deposit, however, with ore mineralization formed at 140-55°C.

The second ore stage of the Chauvay ore field consists of calcite-fluorite-cinnabar-antimonite and cinnabar-calcite associations (T_H 140-110°C); the latter is the analogue of the cinnabar-calcite association of the commercial ore stage of the Alyshskoe deposit.

In the E part of the Chauvay ore field (inclusions in quartz III and calcite III) hydrotherms had $HSiO_3$-HCO_3-Na-Ca composition, T_H 240°C (i.e., over 50°C higher than during preceding ore stage). Realgar - orpiment formed at T indicated by T_H <60°C. (Author's abst.)

KORNILOV, V.F., 1976b Genetic peculiarities of formation of the Alyshskoe deposit (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept. 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 80-81 (in Russian; translation by A. Kozlowski).

Hydrothermal stage includes substages: 1) jasperoid (T_D of quartz I 320-220°C); 2) cinnabar-calcite (T_H for calcite I 135-50°C); 3) realgar-orpiment (T_H of inclusions in calcite II and fluorite II <60°C).

During hydrothermal-karstic stage, carbonate rocks were dissolved to form irregular cavities up to 5 m^2 (a misprint for m^3? A.K.). Overlapping of the hydrothermal karst on cinnabar-calcite ore bodies causes redeposition of cinnabar. When the solutions were oversaturated with $CaCO_3$, prismatic calcite on the walls crystallized forming a continuous layer (T_H 65-55°C). (Authors' abst.)

KOROBEYNIKOV, A.F., 1976, Gold in gas-liquid inclusions in minerals (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 189-190 (in Russian; translation by A. Kozlowski).

In skarn and vein minerals of gold ore deposits there is significant amount of easily water soluble gold in G/L inclusions. In the second and third leachate of the same sample Au usually is absent, but in the first one it appears in concentration $1.2-3.1 \cdot 10^{-6}$ mol/1. Blank determinations did not reveal Au in the distilled water. In leachate from wollastonite Au concentration was $1.2 \cdot 10^{-6}$, from garnets - $4.2-9.6 \cdot 10^{-6}$, from diopside $1.2-9.6 \cdot 10^{-6}$, from hedenbergite - $2.4 \cdot 10^{-6}$, from vesuvianite - $1.8 \cdot 10^{-6}$, from vein quartz - $3-7.4+10^{-6}$, from calcite - up to $31 \cdot 10^{-6}$, all in mol/1.

In vein quartz and metasomatic quartzites of (a ?) Cu-Mo deposit Au is absent and only in individual samples there was found $0.6-1.2 \cdot 10^{-6}$ mol/1.

Water leachates from skarns are of Cl-HCO_3-Ca-Na type (plus Mg); Na/K 2:1-5:1, Cl/F 33:1-200:1, Cl/HCO_3/SO_4 up to 7:10:1; T_H 570-360°C. In quartz and carbonates of various types of ores G/L inclusions bear solutions of Na-CL-SO_4 and Na-CO_3-SO_4 compositions with Cl>F and T_H 380-120°C. For some deposits high concentrations of SO_4 and NO_2 were found in the upper parts of ore zones and decrease of Cl in lower ones, accompanied by decrease of Au content in inclusions below the detection limit. The content of Au in inclusions correlates with Au content in ores. (Author's abst.)

KOROBEYNIKOV, A.F., 1977, Composition and features of mineral-forming solutions in the gold ore deposits of the Sayano-Altay folded area, as indicated by inclusions in minerals (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Sib. Branch, v. II, p. 28-29 (in Russian; translation by A. Kozlowski). Author at Tomsk Polytechnical Institute, USSR.

Inclusions were studied in minerals from gold-bearing skarns, albitites, sulfides, Au-quartz and Au-quartz-sulfide veins, and stockworks of Kuznetskiy Alatau, E. Sayan and Tuva. Mg and Ca skarns have inclusions bearing solutions of HCO_3-Cl-Na-Ca-Mg type (Na:K from 1.8:1 to 5:1, Cl:F from 33:1 to 290:1, Cl:HCO_3:SO_4 from 1:1:0 to 7:10:1, T_H from 420 to 180°C). Minerals of Mg skarns bear fluid inclusions of Cl-Na-Mg composition, but Ca skarns of HCO_3-Cl-Ca-Na composition, T_H 830-570 and 630-360°C. Gold ores in skarns usually formed from Cl-SO_4-Ca-Na or Cl-HCO_3-Ca-Na solutions, T_H 420-220°C, Na:K from 2:1 to 6:1, Cl:F = 31:1, Cl:HCO_3:SO_4 = 1.5:1:1.1. Au-bearing albitites and greisens yielded Cl-F-Na-Ca composition of fluid inclusions (Na:K from 4:1 to 5:1, Cl:F from 1:1 to 113:1, T_H 480-230°C). Early quartz-feldspar and quartz-albite metasomatites formed from alkaline-HCO_3-Cl solutions, T_H 480-260°C.

Minerals of Au-quartz formation bear inclusions filled with solutions of HCO_3-SO_4-Cl-Na-Ca type (Na:K from 1.2: 1 to 7:1, Cl:F from 2.3:1 to 600:1, Cl:HCO_3:SO_4 as 1:1:1, 19:12:1 and 1:2:3, T_H from 440 to 110°C). Gold-bearing sulfides revealed high K content (Na:K as 2:1, 6:1, 1:1.2), as well as Cl and SO_4 ($Cl:HCO_3:SO_4$ 2:1:3). Post-ore quartz, prehnite and carbonates yielded Na:K ratio 1.5:1 to 3.4:1; $Cl:HCO_3:SO_4$ 1.5:1:0 to 1:58:7, T_H 220-70°C. Berezites and listvenites of all deposits have $Ca-HCO_3-Cl-SO_4$ composition of inclusions and T_H 320-180°C. Listvenites, in constrast to berezites, have solutions with higher concentrations of Mg and HCO_3. By polarographic method, concentration of Au in fluid inclusions in gold-bearing quartz was determined as $0.6-15 \times 10^{-3}$ mol/l, in calcite - 3×10^{-3} mol/l, in berezites - 4.8×10^{-3} mol/l, in garnet-pyroxene skarn - 1.7×10^{-3} mol/l. Most effective precipitation of Au was at 300-130°C from solutions rich in S and CO_2. (From the author's abst.)

KOROBEYNIKOV, A.F. and CHERNYAEV, Ye.V., 1976, Use of water leachates during studies of the endogene zoning of gold ore deposits (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 150-151 (in Russian; translation by A. Kozlowski).

At the deposits from E. Sayan Mts., inclusions in minerals of magnesia and lime skarns, and post-granitic autometasomatites are different than inclusions in quartz-ore veins and berezites surrounding ores. Leachates from magnesia skarns mainly bear ions: Na, Mg and Cl; from lime skarns - K, Ca, HCO_3, Cl; contact-sulfide ores - HCO_3, Cl, S compounds; quartz-gold-sulfide veins $S >> HCO_3$; sericitized and silicified rocks - K, HCO_3; berezites - K, Ca, HCO_3, S compounds. Most characteristic indices for hydrotherms are: K/Na, SO_4/HCO_3, NH_4/K and pH - low values are typical for narrow and disappearing zones, high values - for wide ore zones (Medvezhye deposit). At the Konstantinovskoe deposit the above indices increase from the upper levels to the middle ones and then decrease at the lower levels. In berezites the ionic ratios decrease from 3:1 at the upper levels to 1.5:1 and 1:3 at the lower ones. The vertical extent of the full cycle of changes is 160-200 m (Medvezhye) and 360-400 m (Konstantinovskoe). The regularities may be used for the evaluation of the vertical extent of ore mineralization in ore bodies of various mineral composition. (Authors' abst.)

KORZHINSKIY, D.S., 1977, Interaction of magmas with transmagmatic fluids. Vses. Mineral. Obshch. Zapiski, v. 106, no. 2, p. 173-178 (in Russian). Author at Inst. Geol. Ore Deposits, Petrogr., Mineral. and Geochem. (IGEM) Acad. Sci. USSR, Moscow.

In addition to pressure, the alkaline-acid interaction of magmas with transmagmatic fluids of deep, sub-crustal origin is the cause of differentiation of magmas. The paper presents the mechanism of that process. (A.K.)

KOSALS, Ya.A., 1976, Geochemistry of amazonite apogranites, in Transactions of the Inst. Geol. and Geophys. of the Siberian Branch of the Acad. Sci. of the USSR, issue no. 219, 188 pp., "Nauka" Publishing House, Siberian Branch, Novosibirsk (in Russian).

There exist two hypotheses on crystallization of amazonite granites: 1) formation of amazonite from a melt enriched in volatiles and rare alkalies; 2) post-magmatic metasomatism of granites with formation of lithionite-amazonite-albite apogranites.

T_H of melt inclusions in quartz of the parent granites show range 800-1020°C, P at T_H > 1350 atm, G composition (HF, HCl, NH_3, SO_2, H_2S) 18.5 vol.%, CO_2 81.5-83 vol.%. Metasomatites bear inclusions as follows: L/G and G/L, T_H 710-640 (P) and 560-290°C (S), G composition CO_2 up to 68.2 vol.%, P $\sim$1350 atm for in zinnwaldite-amazonite-albite apogranites; L/G and G/L, T_H 620-410 (P) and 350-200°C (S), G composition H_2 up to 15, N_2 up to 20, CO_2 up to 65 vol.%, P 1000 atm in zinnwaldite-albite-amazonite apogranites; L/G and G/L, T_H 520-400 (P) and 320-200°C (S), G composition CO_2 up to 36.4 vol.%, P 610 atm in zinnwaldite-cryophyllite-amazonite-albite apogranites; G/L, T_H 350-260 (P) or N_2 up to 26.4 vol.%, CO_2 up to 63 vol.% (S), P 150-60 atm in quartz-amazonite veins. All inclusions contain H_2O. Rare metal pegmatites bear fluid inclusions as shown in table;

Structural zone of pegmatites	Fluid	Type of inclusion	T_H, °C	G composition, vol.%	Total salts in L phase, wt.%	P at T_H, atm
Aphite-like	Melt	G + dms	1040-960	Not analyzed		1480
Granophyric	do.	do.	960-860	do.		1480
Fine pegmatoid	do.	do.	960-860	do.		1480
Coarse pegmatoid	G-like	L/G	780 600	H_2O; CO_2 up to 65	21-19	1480
Black qz-feldspathic	do.	do.	780-600	H_2O; CO_2 to 30 N_2 to 60.3, H_2 to 14	22	1250
Quartz core	do.	do.	680-520	H_2O; CO_2 to 68, N_2 to 31.6	22	1100
Quartz-muscovite	do.	do.	480-200	H_2O; CO_2 to 36, N_2 to 25	24	410
Quartz-cleavelandite-spodumene	do. and L	L/G and G/L	450-220	H_2O; CO_2 to 51, CO to 16.7, H_2 to 23.7, N_2 to 40	23.5	380
Filling of central cavities (quartz, beryl, spodumene)	L	G/L	420-160	H_2O, CO_2 to 52.5, CO to 11, H_2 to 18.7, N_2 to 28	23	240-60

The paper also includes a discussion of T ranges, complexes, and mobility of various elements during metasomatism. (Abst. by A.K.)

KOSALS', Ya.A., 1977, Thermodynamic conditions of formation of molybdenum-tungsten ores in granite-gneiss domes (Bom-Gorkhon ore field, W. Transbaikalia) (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. I, p. 157-158 (in Russian; translation by A. Kozlowski). Author at Inst. Geol. Geophys. Siberian Branch Acad. Sci. USSR, Novosibirsk.

Main granites crystallized at T_H 1020-930°C, P 1.5-1.3 kbar; late granites, aplites and granite-porphyries at 1050-740°C, 1.5-1.3 kbar; pegmatites and silexites from remnant melt at 720-500°C and 680-660°C, respectively (P 1.02-0.96 kbar). Subsequent alkaline metasomatism (K-feldspathization) developed at 680-300°C, $\sim$1 kbar, and it appeared before each ore-forming stage, as well as following silicification and greisenization. Quartz-pyrite-huebnerite veins of the first stage formed at 395-255°C, 0.96-0.86 kbar; next quartz-sericite and quartz-sulfide association at 270-185°C, 0.6-0.3 kbar. The earliest quartz-molybdenite association of the second stage crystallized at 380-280°C, 0.9-0.8 kbar, but later greisen-quartz veinlets with molybdenite, huebnerite and accessory beryl at 340-260°C, 0.8-0.6 kbar; final barren K-spar metasomatites with fluorite formed at 280-200°C. The first-stage ores precipitated from Na-Ca-F-HCO_3 solutions, the second-stage ores from Na-Ca-Cl-HCO_3 and next from K-Cl-F-HCO_3 solutions. (From the author's abstract)

KOSOVETS, T.N., SHCHITOVA, V.I., and BARKHUDARYAN, N.B., 1976, Application of paleotemperature data for finding the structures conducting (ore-forming) solutions, (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 141-142 (in Russian; translation by A. Kozlowski).

1. A gold ore series of thick veins occurs in andesites in the close-to-contact zone of a granitoid massif. Ore bodies are cut by transverse dikes and faults to form a series of blocks.

2. Following stages of gold ore formation were distinguished: quartz, quartz-carbonate (both commercial), garnet-wollastonite, quartz-tourmaline, dickite-montmorillonite and goethite-psilomelane; the first four were studied.

3. Deposits formed at 520-140°C, initially from pneumatolytic solutions, during the quartz stage. Commercial association of this stage has T_H 380-140°C; initial T_H for the second commercial stage 280°C; the third stage 420-160°C. (...)

4. Vertical zoning of associations of the first commercial stages was found: depth 400-300 m - T_H and T_D 470-160°C, depth 200-150 m - 440-120°C, depth 100-50 m - 360-120°C.

5. Quartz paragenetic with rich Au ores bears high concentration of CO_2.

6. Commercial ores occur in zones of the highest T_H and T_D (...). (Authors' abst.)

KOSTYUK, V.P., 1976, On some typomorphic peculiarities of alkaline rocks of Siberia and the trend of processes of crystallization in alkaline melts: in Genetic studies in mineralogy, Yu. A. Dolgov et. al., eds.: Novosibirsk, Inst. Geol. and Geophy. Sib. Branch Acad. Sci. USSR, p. 50-62 (in Russian).

Genetic problems of alkaline rocks discussed with use of T_H of melt inclusions taken from literature or from previous papers of this author (see entries of Kostyuk, V.P. as author and co-author in previous volumes of Fluid Inclusion Research-Proceedings of COFFI). (A.K.)

KOSTYUK, Ye.A., 1976, Amphiboles: in Genetic studies in mineralogy: Yu.A. Dolgov et al., eds.: Novosibirsk, Inst. Geol. and Geophy. Sib. Branch Acad. Sci. USSR, p. 142-155 (in Russian).

The paper, characterizing rock-forming amphiboles, bears also some literature T_H data for pyroxenes on p. 155. (A.K.)

KOSUKHIN, O.N., 1976, Inclusions of melts in quartz from chamber pegmatites (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 114-115 (in Russian; translation by A. Kozlowski).

Pegmatites from E. Transbaikalia (Kyrinskiy) and Kazakhstan (Dzhel'tau and Dungaly), as well as granites, bear both P and S crystallized inclusions of melts, filled with quartz-feldspar aggregate, L and G phases. Pegmatites in Dzheltau and Kyrinskiy massifs yielded T_H: aplite zone--600-580°C, pegmatoid zone--560-540°C. For pegmatites of the Dungaly massif T_H in quartz of peripheral zones--600-590°C, in quartz of medium-grained granophyric intergrowths--570-550°C. Each zone forms in a narrow T interval. Crystallization of granites finishes at T_H of inclusions in the external zones of the chamber pegmatites (Author's abst.)

KOSUKHIN, O.N., 1977, Low-temperature melt inclusions in the quartz of chambered pegmatites: Geologiya i Geofizika, v. 18, no. 10, p. 66-72 (in Russian; translated in Soviet Geology and Geophysics, v. 18, no. 10, 1978, p. 50-61).

Crystallized melt inclusions in the quartz from different zones of chambered rock-crystal pegmatites, and also their granite host rocks, were studied. The inclusions studied differ from those in other types of granites and pegmatites in the presence, at room temperature, of a dense two-phase fluid consisting of an aqueous solution and gas. The results of the study of the melt inclusions indicate that the pegmatite bodies studied, with pegmatoid-granitic, aplitic, graphic, and fine-grained pegmatoid structures, were crystallized from a low-temperature silicate melt. (Author's abstract)

KOTOV, N.V., ROGOZIN, M.P., SHINKAREV, N.F. and DOMNINA, M.I., 1977, Experimental Na-carbonate metasomatism in the subsolidus part of the haplogranite system at elevated pressure. Vses, Mineral. Obshch. Zapiski, v. 106, no. 5, p. 581-593 (in Russian). Authors at Leningrad Univ.

The paper deals with experiments at T 600-750°C, P 0.9-1.75 kb, Na_2CO_3 concentrations 0.2-2.2 M, indicating the possibility of formation of alkaline rocks (bearing cancrinite, nepheline and analcite) by metasomatism of granite at elevated P and T. (A.K.)

KOTOV, Ye.I., 1976, Thermobarogeochemical methods applied to research projects on prospecting (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 145 (in Russian; translation by A. Kozlowski).

1. P G/L inclusions were found in a region with Cu-Mo, Pb-Zn and rare-metal ore mineralization.

2. Inclusions in the same mineral species but formed at various stages have different types of inclusion fillings, phase ratios, type of homogenization and T_H, shape and size.

3. Obtained reaults may be applied for recognition of a mineral as connected with a generation and type of ore. (Author's abst.)

KOUTZ, F.R., 1977, Silver, base-metal manganese oxides and fluid inclusions geothermometry: Hardshell manto, Patagonia Mountains, Arizona (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 1056-1057.

The Hardshell manto is a zoned, Ag, base-metal, Mn-oxide deposit in Mesozoic, rhyolitic, volcaniclastic-sedimentary strata.

Fluid inclusion homogenization temperatures from quartz intergrown with Mn-oxides are generally between 240-290°C without evidence of boiling. Many of the lower temperature fluid inclusions are larger, contain no daughter salts and are associated with higher-grade mineralization intervals. Some clear quartz associated with late cryptomelane contains no fluid inclusions. Fluid inclusions and stratigraphic evidence would place depth of quartz formation at about 1 km. From district mineralogical-thermochemical considerations Hardshell probably represents multistage oxidation of alabandite, Ag-base metal sulfides and sulfosalts, and pyrite with metal redistribution limited to tens of meters. (From the author's abstract)

KOVALENKO, N.I. and PISSARSKAYA, V.A., 1977, On the solubility of water in fluorine-bearing plumasite melts: Ezhegodnik Sibirsk Inst. Geokhim. (Yearbook Siberian Inst. Geochemistry) for 1976, p. 176-179 (publ. 1977; in Russian with English abstracts).

The water content of melts in the systems 'ongonite-H_2O-HF' and 'granite-H_2O-HF', at 0.4-1.6 wt.%F, at 800-550°C and a total pressure of 1000 atm has been determined. In the liquidus field it is 6-8 wt.% and considerably exceeds that for fluorine-free granite melts under the same conditions. Below the liquidus the water content increases with temperature decrease and at temperatures near the solidus is 15-20 w.p. There is a correlation between the water content and fluorine in the glass, possibly due to the formation of OH^- by combining H^+ with the oxygen of the melt during dissolution of HF in the granitic melt. (Modified by ER from the authors' abstract)

KOVALEV, K.R., GAS'KOV, I.V. and BUSLENKO, A.I., 1977, Conditions of metamorphism of rocks and ores of the Kholodninskoe ore field (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. II, p. 75-76 (in Russian; translation by A. Kozlowski). Authors at the Inst. Geol. Geophys. of Sibertian Branch of Acad. Sci. U.S.S.R., Novoskbirsk.

The deposit occurs in the N. Pribaikal'ye as stratiform ore bodies in the Upper Proterozoic intercalated carbonate-bearing aleurolite and tuffaceous rocks. Ores are of pyrite-polymetallic type. The rocks were metamorphosed under conditions of muscovite schist subfacies of epidote-amphibolite facies. T_H relating to metamorphism of ores are 460-420°C; S inclusions of the retrograde metamorphism stage yielded T_H 330-270°C, 215-160°C and 120-80°C. Kyanite-staurolite-quartz and kyanite-muscovite-quartz parageneses of high-pressure kyanite-muscovite schist facies formed along tectonic zones; T_H of inclusions in quartz of those parageneses range from 585-520°C, plus several determinations up to 625°C, evaluated as anomalous. (Abst. by A.K.)

KOVALEVA, K.V., LEVITSKII, Yu. F. and TURCHENKO, T.L., 1976, On conditions (of formation) of the apatite-rare metal mineralization of the crystalline basement (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept. 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 78 (in Russian; translation by A. Kozlowski).

Apatite-rare metal mineralization developed in zones of post-folding dislocations, mainly in the peripheral zones of the Proterozoic cupola structures. (...) 1. Hydrotherms causing pre-ore silicification gave inclusions with gas content from 35 to 50, and sometimes to 85 vol. %. Solutions were of low salinity; T_H of inclusions in quartz 490-460°C. 2. Inclusions in apatite bear up to 35% G phase; the solution is concentrated. Inclusions also bear colorless transparent daughter crystals of irregular habit, as well as LCO_2 up to 10-15 vol. %. T_D of apatite: 420-400, 320-290, 220-210°C; T_H of post-ore quartz 110-60°C. (Author's abst.)

KOVALISHIN, Z.I., GRIBANOV, B.V., BRATUS', M.D., and ZHOVTULYA, B.D., 1976, Composition and temperature of mineral-forming solutions of polymetallic ores from Beregovskoe Highlands, in Thermobarogeochemistry of mineral formation, N.P. Ermakov, ed.: Rostov, Rostov Univ. Press, p. 103-109 (in Russian).

Full paper corresponding to abstract in Fluid Inclusion Research volume 7, p. 112, 1974.

KOVILIEV, G.A. and TRUFANOV, V.N., 1977, On main stages of formation of the lead-zinc deposits in the N. Caucasus: Akad. Nauk SSSR Doklady, v. 234 no. 5, p. 1156-1159 (in Russian).

Massive galena-sphalerite ores at the Sadon, Zgid, and Kholst deposits assumed until now to be of hydrothermal origin, are reinterpreted on the basis of character of wallrock alterations and fluid inclusion studies as having crystallized from highly-concentrated ore-silicate fluids of high viscosity typical of melts. Wall-rock Paleozoic granite and later subvolcanic and effusive rocks bear melt inclusions: G-crystal, polyphase, and glass, often containing ore dms, T_H 1000-860°C (Sadon and Zgid granites) and 1100-1000°C (albitophyre, i.e., albitite). These melts are followed by polyphase and then crystal-fluid inclusions with T_H 650-520°C and less. T_D of ores by the vacuum method are essentially in ranges 560-470°C, whereas low T decrepitation, in the 220-200°C range, close to T_D of ores of the second, late stage is very weak. Maximum T of origin of ores of the second stage are 425-360°C, the minimum ones--80-60°C. P varies strongly, from 600-550 to 150-100 atm. P-T ranges of origin of minerals, a sort of thermodynamic threshold, were determined: 1) 560-470°C, 1200-1000 atm; 2) 425-360°C, 600-550 atm; 3) 325-265°C, 425-375 atm; 4) 220-180°C, 300-250 atm; 5) 120-80°C, 180-150 atm. 1-first stage galena-sphalerite ores, 2-stage II, pre-ore quartz, 3+4-II stage ores, 5-post-ore associations. Ore melt of the first stage was presumably separated from granite melt during melting of the bottom part of sedimentary core of the Earth's crust. (Abst. by A.K.)

KOZLOWSKI, A., 1976, Halogens in inclusions and genesis of the hydrothermal deposits of the Western Sudetes, Poland (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 201-202 (in Russian; translation by A. Kozlowski). Author at Instytut Geochemii, Mineralogii i Petrografii, Wydział Geologii U.W., 02-089 Warszawa, al. Zwirki i Wigury 93, Poland.

Izera region, Strzegom and Karkonosze granitoid massifs were studied. Izera region consists of ortho- and paragneisses and schist zones, metasomatic leucogranites and greisens. At the exocontact the

Karkonosze massif formed hornfelses, skarns and quartzites. Wolframite-cassiterite-sulfide ore mineralization is connected with the endocontact zone; magnetite and pyrite-chalcopyrite with the exocontact; leucogranites; dispersed Nb-rutile with leucogranites; with schists-cassiterite-polymetallic mineralization with schists; wolframite, scheelite, cassiterite, and native bismuth with greisens. All rocks bear quartz veins. Atomic ratio 1000F/Cl ratio in fluid inclusions in quartz was studied; F content was up to 40 mg/kg of quartz, Cl-up to 240 mg/kg. In schists 3 intervals of values of 1000 F/Cl were found: 0-50 (16-28 and 40-45) in barren quartz, 50-85 (76-85) in quartz surrounding ore zones, and 120-180 - in ore-bearing quartz. In gneisses and metasomatites: 0-50 (15-43) - massive or grainy quartz in gneiss; 50-85 (72-82) - bluish quartz from gneissic blasts; 100-240 (209-233) - bluish quartz from gneissic blasts and tiny veinlets; 250-700 - veins with sericite, some veins in leucogranites and greisens; 700-2250 - veins in leucogranites and greisens, greisen minerals (most frequent values given in parentheses). Hence, early stages of metamorphism were connected with solutions poor in F (1000 F/Cl up to 50 in gneiss and up to 85 in schists) and late, metasomatic stages, rich in F. In contact deposits the highest values were found in quartz from hornfelses and skarns, especially ore-bearing (1500-700), intermediate in quartz from granite apophyses (~400) and the lowest in monomineral quartz zone (10-60). 1000 Br/Cl in solutions from fluid inclusions equals 2-27; this ratio is close to that of sea water and products of its concentration. (Author's abst.)

KOZLOWSKI, A. and KARWOWSKI, K., 1976, Bromine-chlorine ratio in hydrothermal solutions, in Bromine in salt deposits and brines as a geochemical indicator of their genesis and history and as a prospecting tool, editor M.G. Valyashko: Moscow, Moscow Univ. Pub. House, p. 364-370 (in Russian). First author at Instytut Geochemii, Mineralogii, Petrografii, Wydzial Geologii, Warsaw University, 02-089 Warsawa, al. Zwirki i Wigury 93, Poland

Bromine and chlorine were determined in fluid inclusions in hydrothermal vein quartz from grantoid magmatic Strzegom and Karkonosze **massifs and metamorphic Izera area. Atomic ratio 1000 Br/Cl ranges from 2 to 27. On a plot of 1000 Br/Cl versus Cl concentration, characterizing sea water and products of its concentration, the inclusions are close to the sea water line. This may suggest that hydrothermal fluids may be connected with remnant pore water, formerly of marine origin, in ancient sediments subsequently metamorphosed and melted to form magmas. (Authors' abst.)**

KOZŁOWSKI, Andrzej and KARWOWSKI, Lukasz, 1977, Fifth All-Union Thermobarogeochemical Meeting: Przeglad Geol., v. 25, no. 6, p. 339-341 (in Polish).

A review of the major papers at the Ufa meeting in 1976. (ER)

KRÁLÍK, Jiří, 1977, Zircons from the coal-bearing Carboniferous of the Ostrava-Karviná district and their relationship to volcanism: Časopis pro mineralogii a geologii, v. 22, p. 359-372 (in English).

Fluid inclusions in detrital zircons were used, among other features, to determine provenance. (ER)

KRASOV, N.F., 1976, Inclusions of magmatic melts in phenocrysts of andesite from Kamchatka (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 98-99 (in Russian; translation by A. Kozlowski).

P melt and solid inclusions, syngenetic with melt ones (olivine, pyroxenes, hornblende, apatite, magnetite), were studied in minerals of andesite-dacites from Karymskiy and Bezymyannyi volcanoes, andesites from Avachi, basalts from Dvor and Kluchevskiy volcanoes. Some inclusions were crystallized, others are glass.

The following melt inclusions were found: 1) glass + G; 2) glass + G + dms; 3) glass + G + dms + solid inclusions (pyroxene, apatite or magnetite). Inclusions begin to melt at 780-900°C in basalts, 800-960°C in andesites and 740-960°C in andesite-dacites. T_H are as follows:

Volcano	Rock	Mineral	T_H, °C
Karymskiy	andesite-dacite	plagioclases	1440-1040
		orthopyroxene	1300-1250
		clinopyroxene	1270-1085
		apatite	1260-1000
		magnetite (sic.)	1230- 900
Bezymyannyi	andesite-dacite	plagioclases	1340-1080
		pyroxene	1230-1180
		hornblende	1160-1100
		magnetite	1230-1100
Avachi	andesite	plagioclases	1485-1160
		pyroxene	1250-1190
		apatite	1250-1160
		hornblende	1140-1100
		magnetite	1230-1080
Dvor and Kluchevskiy	basalts	plagioclases	1440-1160
		olivine	≥1340
		pyroxene	1225-1115
		magnetite	1230-1100

(Author's abst.)

KRAVTSOV, A.I., 1977, Geology and geochemistry of natural gases of recent volcanoes and zones of deep faults, <u>in</u>: Hydrothermal process in the areas of tectonic-magmatic activity, p. 120-126, "Nauka" Publ. House, Moscow (in Russian).

KREULIN, Rob., 1977, CO_2-rich fluids during regional metamorphism on Naxos, a study on fluid inclusions and stable isotopes, Ph.D. thesis, Univ. Utrecht, 87 pp. (in English with Dutch abstract).

The regional-metamorphic complex of Naxos consists of a central migmatite dome surrounded by schists and marbles of diminishing metamorhpic grade. Sillimanite schists, kyanite schists, biotite schists and chlorite-sericite schists are found at successively greater distances from the migmatite dome. Fluid inclusions in quartz and other minerals indicate that CO_2-rich fluids were common during metamorphism. Irrespective of metamorphic grade, the average fluid composition is 50-80 mol. % CO_2. In many cases, the fluid composition is not buffered by local mineral reactions; most of the fluid is probably pervasive.

$\delta^{13}C$ values of CO_2 from fluid inclusions in most schists and pegmatites are between -1 and -5°/$_{oo}$, which excludes decarbonation reactions as the major source of the CO_2. The $\delta^{13}C$ values are compatible with a deep-seated origin of the fluids, in which 2/3 of the CO_2 is possibly juvenile. Locally, low $\delta^{13}C$ values (the lowest value is -16,4

°/₀₀) are found. Such values seem to be restricted to a distinct zone, in many places containing a graphite-bearing quartzite; they must be explained by interaction of the fluid with graphite, which has $\delta^{13}C$ values from -22 to -27°/₀₀. Three different traverses across the graphite-bearing quartzite and the neighbouring schists show low $\delta^{13}C$ values of fluid inclusion CO_2 fifty or hundred metres beyond the graphite-bearing quartzite. Mass balance calculations indicate that the relatively small amount of graphite in the quartzite can hardly be responsible for these low $\delta^{13}C$ values; larger amounts of graphite may have been gradually oxidized during metamorphism.

Several dolomitic marbles contain isolated quartz lenses with reaction rims of tremolite and calcite. Decarbonation CO_2, trapped in fluid inclusions in the quartz, has positive $\delta^{13}C$ values (up to +5°/₀₀). About half of the quartz lenses in dolomitic marbles give negative $\delta^{13}C$ values of CO_2; in these cases the decarbonation system probably leaked, so that CO_2-rich fluids were able to penetrate from outside.

Some schists contain significant amounts of calcite. The carbon isotopic composition of this calcite is largely controlled by exchange with CO_2-rich fluids, suggesting that considerable quantities of fluid migrated through the schists. Mass balance calculations indicate a volume of fluid between 10 and 100 per cent of the rock volume.

Graphite in marbles has $\delta^{13}C$ values from -19.8 to -1.4°/₀₀. These relatively high values are the result of isotope exchange with calcite. At temperatures of metamorphism above 550°C, equilibrium was attained between calcite and graphite; below this temperature there are considerable deviations from equilibrium. Graphite in graphite-bearing quartzite and in schists has $\delta^{13}C$ values between -22 and -27°/₀₀, which is in the range of organic material in recent marine sediments. (Author's abstract)

KRIVOVICHEV, V.G., 1976, Thermobarogeochemical characteristics of the Belorechiye barite deposit (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 200-201 (in Russian; translation by A. Kozlowski).

1. At this N. Caucasian deposit the main zonal paragenetic associations are: I. Calcite-sulfide, II. Barite-sulfide, III. Fluorite-sulfide, IV. Barite sulfide.
2. Solutions in fluid inclusions are of $Ca-Na-Mg-HCO_3-Cl$ type, low in K, with ionic strength $\mu = 2$. T_H and pH for associations, respectively: I. 130-110°C, 6.3; II. 130-110°C, 6.3; III. 110-90°C, 5.9; IV. 90-70°C, 6.2.
3. Thermodynamic analysis of the system: $Ba-Ca-Pb-Zn-Fe-S-CO_2-F-H_2O$ was made.
4. Main factors controlling precipitation of minerals are an increasing Eh during movement of solutions toward surface, and pH. (From the author's abst.)

KROL', O.F., KARABANOV, V.A., NAIDENOV, B.M., POLYVIANNYI, E.Ya., and CHERNOV, V.I., 1976, Hydrothermal mineral-formation as indicated by argon isotopes (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept. 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 82 (in Russian; translation by A. Kozlowski).

For elucidation of the origin of parent solutions which formed a stock of scheelite-quartz-muscovite veins, the isotopic composition of argon was studied in fluid inclusions in quartz of various T of trapping. P G/L inclusions in minerals of granite of the Bogutinskaia intrusion and of quartz veins cutting the Ordovician sandstones, have the same Ar isotopic composition, with admixture of 30-40% of atmospheric Ar (by the weight of Ar36). In P G/L inclusions from granites of various parts of the Siugatinskaia intrusion, atmospheric Ar occupies from 10 to 70%. On the basis of atmospheric Ar content (50-80%), quartz from the ore deposits Beriktobe, Kurozek and Skarnovyi, touching the Siugatinskaia intrusion, may be considered as being a product of vadose solutions, in rocks formed in the process of the post-magmatic alteration of the Siugatinskii massif. A part of atmospheric argon increases in agreement of decrease of T_D and T_H of G/L inclusions. (Author's abst.)

KRUGER, P., STOKER, A., and UMANA, A., 1977, Radon in geothermal reservoir engineering: Geothermics, v. 5, p. 13-19. Authors at Civil Eng. Dept., Stanford Univ., Stanford, CA 94305, U.S.A.

Radon has been shown to have potential as a tracer in the study of geothermal reservoirs. The combination of its physical and nuclear properties and its emanation and transport in geothermal fluids makes several types of time and concentration measurements useful for studies of fracture permeability and porosity and flow characteristics in different types of geothermal resources. Radon concentrations in several vapor-dominated and liquid-dominated producing reservoirs have been measured by short-period sampling of wellhead geofluid followed by radon separation on a charcoal trap and counting in a sensitive low background ZnS detector. The results show significant variations not only among different fields, but also between neighbouring wells in a single field. Evidences for transport differences between the two major types of hydrothermal systems are noted. (Authors' abstract)

KRUPKA, K.M. and OHMOTO, H., and WICKMAN, F.E., 1977, A new technique in neutron activation analysis of Na/K ratios of fluid inclusions and its application to the gold-quartz veins at the O'Brien mine, Quebec, Canada: Can. J. Earth Sci., v. 14, p. 2760-2770. First author at Dept. Geosci., The Penn State Univ., Univ. Park, PA 16802, U.S.A.

A new analytical technique which employs hydrated antimony pentoxide to selectively remove Na from Na-K-Cl mixed fluids was successfully tested. With this technique, the uncertainty in the K determination of inclusion fluids by neutron activation analyses can be reduced to less than ±10% compared to greater than ±20% uncertainty which is typical in the conventional techniques.

Na/K ratios of fluid inclusions in 14 quartz samples from gold-quartz at the O'Brien mine, Quebec, Canada were determined using this technique. The Na/K atomic ratio of the samples ranges from 0.9±0.1 to 24.3±3.9. Optical examinations of the fluid inclusions indicate that the variation in the Na/K ratios is caused by the presence of varying proportions of four different types of fluid inclusions: type I (pregold mineralization fluids; CO_2 rich), type II (gold mineralizing fluids showing evidence of boiling at temperatures of 380°-300°C), type III (postgold mineralization fluids; vapor-liquid two phase inclusions), and type IV (postgold mineralization fluids; halite bearing). Type II fluid inclusions appear to have Na/K atomic ratios of approximately 1.0, while type IV inclusions show Na/K ratios of over 24. (Authors' abstract)

KRUSTEVA, Margarita and ANTIMOVA, Tsvetana, 1975, Mineral-thermometry studies in the Lozen lead-zinc deposit, district of Khaskovo: Rudoobraz. Protsesi Miner. Nakhodishaha, v. 3, p. 27-35 (in Russian).

In order to clarify the temperature conditions during the ore-forming process which has produced the ores in the Lozen deposit, mineral-thermometry studies of sphalerite, quartz and carbonate from the Chinarya, Eremichki Doupki and Madanya sections of the deposit were carried out. The method of homogenization of fluid inclusions by heating was employed using a Koffler type heating stage. Mostly primary fluid inclusions were examined.

The results obtained show that the ore-forming process in the Lozen deposit took place under medium- to high-temperature conditions. The mineral-forming solutions during the deposition of quartz had a temperature of 330°C to 300°C. The temperature ranges of deposition of sphalerite and quartz almost overlap. The bulk of sphalerite was deposited between 330°C and 290°C. Calcite deposition took place between 280°C and 230°C.

The temperature maxima around 240°C and 220°C present an evidence of additional action of hydrothermae. (Authors' abstract)

KRYLOVA, G.I., KAYNOV, V.I. and DOROGOVIN, V.A., 1976, On pyrite mineralization in rock-crystal bearing quartz veins, in Minerals and parageneses of rock-forming minerals, editors P.M. Tatarinov and D.V. Rundkvist: Leningrad, Leningrad Division of "Nauka" Publishing House, p. 91-102 (in Russian).

At a southern Ural deposit of rock crystal, occurring in the ranges of the E. Ural anticlinonium, three generations of pyrite were found. Pyrite I forms euhedral solid inclusions in rock crystal growth zones; pyrite II-fillings of fractures in quartz veins; pyrite III appears in zones of dissolution and recrystallization of pyrite II. P and PS fluid inclusions in quartz, syngenetic with pyrite I, are polyphase, bearing LH_2O, LCO_2, GCO_2, dms:NaCl, KCl and carbonate; T_H 245-345°C in L. S inclusions usually are two-phase G/L, sometimes plus LCO_2, T_H 284°C in L or 360-510°C in G. Decrepitation of pyrite I is weak, $T_D > 200°C$; T_D of pyrite II 250-330°C and pyrite III - 250-310°C. Reference data on solution composition in fluid inclusions are cited. (Abst. by A.K.)

KRYLOVA, G.I. and OSTAPENKO, G.T., 1976, Parameters of the epidote-amphibolite facies of metamorphism in metapelites of the Svetlinskaya structure (S. Urals)(abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 119-120 (in Russian; translation by A. Kozlowski).

Andalusite, kyanite and sillimanite bear G + L + solids; solid phase occupying 40-90 vol. % does not dissolve even at T>700-800°C. Inclusions bearing 20-25 vol. % of solution homogenize in G phase in kyanite at 520°C, in andalusite at 535-500°C, in sillimanite at 540°C and in cordierite at 485°C. Inclusions bearing 20 to 75 vol. % of L CO_2 homogenize at 280-260°C, P calculated on this basis, at T_H, equals

∼0.5 kb for andalusite, 2.5 kb for cordierite and <1 kb for kyanite. T estimated by mineral geothermometers are: 520-460°C for staurolite-muscovite subfacies and 620-540°C for sillimanite-muscovite subfacies, both of epidote-amphibolite facies. Inclusions with solid phases testify to metastable equilibria due to differing P and T gradients. (Authors' abst.)

KULAGINA, M.A. and BOIARKIN, A.P., 1976, Temperatures of formation of anhydrite in sulfide deposits of the N part of the Magnitogorsk megasynclinorium (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 86 (in Russian translation by A. Kozlowski).

At the Uzel'ginskoe and Safarovskoe deposits the light-violet anhydrite associates with pyrite, quartz, calcite and gypsum, forming nests and veinlets in sericite-chlorite-quartz metasomatites. Anhydrite from the Uzel'ginskoe deposit bears one- and two-phase inclusions, T_H of the latter is 140-100°C, with the gas bubble occupying up to 20 vol.%. Anhydrite from Safarovskoe bears mostly two-phase inclusions (10-40 vol.% of gas); rarely three-phase inclusions were found with phase ratios: L:G:halite = 8:1:1. By modal values of T_H, G/L inclusions were divided as follows: T_H 200-170°C, with moving gas bubble - 5% of total inclusions; T_H 280-240°C, with non-moving gas bubble - 90% of total inclusions; T_H 350-300°C, with non-moving gas bubbly occupying about 40 vol.% (probably 5% of total inclusions, A.K.). T_D obtained by vacuum decrepitometry are in agreement with T_H. Hypogene origin of anhydrite is hence proven. (Authors' abst.)

KUL'CHITSKAYA, A.A., 1977, Discussion on information of national subcommittees, in: IGC-Carpatho-Balkan Geological Association, Materials of Commission of Mineralogy and Geochemistry, no. 3, p. 31-33 (in Russian). Author at Inst. Geochem. and Physics of Minerals of the Acad. Sci. Ukraimian SSR, Kiev, USSR.

Gypsum from the Pb-Zn deposit Truskavets contains over 50% by vol. of solid and L inclusions. Solid inclusions are round, black, with spotty light-brown fluorescence in UV. L inclusions (<0.01 mm) are one-phase, occupying 40-50 vol.% of the host mineral, and are filled with light brown L with refractive index very close to gypsum (1.520); luminescence under UV is pale-bluish. P water inclusions are absent in this variety of gypsum. The trapped oil is under relatively low P. At T -5 to -6°C G bubble (2-5 vol.%) appears, and at ∿-10°C -- L divides into new L_2 phase (5-8 vol.%) and the former L, becomes darker and its refractive index increases. Luminescence of L_1 is dark yellow and of L_2--pale yellow. The complete homogenization appears at +13 to +33°C, disappearing of L_2 at -8 to -10°C. L_1 becomes solid at -15 to -30°C; at -130°C cracks form in it. L_2 at -130°C remains liquid and injects into those cracks.

The second generation of gypsum contains L and G/L water inclusions, T_{Frz} -0.5 to -2°C (total salts 1-5% NaCl equiv.). (Abst. by A.K.)

KULIK, Zh.V., and KUZNETSOVA, S.V., 1976, Chemical compostion of mineral-forming solutions at Precambrian uranium-albite deposits (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad.

Sci. USSR, Inst. of Geol., p. 192 (in Russian; translation by A. Kozlowski).

1. Albite metasomatites in a granite-migmatite complex with pegmatoid veins and remnants of gneisses are the wall nocks of the uranium deposits.

2. In albitites G/L inclusions with T_H 320-110°C were found. Uranium mineralization is characterized by T_H 260-110°C in the upper levels and 300-170°C in the lower (deep) levels; P 600-1000 atm.

3. Solutions forming pre-ore albitites were of Cl-Na composition with HCO_3, the uranium deposits are connected with HCO_3-Na solutions with minor Cl and SO_4. K was completely removed from the system during albitization. (Authors' abst.)

KUNTZ, A.F., 1977, Experimental study of the process of interaction of limestone with fluorine-containing hydrothermal solutions (Model of formation of metasomatic fluorite deposits in carbonate rocks): Trudy Inst. Geol., Komi Filial, Akad. Nauk SSSR, 1977, no. 23 ("Experiment in mineralogy and modelling of mineral-forming processes"; N.P. Yushkin, ed.), p. 32-52, in Russian).

Experiments in T range 75-400°C and their discussion; no inclusion data. (A.K.)

KURODA, Yoshimasu, SUZUOKI, Tetsuro, MATSUO, Sadao, 1977, Hydrogen isotope composition of deep-seated water: Contrib. Mineral. Petrol., v. 60, p. 311-315. First author at Dept. of Geol., Shinshu Univ., Matsumoto, Nagano Pref. 390 Japan.

D/H ratios of phlogopites and amphiboles from rocks of possible mantle origin and also those of water from (glass?) inclusions in olivines of the olivine nodule and peridotites have been determined. The mantle water seems to have a δD value of -85±10‰ on the basis of results of inclusions in the nodule olivine. (Authors' abstract)

KURSHAKOVA, L.D., 1976, Physico-chemical conditions of formation of skarn-boron-silicate deposits: Moscow, "Nauka" Publish. House, 274 pp. (in Russian).

Consists of three parts: Geologic-mineralogic characteristics of the lime-ferruginous skarns with overlapped boron-silicate ore mineralization; Experimental studies of the redox mineral equilibria of calcareous ferruginous skarns; and Conditions of boron-silicate mineralization, by experimental and theoretical data. (A.K.)

KUSAKABE, Minoru and ROBINSON, B.W., 1977, Oxygen and sulfur isotope equilibria in the $BaSO_4$-HSO_4^--H_2O system from 110 to 350°C and applications: Geochimica et Cosmochimica Acta, v. 41, p. 1033-1040.

KUSAKABE, Minoru, TSUTAKI, Yasuhiro, and YOSHIDA, Minoru, 1977, D/H and $^{18}O/^{16}O$ ratios of steam condensates from Japanese volcanoes: Chikyukagakn (Geochemistry), v. 11, no. 1, p. 14-23. In Japanese with English abstract. First author at Dept. Chem., Tokyo Inst. Tech., Meguro-ku, Tokyo, Japan.

KUZ'MINA, T.M., ZAGORSKII, V.Ye. and MAKAGON, V.M., 1976, Conditions of formation of metasomatites surrounding rare-metal pegmatites (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 66 (in Russian; translation by A. Kozlowski).

Hydrothermal-metasomatic alterations of rocks, surrounding 1) spodumene non-zonal pegmatites, 2) essentially albite, weakly zoned pegmatites, and 3) lepidolite-albite zonal pegmatites, all from Siberia, were studied. Following processes developed in the exocontact zone of pegmatites: tourmalinization, chloritization, crystallization of holmquistite, and micas (replacing amphiboles). Exocontacts of pegmatites of the type 1 formed under elevated P and T $\geq$500°C, in zones of tectonic activity. Veins of 2 and 3 type formed under lower P and quiet tectonic regime. Exocontacts of these veins are altered at 350-400°C, and greisenized at T < 300°C. Minerals of the micaceous exocontact of the veins bear G/L inclusions with T_H 360-430°C. T_H of G/L inclusions in minerals of the exocontacts of pegmatites in the regionally metamorphosed rocks differs, reaching 420-520°C. (Authors' abstract).

KUZNETSOV, A.F., KASHKUROV, K.F., SIMONOV, A.V., CHERNYI, L.N., and CHUVYROV, A.N., 1976, Certain peculiarities of quartz crystals grown from fluoride solutions (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 158 (in Russian; translation by A. Kozlowski).

Morphology and internal structure of crystals grown from water solution of NH_4F were studied. Differences between those crystals and crystals grown from alkaline solutions were noted. (...) Unusual piezoelectric features of crystals were explained. (From the authors' abst.)

KUZNETSOV, A.G., 1976, Determination of centers of volcanic eruptions (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 103 (in Russian; translation by A. Kozlowski).

Jurassic volcanic formations of Upper Osetia consist of the lower-effusive, middle-pyroclastic and upper-sedimentary-volcanogenic complexes. Samples were collected from the bottoms of the lower and middle complexes close to contact of volcanic rocks with the underlying conglomerates. T_H of P melt inclusions were measured in phenocrysts of quartz from porphyrites, albitophyres (i.e., albitites) and porphyrite tuffs. Maps of isotherms of T_H were made. Background values of T_H in areas distant from centers of eruption, for effusives of moderately basic composition are 863-842°C (average 857°C), for tuffs of basic composition — 718-680°C (average 703°C); close to the center of eruption T_H are 978-954°C (960°C) and 896-859°C (872°C), respectively, hence the T_H differences between central and marginal parts of volcanic complexes are 100-170°C. (Author's abst.)

KUZNETSOV, V.A., (ed.), 1977, Copper-molybdenum ore formations, as exemplified in Siberian and nearby regions: Novosibirsk, "Nauka" Press, 424 pp. (in Russian).

KUZNETSOV, V.A., and DISTANOV, E.G., (eds.), 1977, Problems of genesis of the stratiform lead-zinc deposits of Siberia: Novosibirsk, "Nauka" Press, 264 pp (in Russian).

KUZNETSOV, V.A. and GODOVIKOV, A.A., eds., 1977, Essential parameters of the natural processes of the endogene ore formation (Abstracts of papers of the All-Union Meeting(, vols. 1-3: Novosibirsk, Acad. Sciences USSR, Scientific Council on Ore-Formation, Siberian Branch, Scientific Council on Ore-Formation Problems and Metallogeny of Siberia, Institute of Geology and Geophysics, 184+151+110 pp. (in Russian).

The books contain abstracts dealing with the following problems: vol. I--1. Physico-chemical evolution of the ore-forming systems; 2. Cu-Ni-deposits; 3. Fe ore deposits; 4. Sn-W deposits; 5. Mo deposits; vol. II--6. Au deposits; 7. Sulfide-polymetallic deposits; 8. Sb-Hg deposits; vol. III--Experimental methods of studies of ore-forming systems under hydrothermal conditions, including: 1. Theory of solutions; 2. Electrochemical methods of investigations; 3. Spectrophotometry and solubility methods; 4. Various methods of investigations; 5. Buffer mixtures, minerals of variable composition; 6. Physico-chemical conditions in natural solutions. A number of entries, abstracted in the current volume, are pertinent to fluid inclusion studies. (A.K.)

KUZNETSOVA, S.V. and KUCHERENKO, Ye.V., 1976, Practical application of the rapid determination of CO_2 from gas-liquid inclusions (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 134-135 (in Russian; translation by A. Kozlowski).

CO_2 is an active agent in processes of formation of the alkaline U-bearing metasomatites of Precambrian age. It is always present in inclusions of mineral-forming solutions. Ore bodies have wide, often zonal aureoles, extremely important for prospecting. Authors worked out the rapid method of determination of CO_2 in small samples (<0.5g). Simple method gives good reproducibility of results. By this method the variation of CO_2 content inside zone of U-bearing metasomatites was found. (Authors' abst.)

KUZNETSOVA, S.V. and KUZNETSOV, Yu.A., 1977, Conditions of forming of gold-ore mineralization in the southern part of Ukrainian shield (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council or Ore Formation, Sib. Branch, v. II, p. 30 (in Russian; translation by A. Kozlowski). First author at Inst. Geochem. and Physics of Minerals. Acad. Sci. Ukrainian SSR, Kiev, USSR.

The mineralization is of Au-quartz vein type, formed in two stages. The first Au-quartz stage (precipitation of quartz, pyrite, arsenopyrite, pyrrhotite, gold) yielded T_H of fluid inclusions in quartz 460-250°C. The second Au-quartz stage with Hg mineralization (galena, chalcopyrite, Bi telluride, cinnabar, calcite, fluorite, quartz, gold) developed at 280-100°C. Solutions were of HCO_3-Na type plus K, Cl and Li. P at final stage equal 680-380 atm. (Abst. by A.K.)

KWAK, A.P., 1977, Conditions of formation of the King Island Scheelite deposits, King Island, Tasmania (abst.): Abstracts of Second Australian Geological Convention, Monash Univ., 2-4 Feb., 1977, p. 54-55 (National Library of Australia card number and ISBN-0 86910 072 6). Author at Department of Geology, Latrobe University.

The aim of this study is to determine the conditions of formation of the King Island Scheelite deposit (King Island, Tasmania, Australia) from its initial to its final crystallization. This was done by use of field studies, electron microprobe analyses and fluid inclusion studies. At the deposit, reactions between the chemically dissimilar calcic hornfels and marble have resulted in a zonation at their contact which ideally results in the development of green hornblende in the hornfels followed by a zone of green diopside-hedenbergite pyroxene, grossularite garnet, Fe-vesuvianite, wollasonite and finally marble. Superimposed on & largely subsequent to this is the tungsten-bearing skarn in the unaltered marble. The process involved a complex interaction between hornfels, marble and a saline fluid to produce a nearly pure diopside-hedenbergite pyroxene rock of the hornfels with anomalous Mo and W values and the skarn. Intermediate between the marble and skarn either a (1) wollastonite - vesuvianite - scheelite rock or a (2) amphibole-rich skarn zone occurs while between the hornfels and the pyroxene rock a hornblende-rich hornfels occurs. Case (1) occurs where the volumetric hornfels/skarn ratio in the immediate area is large while case (2) occurs where it is relatively small.

The tungsten-bearing skarn consists of hedenbergitic pyroxenes with Mg relatively rich at the core which decreases to Mg-poor at the edge of the grains in both case (1) and (2). The quantity of Mg present in the pyroxene very much depends on the volumetric hornfels/skarn ratio, the Mg being derived largely from the hornfels. Skarn garnets are zoned grossularite to andradite in case (1) while the reverse is true in case (2). This is due to Al being retained as grossularite garnet at the skarns periphery and released near the end of crystallization in case (2) but not case (1). In the case (2) skarns, fluid inclusion studies indicated homogenization temperatures, corrected for salinity and pressure (600 bars) of 350° ± 20°C at the core of garnet, 370 ± 20°C at two-thirds of the radius out and 505-510° ± 20°C at the edge. Salinities at the core are low (≈5 weight percent equivalent NaCl) while at the 370° ± 20°C temperature they rise dramatically to near 30 weight percent NaCl or more which persists to the edge of the garnet. Tensional fractures, partly healed and filled with two-phase fluid occur everywhere up to approximately the 370° ± 20°C temperature where they terminate near a garnet growth layer containing minute wollastonite fibers. The phenomenon is interpreted to be due to faulting produced pressure-release causing the fluid to reach a two-phase area (boiling). Pyrrhotite in the skarn is always rimmed by pyrite indicating at their contact a temperature of 310°C and a f_{S_2} of 10^{-10}. Scheelite often has a central powellite-rich core (∿ 30 mole percent) which falls abruptly (to < 1 mole percent) at a distance of half the radius of the crystals. Using pertinent thermodynamical data writing reactions, involving (a) andradite-hedenbergite, (b) wollastonite-quartz-calcite, (c) powellite-scheelite-molybdenite-tungstenite and finally (d) pyrite-pyrrhotite it is suggested the skarn began to form at T = 350 ± 20°C, $fO_2 < 10^{-42}$, $f_{CO_2} < 10^{-0.5}$, and $fS_2 < 10^{-10}$ from a relatively dilute solution. At the interpreted faulting period T = 370 ± 20°C, $f_{O_2} \approx 10^{-0.5}$ and $fS_2 \approx 10^{-9.5}$ while the solution is fairly saline. Near the termination of the episode $T = 505 - 510 \pm 20°C$, $f_{O_2} \simeq 10^{-25}$, $f_{CO_2} \simeq 10^{+1.2}$, and $f_{S_2} \simeq 10^{-5.5}$. Pressure varied between 400 to 600 bars being initially high, low at the period of faulting (hydrostatic) and high again at the termination of the skarn producing episode. In skarns where the hornfels/marble ratio is low, the values of f_{S_2}, f_{H_2O} and f_{CO_2} rose with falling f_{O_2} and temperature to produce a mixture of epidote, calcite, ferrohastingsite, quartz and pyrite from the previously formed garnet skarn. This occurred near the skarn-marble interface. (Author's abstract)

KYLE, P.R., 1977, Mineralogy and glass chemistry of recent volcanic ejecta from Mt. Erebus, Ross Island, Antarctica: N.Z. Jour. Geol. and Geophys., v. 20, no. 6, p. 1123-1146. Author at Antarctic Research Centre, Victoria Univ. of Wellington, New Zealand.

Bombs erupted in 1972 and recent flows of anorthoclase phonolite from Mt Erebus both contain phenocrysts of anorthoclase and microphenocrysts of olivine ($Fa_{46}Te_3Fo_{51}$), clinopyroxene ($Wo_{48}Fs_{15}En_{37}$), titanomagnetite (Usp_{70}), pyrrhotite and apatite; the associated glass is peralkaline (agpaitic index=1.06). The composition of glass inclusions in large anorthoclase ($Ab_{65}An_{16}Or_{19}$) phenocrysts, which form a lag gravel on the summit cone of Mt Erebus, is generally more evolved than that from the groundmass of recent flows and bombs. Glass inclusions from between the core and rim of anorthoclase phenocrysts represent variations with time and show a small and systematic increase of Al_2O_3 and decrease of FeOT (total iron as FeO), possibly owing to reaction of the glass with the anorthoclase after entrapment. In contrast, whole rock-groundmass trends show decreasing Al_2O_3 and increasing FeO_T. The whole rock compositions of recent flows and ejecta are similar to older (up to 1 m.y.) anorthoclase phonolite flows exposed around the base of Mt Erebus. (Author's abstract)

KYSER, T.K., and O'NEIL, J.R., 1977, ^{18}O, D, and H_2O contents of basalts and ultramafic nodules from Hawaii (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 1063-1064. First author at Dept. of Geology and Geophysics, University of California, Berkeley, CA 94720.

$\delta^{18}O$ values of submarine basalts dredged from the East Rift Zone of Kilauea range from +4.7 to +6.3 and are correlated positively with degree of differentiation. The chemical and isotopic relations of these basalts are controlled by olivine. $\delta^{18}O$ values of subaerial Hawaiian tholeiites ranges from +5.2 to +5.8. Unaltered alkali olivine basalts and xenoliths, on the other hand, are generally more ^{18}O-rich with values of $\delta^{18}O$ between +5.8 and +7.7. These oxygen isotope data indicate isotopically distinct sources for AOB's and tholeiites and imply a possible genetic relation between AOB's and xenoliths in Hawaii. Oxygen isotope reversals are observed in mineral separates from several xenoliths.

δD values are positively correlated with H_2O contents and eruption depths of Kilauean submarine basalts and indicate contamination of the molten basalts with seawater. Hawaiian tholeiites contain a maximum of 0.26 to 0.31 weight percent magmatic water that has a δD value between -90 and -75. The calculated quantities of added seawater are too low to affect the chemical and oxygen isotope compositions of the basalts or to mask the detection of any rare gas isotopic anomalies. (Authors' abstract)

LAGACHE, M. and WEISBROD, A., 1977, The system: two alkali feldspars-KCl-$NaCl$-H_2O at moderate to high temperatures and low pressures: Contrib. Mineral. Petrol., v. 62, p. 77-101. First author at Laboratoire de Géologie, Ecole normale supérieure, 46, rue d'Ulm, F-75005 Paris, France.

Because of frequent discrepancies between the available experimental data and the measured composition of alkali chloride aqueous solutions coexisting with two alkali feldspars in high temperature-low pressure natural systems, a systematic investigation of the system $KAlSi_3O_8$-$NaAlSi_3O_8$-KCl-$NaCl$-H_2O has been undertaken at 300°C - 660°C, 0.2 to 2 kbar, and total chloride concentrations ranging from 0.05 to 14 moles/kg H_2O.

No effect of pressure on the feldspars solvus could be detected. Smoothing the experimental data on the basis of the regular assymetric solid solution model yields a critical temperature of 661°C and a critical composition of $Or_{0.36}Ab_{0.64}$.

The "equilibrium constant" $C=m_{KCl}/m_{NaCl}$ does not depend on total chloride molality, as long as the aqueous solution is homogeneous. But, in the miscibility gap (liquid+vapour) of the fluid, C is always lower in the vapour than in the liquid. The higher the temperature and the lower the pressure, the more striking this effect. For instance, at 500°C: $C_{vapor}/C_{liquid}=1$ above 1 kb, 0.9 at 600 bars, 0.8 at 500 bars, 0.7 at 400-450 bars.

The effect of pressure can be neglected in homogeneous fluids and in the liquid phase of unmixed fluids, but it is very important in the vapour phase (dilute solutions at low pressure).

The selected values of C_{max} are (±0.01):

300°C:0.083; 400°C:0.139; 500°C:0.200; 600°C:0.264; 650°C:0.298

Such a behaviour of the fluid at low pressures explains the abnormally low values of m_{KCl}/m_{NaCl} measured in many natural hydrothermal systems. A new mechanism of "alkali metasomatism" (especially potassic alterations) is also proposed, taking into account the unmixing of alkali chloride aqueous solutions. This model seems particularly interesting in late magmatic hydrothermal processes, such as those occurring in porphyry type deposits. (Authors' abstract)

LAMBERT, Philippe and PAGEL, Maurice, 1977, On the origin of planar elements in quartz from the structures at Carswell and Charlevoix (Canada) and Rochechouart (France): C.R. Acad. Sci., Paris, v. 284, Ser. D, p. 1623-1626 (in French).

The study of fluid inclusions involves post shock origin of inclusions in quartz exibiting planar elements. Morphological investigations by scanning electron microscope reveal 2 types of decorated planar elements. The origin of planar elements is discussed. (Authors' abstract)

LANGE, I.M. and MURRAY, R.C., 1977, Evaporite brine reflux as a mechanism for moving deep warm brines upward in the formation of Mississippi Valley-type base metal deposits: Econ. Geol., v. 72, p. 107-109.

LANGMYHR, F.J., KOLSAKER, P. and STEEN, B.G., 1977, A gas chromatographic/mass spectrometric determination of some organic compounds of two Norwegian rocks: Norsk Geologisk Tidsskrift, v. 57,

p. 285-294. Authors at Kjemisk inst., Univ. i Oslo, Blindern, Oslo 3, Norway.

Pulverized samples of a Cambrian schist from Slemmestad by Oslofjorden and a coarse-grained marble from Storforshei, Mo i Rana, were extracted with a mixture of benzene and methanol. Qualitative analyses of the up-concentrated extracts were made with a gas chromatograph connected to a mass spectrometer; the subsequent quantitative analyses were made with a gas chromatograph. In the two samples about 25 organic compounds were detected, their concentrations varying about 1 p.p.m. (Authors' abstract)

LAPUKHOV, A.S., 1976, Temperatures of formation and fluids of porphyry intrusions (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 112-113 (in Russian; translation by A. Kozlowski).

Commercial sulfide-polymetallic ores of Altai are connected with pre-ore intrusions. In phenocrysts of quartz P glass and crystallized inclusions have highest T_H in the inner part of crystal, and in outer part T_H decreases over an interval of 100-150°C. In apophyses of quartz porphyries cutting surrounding rocks the decrease of T_H is 100-300°C.

Ore field	T of beginning of melting, °C	T_H of P melt inclusions, °C	Average composition of gases, vol.%*		
			N_2	CO_2	"Acid" gases
Salairskoe	850-900	1125-1150	89.5	9.1	1.4
Kamenushinskoe	do.	1250-1370	44.1	53.3	2.6
Zyryanovskoe	do.	1200-1300	not analysed		

<u>Note</u>: O_2, CO and H_2 not found. *Analyses by N.A. Shugurova

In upper zones of shallow intrusions N_2 content increases, whereas in their deep zones -- CO_2 content. T_H is close to T of beginning of crystallization of anhydrous melts of respective composition. (Author's abst.)

LAZARENKO, E.K., VOZNYAK, D.K., PAVLISHIN, V.I., and SHELUKHIN, V.I., 1976, Typomorphic characteristics of Donets Basin quartz crystals with inclusions of methane solutions: Dokl. Akad. Nauk SSSR, v. 231, p. 1446-1449 (in Russian; translated in Doklady Acad. Nauk SSSR, v. 231, p. 124-127, 1978).

See abstract in <u>Fluid Inclusion Research--Proceedings of COFFI</u>, v. 9, p. 76. (ER)

LAZARENKO, Ye.Ye, 1976, Use of siderite as an indicator of pH of (mineral-forming) medium (abst.): Problems of genetic information in mineralogy (Proceedings of the All-Union Mineralogical Seminar), Syktyvkar, June 1-4, 1976: Syktyvkar, Acad. Sci. USSR, Komi Div., p. 43 (in Russian; translation by A. Kozlowski). Author at the Inst. Geochem. and Physics of Minerals of the Acad. Sci. Ukrainian SSR, Kiev.

Measurements of pH in individual inclusions (in siderite?-A.K.) yielded values 7.4-8.0. The presence of large amounts of siderite proves alkaline conditions and redeposition of SiO_2 in the chamber of the pegmatite.

LAZARENKO, Ye.Ye., VYNAR, O.N. and FEDUSIV, Ye.N., 1976, Physico-chemical conditions of forming of quartz from the schlieren pegmatites in the north-eastern part of the Korostienskiy pluton: Mineralog. Sborn., v. 30, no. 1, p. 54-57 (in Russian, English abst.). Authors at the Inst. Geol. Geochem. of Mineral Fuels, Acad. Sci. of the Ukrainian SSR, L'vov, Naukova 3a, USSR.

Minerals from schlieren pegmatites from Yemel'yanovka quarry contain various types of fluid inclusions. T_H range from 400 to 70°C in all zones of pegmatites - from wall granite (S inclusions) to minerals in central cavity, homogenization mostly in L, rarer in G phase, pH 7.2-7.4, occassionally 7.6-7.8. At lower T (∿240°C) pH was 6.8-7.0. Total salt concentration equals ∿4 wt.%. By water leachates the composition of ions was found as follows: Na, K, Li (in all samples), Ca, Mg (in block quartz and in morion), Cl, SO_4, CO_3, HCO_3; the higher the concentration of Na, the lower the concentration of K. Minimum CO_2 concentrations were found in granite; over 90% of the gas in granophyric and block zones and in central cavity. The balance of gases are N_2 and hydrocarbons, distributed with irregular pattern in pegmatite zones. (Abst. by A.K.)

LAZ'KO, Ye.M., LYAKHOV, Yu.V., and PIZNYUR, A.V., 1977, On thermobarogeochemistry of processes of post-magmatic ore formation (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. I, p. 159-160 (in Russian; translation by A. Kozlowski). Authors at the L'vov State Univ., Lvov.

1. Thermobarogeochemical studies of ore deposits (Mo-W, Au-Ag, Pb-Zn, Hg-Sb) in Transbaikalia, Central Kazakhstan, S. Kirgizia, N. Caucasus, Rudnyi Altai and other regions suggest that the process of post-magmatic ore formation developed during T decrease from 600-500 to 50-30°C, P decrease from 2500-1500 to 200-10 atm and total salt concentration from 60-40 to 1-0.1 wt%. Chemical composition of hydrotherms changes from Cl-Na to HCO_3-Mg-Ca; activation of CO_2 was noted especially in moderate-T part of the process (300-180°C).

2. (...) At the beginning of the process T and P often rapidly increased over the interval of 50-150°C and 300-600 atm, whereas at the end T and P similarly decreased over 40-60°C and 50-100 atm. Minor fluctuations of 1-15°C and 1-20 atm were also noted. These (fluctuations) stimulated the mineral-forming process.

3. P-T conditions are very similar in the same type of deposit in various areas, as shown in the table:

Deposit	T, °C	P, atm
Cu-Mo, Mo, W-Mo	600- 40	2000-400
W-Sn-Mo	450- 40	1000-200
Au-sulfide	450- 30	1100-200
Pb-Zn	360- 30	800-200
Au-Ag	360- 30	300- 30
Hg-Sb	200- 30	200- 1

4. Commercial ores formed within narrow T-P ranges:

Ore-bearing association	T, °C	P, atm
Mo	440-340	1150-800
W	360-300	-
Sn	360-280	-
Au	265-200	900-500
Au-Ag	250-190	200- 30
Pb-Zn	300-180	-
Sb	180-140?	200-100?
Hg	140- 30	100- 30

(From the authors' abstract)

LAZ'KO, Ye.Ye., 1977, Crystalline inclusions in minerals of kimberlitic rocks and their petrogenic significance: Akad. Nauk SSSR, Dokl., v. 234, p. 918-921 (in Russian; translated in Doklady Acad. Sci. USSR, v. 234, p. 203-207, 1979). Author at the Inst. of Geology of Ore Deposits, Mineralogy, Petrography and Geochemistry of the Acad. Sci. USSR, Moscow.

Kimberlites and deep-seated xenoliths from pipes "Mir" and "Eastern Udachnaya" (Yakutia) bear olivine, ortho- and clinopyroxene, chrome spinel, garnet, ilmenite, sulfides, graphite, phlogopite as solid inclusions in the following rock-forming minerals: olivine, ortho- and clinopyroxene, garnet, chrome spinel, etc. Sulfides form drop-like inclusions of presumably melt origin. Differences in patterns of distribution of solid inclusions in kimberlite and xenoliths are outlined. Inclusions are assumed to be mostly P and the original parageneses were a) dunite-harzburgite and b) lherzolite. (Abst. by A.K.)

LE BAS, M.J., 1977, Carbonatite-nephelinite volcanism, an African case history: London, J. Wiley & Sons, 341 pp. Author at Dept. of Geol., Univ. of Leicester.

References to immiscibility and fluid inclusions on pp. 285-287. (ER)

LE BAS, M.J., ASPDEN, J. and WOOLLEY, A.R., 1977, Contrasting sodic and potassic glassy inclusions in apatite crystals from an ijolite: J. Petrol., v. 18, pt. 2, p. 247-262. First author at Dept. Geol., Univ. of Leicester, Leicester LE1 7RH, England.

Electron probe analysis of isotropic to weakly birefringent glassy inclusions in apatite crystals within the Usaki ijolite of western Kenya, indicates that two contrasting compositions exist. These inclusions are thought to represent samples of original silicate melts. One is rich in K_2O (∿6 weight per cent), poor in Na_2O (∿0.3 weight per cent), and oversaturated with respect to silica; and the other is rich in Na_2O (6-14 weight per cent), poor in K_2O (∿0.2 weight per cent), has an antipathetic relation between Na_2O and CaO (together they usually total 15 weight per cent) and is undersaturated with respect to silica. One inclusion shows these two compositions co-existing, apparently in an immiscible relationship. Other inclusions show compositions intermediate between the Na-rich and K-rich types, and they are interpreted as the result of reduced immiscibility. The presence of halides and calcium phosphate is considered to enhance the immiscibility process. The parental composition, estimated on a volatile-free basis is: SiO_2 54·9, Al_2O_3 27·4, CaO 7·3, Na_2O 3·4, K_2O 6·9, which corresponds to a lime-rich aluminous syenite. (Authors' abstract)

LE GUERN, F. and CARBONNELLE, J., 1977, Carbon + sulfur contribution of two lava lakes to the atmosphere (abst.): EOS, v. 58, p. 921.

LeRIBAULT, L., 1974, External and internal study of detrital quartz: Rend. Soc. Ital. Mineral. Petrol., v. 30, p. 373-416 (in French).

A combination of scanning electron microscopy of the exterior and study of the interior (and its inclusions) permits clarification of a complex grain history. (From the author's abstract, translated by H.A. Stalder)

LETNIKOV, F.A., 1977a, On the distribution of fluid components in magmatic and metamorphic rocks: Akad. Nauk SSSR, Doklady v. 232 no. 2, p. 463-465 (in Russian). Author at Inst. of the Earth's Crust, Siberian Division of Acad. Sci. USSR, Irkutsk.

Since most of gas components in minerals occur in various defect structures of submolecular size, not in visually recognizable G/L inclusions, gases for gas chromatography were derived by heating of minerals in a He atmosphere. Mantle specimens (lherzolite nodules from Pribaikal'ye and Nigeria, basalts from Middle-Atlantic, E. African and Baikal rift zones, anorthosites, diabases and diabase porphyrites from E. Siberia) may be divided into those bearing reduced fluid components, i.e., $H_2 > H_2O$ & $CO > CO_2$ (the lherzolites), and those with fluid oxidized to various degrees, (the remaining rocks). Analysis of gases permits also evaluation of the rate of migration of mantle melt through the Earth's crust: slow migration causes stronger oxidation of primitive reduced mantle fluids. In metamorphic rocks the amount of water increases from rocks of granulite facies through amphibolite, epidote-amphibolite to greenschists facies. Degree of oxidation of H_2 and CO increases the same way (CO/CO_2 decreases from 2.1 to 0.01-0.02, H_2/H_2O from 1.3 to 0.09). Also CO/CO_2 and H_2/H_2O in granitoids depend strongly on the facies of their origin. The paper also has a table with typical concentrations of H_2O, CO_2, CO, CH_4, H_2, N_2 and H_2/H_2O and CO/CO_2 ratios fro 19 varieties of rocks. (Abst. by A.K.)

LETNIKOV, F.A., 1977b, Evaluation of fluid regime of processes of endogene ore formation (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Sib. Branch, v. II, p. 33-34 (in Russian; translation by A. Kozlowski). Author at Inst. of the Earth's Crust of Siberian Branch Acad. Sci. USSR, Irkutsk.

On the basis of a large number of chromatographic determinations of contents of H_2O, CO_2, CO, CH_4, H_2, N_2 and other components of fluid in ores of the rare metal and gold ore deposits, as well as physico-chemical calculations, the following may be concluded:

1. G components are very important buffers, determining ore precipitation and alterations of wall rocks. Depending on H_2O/CO_2 ratio, one or another type of rare metal ores develops. T decrease may cause appearance of more polymerized forms of C-bearing compounds, as "bituminoids". Especially high buffering role belongs to components weakly linked into minerals: N_2, Cl, Br, I: their accumulation at the end of hydrothermal process helps in wide development of complexes and polymerization, leading to concentration of ore elements and forming of massive ores.

2. During forming of gold ore mineralization of metamorphogene nature, commercial ores precipitate at final stage ($T<300^\circ C$, $P<1.5$ kbar), when ratio $\frac{H_2+CO+CH_4}{H_2O+CO_2} < 0.4$. In hydrothermal gold ore deposits connected with magmatism, strong variations of regime of ore forming were noted, comparable with fluctuations of ore content in vein bodies.

3. For shallow deposits one of most important factors is how the system is opened, determining in significant degree the course of ore precipitation. (Author's abst.)

LETNIKOV, F.A., YESKIN, A.S., VILOR, N.V., GANTIMUROVA, T.P., SHKANDRIY, B.O. and SHKARUPA, T.A., 1976, Fluid regime of metamorphism of complexes from Pribaikal'ye (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 122 (in Russian; translation by A. Kozlowski).

Chromatographic analysis (H_2O, CO_2, CO, CH_4, H_2, N_2) provided data on the complexes of Priol'khon'ye, Sharyzhalgay, Khamar-Daban and Mama. For complicated polymetamorphic series, formed in a zone that was active for long time, a long action of essentially reducing fluids of mantle nature is characteristic; only the final late stage developed in presence of oxidizing fluids.

Zonal metamorphic Upper Proterozoic complexes of epidote-amphibolite facies bear oxidized fluids. Transition to garnet-muscovite and garnet-biotite-muscovite zones of amphibolite facies is connected with a very distinct increase of pH of fluids, accompanied by a decrease of H_2O content. In the kyanite-sillimanite and sillimanite zones, where granitization appeared and migmatites formed, the reducing regime sharply changes into oxidizing and amount of H_2O in fluid increases. Beginning from garnet-muscovite zone, toward more elevated P-T metamorphic conditions, ratio CO/CO_2 increases and H_2/H_2O decreases. Pyrolysis of organic compounds has an important influence on formation of fluids during P and T increase. Content of H_2O decreases from greenschist zone to migmatites. (...) (Authors' abstract.)

LETUVNINKAS, A, MEL'NIKOVA, N.D., and MOISEEVA, S.V., 1976, Temperature conditions for the formation of Tal'skoe deposit magnesites (Enisei Ridge): Tr. Tomsk. Gos. Univ., v. 257, p. 92-97 (in Russian).

The formation temps of the Tal'skoe hydrothermal-metasomatic deposit are evaluated from T_D and T_H of the fluid inclusions in magnesite and dolomite. The 1st, productive mineralization developed at 190-210 and 2 subsequent mineralizations occurred at 150-240°. The temp. intervals of the 3 successive mineralization stages were 120, 70, and 40°. T_D-T_H of dolomite was 105-30°. High O activity during mineralization is reflected in the color of the carbonates formed during the different mineralization stages. (Chem. Abst., 87:204420t)

LEVY, Yitzhak, 1977, The origin and evolution of brine in coastal sabkhas, northern Sinai: J. Sed. Petrol., v. 47, p. 451-462.

LIKHACHEV, A.P., 1977, Conditions of crystallization of trap magmas from NW part of Siberian Platform. Vses. Mineral. Obshch. Zapiski, v. 106, no. 5, p. 594-605 (in Russian). Author at Central Sci.-Research Geol.-Prosp. Inst. of Color and Noble Metals, Moscow.

Pertinent to silicate-sulfide melt immiscibility. (A.K.)

LISITSYN, A.Ye. and RUDNEV, V.V., 1976, Genesis of boron-silicates in skarns, based on studies of gaseous-liquid inclusions (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 68-69 (in Russian).

Datolite concentrates mainly in skarns formed after limestones; danburite in skarns formed from alumino-silicate rocks mixed with limestones. Two-phase, essentially liquid P inclusions are typical for danburite, datolite and associated quartz and calcite. In danburite polyphase inclusions were found bearing halite, probable sylvite, calcite, and a number of unidentified minerals. Borosilicates formed from chloride, bicarbonate and sulfate solutions of various concentration.

T_H of G/L inclusions in L phase for datolite is 240-380°C, danburite - 230-380°C, quartz and calcite - 150-280°C. Amount of borosilicates decreases with T drop, whereas amount of quartz and calcite increases, although B content in solutions remains high, as it results from G/L inclusions in quartz, studied by (n, α) radiography. (Authors' abst.)

LISOGOR, L.N. and MOROZOV, S.A., 1976, On relations between quartz-gold-ore veins from Karamazar and dikes of diabase porphyrites (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa. USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 154 (in Russian; translation by A. Kozlowski).

Decrepitation of quartz decreases at the contact with dikes of diabase porphyrites, from thousands to tens of impulses, whereas T_D increases over an interval of about 50-100°C. (...) (From the authors' abst.)

LITOVCHENKO, Ye.I., 1976, Genetic relations of minerals and inclusions of mineral-forming solutions as a reflection of conditions of formation of pegmatites from the Western Priazov'ye (Ukrainian shield) (abst.): Problems of genetic information in mineralogy (Proceedings of the All-Union Mineralogical Seminar, Syktyvkar, June 1-4, 1976: Syktyvkar, Acad. Sci. USSR, Komi Div., p. 108-109 (in Russian; translation by A. Kozlowski). Author at Inst. Geochem. and Physics of Minerals of Acad. Sci. Ukrainian SSR, Kiev.

On the basis of inclusions of mineral-forming fluids in quartz from various zones of pegmatites, only zones of aplite and granophyric intergrowths may be accepted as apparently formed from melt. In quartz from apographic, pegmatoid and blocky zones inclusions of melt were not found. The highest T G/L inclusions yielded T_H 600-710°C. P and early S inclusions of G and G/L type prove the forming of those zones from G and G/L fluids; such inclusions were not only found in quartz, but also in beryl (T_H 380-420 and 200-350°C), tourmaline (T_H 300-320°C and 150-200°C), spodumene (T_H 240-320°C), and apatite (T_H 300-320°C). The following stages were distinguished in the formation of pegmatites: magmatic, 1100-710°C; pneumatolytic-hydrothermal recrystallization and metasomatosis, 600-100°C; hydrothermal-supergene alteration 200-30°C; P of formation of pegmatites $\leq$ 500 atm. (From the author's abst.)

LITVINOVSKIY, B.A., 1977, Role of mantle potassium in formation of large masses of granitoid magma (exemplified by Angaro-Vitim batholith): Akad. Nauk SSSR, Doklady, v. 234 no. 3, p. 653-656 (in Russian). Author at Geol. Inst. of Buryat Div. Siberian Branch Acad. Sci. USSR, Ulan-Ude.

LIVNAT, Alexander, RYE, R.O. and KELLY, W.C., 1977, Stable-isotopic and fluid-inclusion studies of the Keweenawan copper district, northern Michigan (abst.): Econ. Geol., v. 72, no. 4, p. 733.

See Fluid Inclusion Research -- Proceedings of COFFI, v. 9, p. 80 (ER)

LOFGREN, G.E., 1977, The nature of growth processes for silicate minerals from the melt (abst.): in Program and Abstracts, Third M.S.A.-F.M. Symposium, Crystal Growth and Habit, Tucson, Arizona, Feb. 13-14, 1977 (unpaginated)

LOFGREN, G.E. and GOOLEY, R., 1977, Simultaneous crystallization of feldspar intergrowths from the melt: Amer. Min., v. 62, p. 217-228.

LOMONOSOV, I.S., FLESHLER, V.I. and YURGENSON, G.A., 1977, Recent hydrothermal activity and mineral forming in the Baykal rift zone, in: Hydrothermal process in the areas of tectonic-magmatic activity, p. 56-64, "Nauka" Publ. House, Moscow (in Russian).

LONG, D.T., 1977, Mobilization of selected trace elements from shales by brine solutions (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 1073-1074.

LONG, D.T., and ANGINO, E.E., 1977, Chemical speciation of Cd, Cu, Pb, and Zn in mixed freshwater, seawater, and brine solutions: Geochim. Cosmochim. Acta, v. 41, p. 1183-1191.

LONG, P.E., 1977, Zoning and morphology of synthetic alkali feldspar; implications for the origin of K-feldspar megacrysts (abst.); in Program and Abstracts, Third M.S.A.-F.M. Symposium, Crystal Growth and Habit, Tucson, Arizona, Feb. 13-14, 1977 (unpaginated).

LU, Hung Zhang, ed., 1977, Fluid inclusions and their significance in geology: Peking, Inclusion Laboratory, Geochemistry Research Inst., Chinese Acad. Sci., 113 pp (in Chinese).

A general review of literature data, with 46 figures, 25 references and 20 photomicrographs. (E.R.)

LU, Huanzhang, SHI, Jixi, YU, Cimei and XU, Shengjiao, 1977, A study of the characteristics and temperatures of formation of fluid inclusions from various types of tungsten deposits in the Nanling region: Geochimica, v. 9, no. 3, p. 179-193 (in Chinese, with English abstract).

The types and features of fluid inclusions from various types of tungsten deposits are discussed at some length after a brief account of the geological setting of the 23 tungsten mining districts in Nanling, the greatest tungsten-producing area in China. Temperatures of formation of these inclusions, ranging from 140° to 330°C, are determined by homogenization or decrepitation runs. On the basis of this study the authors hold that in this region wolframite as well as scheelite deposits in most instances may be genetically connected with the Yenshanian granites, and that the ore-forming fluids responsible for wolframite mineralization possess low salinity, high density, high CO_2 content, and that part of them is of the nature of pneumatolytic hydrothermal fluids. The characteristics and temperature variation of the inclusions are examined in the light of the nature of ore-forming veins, their elevation, wall-rock alteration, stages of mineralization, mineral association, the order of crystallization and other aspects, providing some useful information for the investigation of ore-forming process. (Authors' abstract)

LUCKSCHEITER, B. and MORTEANI, G., 1977, Fluid inclusion studies in fissure quartz from the Pennine rocks of the Western "Tauernfenster": Fortschritte der Mineralogie, v. 55, pt. 1, p. 89 (in German). Authors at Berlin, W. Germany.

Geochemical studies by Hörmann and Morteani (1972), Lausch, Möller and Morteani (1974) and studies of oxygen isotopes in biotite, quartz and carbonate by Friedrichsen and Morteani (unpublished), show that the fissure minerals of the Pennine rocks of the "Tauernfenster" have crystallized generally under the same temperatures as the minerals of the surrounding rock, that is, at the climax of the alpine metamorphism.

Therefore, fluid inclusions in fissure quartz can give direct data on the composition of fluid phases immediately during or after the maximum temperature of metamorphism, provided that the analyzed fluid inclusions are cogenetic with the host quartz. With the aid of data on T_H and T_{Frz} of the fluid inclusions, the Western "Tauernfenster" may be divided in two areas:

a) An area in the Tuxer and Zillertaler Alps distinguished by CO_2-contents ranging between approximately 10 and 80 vol.-%, with three specific types of inclusions (see Fig. 1):

Type A: CO_2-rich with >50 vol.-% CO_2, CO_2-densities between 1 g/cm^3 and the critical density (0.46 g/cm^3) and relatively low salinity of 5.5 to 8 wt.% NaCl equiv.

Type B: CO_2-bearing with 10 to 35 vol.-% CO_2, CO_2-densities about critical, and high salinity (10 and 20 wt.-% "NaCl").

Type C: CO_2-poor, with <20 vol.-%, considerably below $d_{crit.}$; salinity as with type A.

Type A formed at the beginning of the fissure mineralization under maximum metamorphic P-T. With progressive opening of the fissures, CO_2-poorer aqueous solutions appear, initially showing very high salinities (Type B). The salinities of the still later fluid phases are even lower and the CO_2-contents are partly below the zone of detectability (Type C).

b) In the region of the "Grossvenediger" and SE of it, no CO_2 (< 2 mol.%) can be detected. The salinity of the aqueous solutions ranges between 2.5 and 8 wt% "NaCl". The only CO_2-rich fluid inclusions in this area occur in quartz segregations of eclogites south of the Grossvenediger.

T_H and T of the metamorphism give pressure values during the fissure mineralization of maximum 6 kbs in the center of the Tuxer and Zillertaler Alps down to 4.3 kbs and ∿3.5 kbs in the zone of the Grossvenediger. The 6 kbs value is in agreement with the mineral equilibrium. The low pressures can be explained with the fact that the opening of the clefts required for the fissure mineral formation implies a pressure relief. (Authors' abstract, translated by H.A. Stalder)

References:

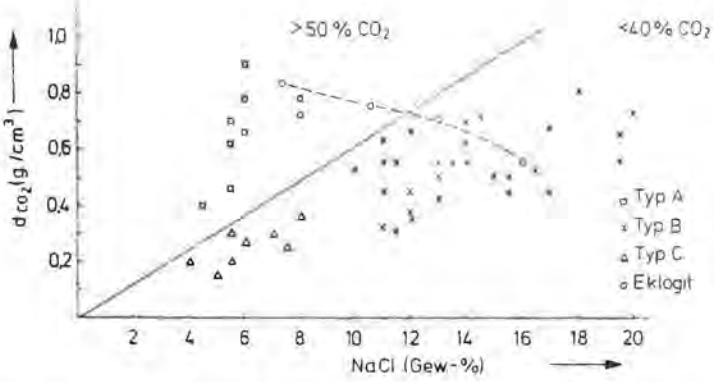
Hörmann, P.K. and Morteani, G., 1972, Tscherm. Min. Petrogr. Mitt., v. 17, p. 46-59.

Lausch, J., Möller, P. and Morteani, G., 1974, N. Jb. Miner. Mh., v. 11, p. 490-507.

Fig. 1

Relations between CO_2-density and "NaCl"-content in CO_2-containing fluid inclusions in fissure quartz from the Western Tauernfenster.

(Continued on next page)



LUDDEN, J.N., 1977, Residual glass phases as monitors of crystal fractionation of the lavas of Piton de la Fournaise, Reunion Island (abst.): Amer. Geophys. Union, Trans., EOS, v. 58, no. 6, p. 529.

Glass phases in the basaltic rocks from Piton de la Fournaise, Reunion Island occur, either interstitially, or as vesicle infillings, or as primary inclusions within the mineral phases. Microprobe analyses have shown that the glasses define three groups: (1) a fractional crystallization sequence through nepheline-normative hawaiites and mugearites to quartz and corundum-normative residua; (2) highly alkaline glasses, included as a primary phase within olivine phenocrysts; (3) glasses segregated into vesicles, which define a trend to rhyodacite residua.

Least squares estimates of fractional crystallization for the first group indicate that clinopyroxene, which is the dominant fractionating phase during the early stages of evolution, is replaced by plagioclase during the evolution to trachytic residua. The second group are interpreted as being immiscible droplets of intercumulus liquid, liberated from a crystal mush flooring the magma chamber and trapped within the olivine during rapid crystal growth. The vesicles into which the third group of glasses are segregated are surrounded by a 2-5 cm mantle, in which the olivine is densely charged with magnetite and the iron-titanium oxides are complex intergrowths of ilmenite, magnetite and hematite. These glasses are interpreted as having an origin by the development of abnormally high P_{O_2} conditions during the crystallizaton of the basaltic melt. (Author's abstract)

LUKASHEV, K.I., KUDEL'SKIY, A.V., SHIMANOVICH, V.M., KOMRAKOVA, S.G., GURKCVA, L.S., and KLEBTSOVA, L.I., 1976, Iodine in rocks, oil and brine of the Pripyat Basin: Dokl. Acad. Nauk SSSR, v. 227, p. 712-714 (in Russian; translated in Dokl. Acad. Sci. USSR, Earth Sci. Sect., v. 227, p. 207-209, 1976).

LUPTON, J.E., WEISS, R.F. and CRAIG, H., 1977, Mantle helium in the Red Sea brines: Nature, v. 266, p. 244-246.

LYAKHOV, Yu.V. and POPIVNYAK, I.V., 1976, Factors of localization of gold ore mineralization and their significance for prospecting (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 139 (in Russian; translation by A. Kozlowski).

Main criteria of Au ore mineralization are as follows: 1) CO_2-water composition of solutions, 2) degree of compositional heterogeneity, 3) moderate T (260-200°C), 4) P 500-700 atm, 5) relatively high activity of alkalies in solutions of commercial stage, for moderate depth - Na, for shallow deposits - K. The latter permits consideration of influence of Na and K concentration on the degree of heterogeneity of CO_2-H_2O solutions, even under quasi-isothermal (260-200°C) conditions during P decrease. Above statements are the generalization of studies of deposits from Transbaikalia. (Authors' abst.)

LYAKHOV, Yu.Ya., 1976, Paleothermal zonality of gold ore fields at Transbaikalia (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 148-149 (in Russian; translation by A. Kozlowski).

1) Differences in the thermal field in which ore mineralization has been formed were revealed by the homogenization of G/L inclusions. Paleothermal modes were made by use of a computer for ore fields (Baley, Irokinda), deposits (Darasun, Kariyskoe, Itakinskoe) and individual veins.

2) Signs of pulsation and paleotemperature zoning with depth were revealed. There are common contours of both kinds of zoning and their connection with large faults and intrusive bodies. Depth zoning appears as an increase of T over the studied range of depth of 30-35°C per 100m. Zoning is the same during all the ore-forming process. Variations of the mean paleothermal gradients are 2-10°C per 100 m (horizontal) and 10-25°C per 100 m (vertical). Above the zones of fluids, aureoles of increased T were found as well as anomalous T gradients: vertical up to 30°C/100m and horizontal up to 15°C/100m. (...) (From the author's abst.)

MC HARDY, W.J., 1977, Applications of scanning electron microscopy and microanalysis to the study of soil mineralogy: Geol. Appl. Idrogeol., v. 12, p. 213-234. Author at the Macaulay Inst. for Soil Research, Aberdeen, Scotland.

Possibly of interest for application to the study of daughter minerals (Piero Lattanzi).

McIVER, R.D., 1977, Hydrates of natural gas -- important agent in geologic processes (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 1089-1090.

McKENZIE, W.F. and TRUESDELL, A.H., 1977, Geothermal reservoir temperatures estimated from the oxygen isotope compositions of dissolved sulfate and water from hot springs and shallow drillholes: Geothermics, v. 5, p. 51-61. Authors at U.S. Geol. Survey, Menlo Park, CA 94025, U.S.A.

The oxygen isotope compositions of dissolved sulfate and water from hot springs and shallow drillholes have been tested as a geothermometer in three areas of the western United States. Limited analyses of spring and borehole fluids and existing experimental rate studies suggest that dissolved sulfate and water are probably in isotopic equilibrium in all reservoirs of significant size with temperatures above ca. 140°C and that little re-equilibration occurs during ascent to the surface. The geothermometer is, however, affected by changes in

$\delta^{18}O$ of water due to subsurface boiling and dilution and by addition of sulfate of nearsurface origin. Methods are described to calculate the effects of boiling and dilution. The geothermometer is applied to thermal systems of Yellowstone Park, Wyoming, Long Valley, California, and Raft River, Idaho to estimate deep reservoir temperatures of 360 240, and 142°C, respectively. (Authors' abstract)

McLIMANS, R.K., 1977a The upper Mississippi Valley zinc-lead district: results of fluid inclusion studies (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, p. 631.

Based on sphalerite stratigraphy (McLimans and Barnes, GSA abs., 1975) the main sulfide stage of deposition is divided into early (A), middle (B), and late (C) stages. Inclusion fluids in each of these stages, as well as in the later barite and calcite stages, were examined for filling temperature, freezing temperature, chemical composition, and hydrogen and oxygen isotopic composition.

Heating studies of inclusions in sphalerite indicate temperatures of 150-225°C for the early stage to 75°C for the late stage. Freezing studies indicate fluid salinities of 18-24 eq. wt. % NaCl for all sphalerite stages. The salinities calculated from the chemical analyses are 18-28 wt. %. The K/Na and Mg/Na ratios are .02-.03 and the Ca/Na ratio ranges from .17 to .27.

In the barite stage, salinity drops to 7-12 wt. % and the K/Na and Mg/Na ratios increase to .16-.21 and .25-.3, respectively. In the calcite stage, salinity again drops to 4-7 wt. % and the K/Na ratio decreases to .05-.09 but the Mg/Na ratio increases to .4-.5.

Water is the dominant gas phase with a mole fraction of .99 for all samples. Carbon dioxide is the most abundant condensible gas with a range of 3×10^{-2} to 1.4×10^{-7} moles/kg water. Up to 5×10^{-2} moles/kg water of hydrocarbons are present.

The δD (SMOW) values of the inclusions fluids are -25 to +2 $^{\circ}/_{\circ\circ}$ for galena and sphalerite, -23 $^{\circ}/_{\circ\circ}$ for late barite, and -52 $^{\circ}/_{\circ\circ}$ for calcite. The $\delta^{18}O$ (SMOW) values are -2.9 - +5.7 $^{\circ}/_{\circ\circ}$ for sphalerite and galena, +5.7 $^{\circ}/_{\circ\circ}$ for barite, and +.5 $^{\circ}/_{\circ\circ}$ for calcite.

The chemical and isotopic compositions of the main sulfide stage inclusion fluids are compatible with an origin similar to that for oil field brines whereas the late stage calcite fluids indicate the influx of a dilute fluid of much lighter hydrogen isotopic composition. (Author's abstract)

McLIMANS, R., 1977b Geological, fluid inclusion, and stable isotope studies of the Upper Mississippi Valley zinc-lead district, southwest Wisconsin: PhD dissertation, Penn. State Univ., Univ. Park, PA, 175 pp.

The Upper Mississippi Valley zinc-lead district is located in southwest Wisconsin and parts of Illinois and Iowa. The ore deposits are in Ordovician carbonates underlain by Cambrian sandstones and shales. Current (1976) production is about 1,500 tons of ore per day with an average grade of 3% zinc and 0.5% lead.

Sphalerite in the ores is multibanded. Based on color and textures a uniform stratigraphy can be recognized and correlated across several kilometers in the ore district. For complete wall-to-wall sections of the ore, the stratigraphic sequence is consistent from the vein margins to the vein center. The banded sphalerite is divided into three stages of deposition; A, early; B, middle; and C, late. The regularity of the sphalerite stratigraphy and the common corrosion of bands indicates deposition was both stable and reversible. The uniform thickness of a few centimeters across the ore section suggests that the rate of deposition was nearly constant whether in or between ore bodies; consequently, ore bodies are found where deposition took place on many surfaces rather than due to local, more rapid deposition. These observations are more consistent with an ore solution carrying both metals and sulfur than with a mixing model.

The color of the sphalerite bands, which ranges from pale yellow to dark brown-black, is clearly related to the FeS content which ranges from 0.15 to 19.9 mole per cent FeS in ZnS. In general, the darker the color, the higher the FeS content.

Filling temperatures of fluid inclusions indicate that early sphalerite precipitated at temperatures as high as 200°C, temperatures significantly higher than previously reported. Temperature generally decreased during mineralization until the late stage sphalerite precipitated near 75°C. However, within each stage of mineralization more than 50°C variation took place.

$\delta^{34}S$ values of sphalerite were found to be very uniform at 15.5 ± 1.5 o/oo except for 10 ± 1 o/oo in the very late sphalerite (C stage). $\delta^{34}S$ values of galena decrease gradually from early to late stage from 13.9 o/oo to 5.4 o/oo. Pyrite and marcasite have $\delta^{34}S$ values of 15.5 ± 3 o/oo during the sphalerite stage. Late, post-sphalerite, marcasite shows a range of values from 12 to 29.9 o/oo. Early, pre-sphalerite, barite has a $\delta^{34}S$ of 23 o/oo whereas late, post-sphalerite, barite shows a range of values from 25.8 to 35.9 o/oo.

Isotopic temperatures calculated from co-precipitated galena and sphalerite range from 227°C to 52°C from early to late stage sphalerite. These temperatures agree well with fluid inclusion filling temperatures indicating that chemical and isotopic equilibrium were established between aqueous sulfide species and precipitating sulfide minerals. However, the isotopic relationships between late stage barite and iron sulfides indicates disequilibrium between aqueous sulfide and aqueous sulfate.

The salt content and the hydrogen and oxygen isotopic compositions of the sphalerite stage inclusion fluids are very similar to present day values of oil field brines suggesting a similar mode of origin. The data indicate that the ore fluid was a Na-K-Ca-Mg brine with a range of dissolved salts of 12 to 30 weight per cent. The range of values of δD and $\delta^{18}O$ of the inclusion fluids is -47 to +2 o/oo and -5.1 to +5.7 o/oo, respectively. The dominant gas phase in the inclusion fluids is H_2O (mole fraction >0.99) but appreciable amounts of CO_2 and organic compounds are present.

No evaporite deposits are known in the Upper Mississippi Valley region. The nearest deposits occur in the Michigan basin suggesting that the ore fluid may have migrated from this basin to the ore district, scavenging metals during its passage through the underlying sandstones, shales, and basement rocks.

Chemical and geological data are combined to determine the chemical environment and postulate mechanisms of transport and deposition of the ores. The chloride and bisulfide complexing models are examined in detail. Neither the chloride nor the bisulfide complexing model adequately explain the formation of the ores in detail. Necessarily, other mechanisms are involved. (Author's abstract)

McMAHON, B.M. and HAGGERTY, S.E., 1977, The Oka carbonatite complex:

magnetite compositions and the role of immiscible silicate liquids, in Second International Kimberlite Conference 1977, Extended Abstracts (unpaginated).

This work offers additional support for deep-seated "kimberlitic" devolatilization as a source of CO_2 which is apparently largely responsible for higher level fractionation and immiscibility/segregation processes in upper mantle-low crustal continental rocks. The carbonate-silicate assemblage ijolite and aegerine carbonatite must closely approximate an equilibrium situation. (From the authors' abstract)

McSWEEN, H.Y., Jr., 1977a, Petrologic and chemical studies of the (C3) carbonaceous chondritic meteorites: PhD thesis Harvard University, Cambridge, Mass., 232 pp.

See next abstract.

McSWEEN, H.Y., JR., 1977b, On the nature and origin of isolated olivine grains in carbonaceous chondrites: Geoch. Cosmo. Acta. v. 41, p. 411-418. Author at Univ. Tennessee, Knoxville, TN.

Many carbonaceous chondrites contain discrete olivine fragments that have been considered to be primitive material, i.e., direct condensates from the solar nebula or pre-solar system material. Olivine occurring in chondrules and as isolated grains in C3(O) chondrites has been characterized chemically and petrographically. Type I chondrules contain homogeneous forsterite grains that exhibit a negative correlation between FeO and CaO. Type II chondrules contain zoned fayalite olivines in which FeO is positively correlated with CaO and MnO. The isolated olivines in C3(O) chondrites form two compositional populations identical to olivines in the two types of porphyritic olivine chondrules in the same meteorites. Isolated olivines contain trapped melt inclusions similar in composition to glassy mesostasis between olivines in chondrules. Such glasses can be produced by fractional crystallization of olivine and minor spinel in the parent chondrule melts if plagioclase does not nucleate. The isolated olivine grains are apparently clastic fragments of chondrules. Some similarities between olivines in C3(O), C2, and C1 chondrites may suggest that olivine grains in all these meteorites crystallized from chondrule melts. (Author's abstract).

MADANYAN, O.G., 1976, On the relationship between dikes and ore mineralization on the basis of data of gas-liquid inclusions (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 154-155 (in Russian; translation by A. Kozlowski).

Pecularities of the relationship between dikes and ore mineralization were studied by the decrepitation method. A quartz-syenite-porphyry dike bears xenoliths of quartz with molybdenite; this quartz contains decrepitated G/L inclusions, as well as late S inclusions connected with quartz-chalcopyrite, quartz-pyrite and quartz-polymetallic stages after intrusion of dike. Also 2-phase inclusions not homogenizing up to 500°C were found in this quartz. (...) (From the author's abst.)

MADANYAN, O.G. and IGUMNOV, V.A., 1977, The Fifth All-Union Meeting on Thermobarogeochemistry: Acad. Sci. Armenian SSR, Izvestia, Earth Sci. v. 30 no. 1, p. 104 (in Russian).

MADSEN, J.K., 1977, Composition and microthermometry of fluid inclusions in the Kleivan Granite, south Norway: Am. Jour. Sci., v. 277, p. 673-696. Author at Dept. of Geol., Univ. of Aarhus, 8000 Aarhus, Denmark.

Fluid inclusions have been studied in matrix quartz from a differentiated intrusive granite showing evolution in mafic mineralogy from pyroxene, to hornblende, to biotite. Three main types of fluid inclusions were found: CO_2, H_2O, and CO_2-H_2O inclusions. These represent fluids that were present in the Kleivan granite at some period between the initial Kleivan melt and the present, that is, they are all secondary inclusions. They are believed to be the result of sequential trapping of different fluids rather than the simultaneous trapping of immiscible fluids.

The CO_2 inclusions represent the earliest trapped fluids. They contain up to 10 equivalent mol percent CH_4 and have densities from 0.60 to 0.95 g/cc. There is a close correspondence between the regional distribution of pyroxene and/or hornblende within the granite body and the abundance of CO_2-rich inclusions. A juvenile origin of the CO_2 fluid is considered most likely.

The majority of H_2O inclusions have salinities between 5 and 15 equivalent wt percent NaCl. The composition of these fluids can only partly be described in terms of the $NaCl$-H_2O system, as other cations such as K^+, Ca^{2+}, and/or Mg^{2+} are present. The H_2O inclusions primarily represent fluids present at a late stage of fracturing and healing of the Kleivan granite and reflect the interaction between the solid rock and deep-circulating meteoric water.

The CO_2-H_2O inclusions represent two periods of fluid entrapment. Isolated CO_2-H_2O inclusions reflect an early secondary entrapment of a dense homogeneous CO_2-H_2O fluid with approx 20 mol percent CO_2. Fracture-bound CO_2-H_2O inclusions are closely related to late aqueous inclusions and show a wide compositional range. These inclusions may indicate the existence at a late stage of locally developed heterogeneous mixtures of CO_2 and H_2O. (Author's abstract)

MAISKIY, Yu.G., 1976a, Thermovacuum studies in genetic mineralogy (abst.): Problems of genetic information in mineralogy (Proceedings of the All-Union Mineralogical Seminar), Skytyvkar, June 1-4, 1976: Syktyvkar, Acad. Sci. USSR, Komi Div., p. 75-76 (in Russian; translation by A. Kozlowski). Author at the Rostov State Univ., Rostov.

A review. (A.K.)

MAISKIY, Yu.G., 1976b, On the local and regional nearly isothermal conditions of processes of mineral formation, in Thermobarogeochemistry of Mineral Formation, N.P. Ermakov, ed.: Rostov, Rostov Univ. Press, p. 54-60 (in Russian).

On the basis of studies of fluid inclusions in hydrothermal deposits from Donbass and N. Caucasus, the existence of certain optimum conditions of crystallization of minerals was corroborated. Main factors determining the almost isothermal conditions of mineral formation are: type of solutions, crystallochemical peculiarities of minerals, and dynamics of development of fluids. Reverse T zoning, found in some crystals and veins, may be explained by self-dumping (? - A.K.) of hydrothermal systems. Criteria of determination of the nature of solutions forming hydrothermal deposits are discussed. (Author's abstract, translated by A. Kozlowski)

MAKAGON, V.M., 1974, Effect of the physicochemical conditions of formation of rare-metal pegmatite on its geochemical properties: Dokl. Akad. Nauk SSSR, v. 217, p. 693-696 (in Russian; translated in Doklady Akad. Nauk SSSR, v. 217, p. 190-192, 1975).

See Makagon, 1974, Fluid Inclusion Research--Proceedings of COFFI, v. 7, p. 133-134, 1974. (E.R.)

MAKAGON, V.M., 1976, Physico-chemical factors of formation of the lithium and cesium pegmatites of Siberia (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 67 (in Russian); translation by A. Kozlowski).

There were studied: 1) non-differentiated spodumene-bearing pegmatites of the complex Ta-Cs-Li type (spodumene, pollucite); 2) lepidolite-albite pegmatites with distinct zoning (amblygonite, elbaite, muscovite-lepidolite). T_H for inclusions in spodumene of type 1 pegmatites was ≥550°C, P 4-4.5 kbar. Gas phase has high content of CO_2 and low F. Complex pegmatites crystallized at lower P and T. High CO_2 and low F pressures precluded formation of lithium micas and dispersion of cesium, and caused formation of pollucite at the final stage of crystallization. Lepidolite-albite pegmatites formed from 600 to 290°C under lower pressure than spodumene ones. Main factors of mineral-formation there are high concentrations of boron, phosphorus and especially fluorine in melt-solution. (Author's abst.)

MAKAROVA, T.A., NESTERCHUK. N.I. and KORYTKOVA, E.N., 1977, Studies of mechanism of formation of amphibole under hydrothermal conditions: Vses. Mineral. Obshch. Zapiski, v. 106, no. 2, p. 241-242 (in Russian). Authors at Inst. of Chemistry of Silicates Acad. Sci. USSR, Leningrad.

MAKRYGHINA, V.A., GALKINA, T.N., TAUSON, L.S., and PETROV, L.L., 1977, Volatile components in processes of metamorphism, granitization and pegmatite formation: Ezhegodnik Sibirsk Inst. Geokhim. (Yearbook Siberian Inst. Geochemistry) for 1976, p. 105-109 (publ. 1977; in Russian with English abstracts.)

With a drop of pressure in regional metamorphic series there is observed a decrease of the CO_2, H_2O, and B in the fluid and an increase in partial pressure of F and Cl, but without change in the amounts of the latter. During granitization volatile components are lost at various pressures. Two types of granitic melts are formed: the more water-rich in metamorphic rocks with high fluid pressure, and lower-water metasomatic granites at low pressures. The first are accompanied by large scale muscovite pegmatite belts. In the series at intermediate pressure there appear raremetal-muscovite or raremetal pegmatites. For the lowest pressure series pegmatite are not characteristic. (Modified by ER from the authors' abstract).

MALAKHOV, V.V., 1977, Investigation of gas-liquid inclusions in minerals by gas chromatography: Geokhimiya, 1977, p. 1192-1198(in Russian; translated in Geochem. Internat., v. 14, no. 4, p. 142-147). Author at Geol. Inst. Far East Sci. Centre, USSR Acad. Sci., Vladivostok.

The possibility of a simultaneous determination of H_2O, H_2, N_2, CO, CH_4, and CO_2 in gas-liquid inclusions in minerals from a single sample is shown. High-temperature decrepitation made it possible to analyse the composition of the gas phase of inclusions in minerals not only of hydrothermal, but also of pneumatolytic and magmatic origin. The error in determination of true concentrations of gases in the solution of inclusions does not exceed 3-5% and the sensitivity of the analysis is so high that only small samples are needed. Results of the comparison of the gas phase composition in quartz are given, obtained by mass-spectrometric and chromatographic methods, compare satisfactorily. (Author's abstract)

MALINKO, S.V., LISITSYN, A.Ye., RUDNEV, V.V., MIRONOV, O.F., SEMENOV, YuV. and KHODAKOVSKIY, I.L., 1977, Physico-chemical parameters of the processes of formation of the commerical boron-silicate ores (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. I, p. 93-94 (in Russian; translation by A. Kozlowski). First author at VIMS, Moscow.

The datolite-danburite ores in the deposits Dal'negorsk and Ak-Atkhar bear fluid inclusions with solutions of CO_3-HCO_3-Cl type, salt conc. 50-110 to 430-540 g/kgH_2O (in NaCl equiv.); by gas chromatography N_2, CO, CO_2, CH_4, H_2O were found. Total oxygen compounds of C 15-30 to 80-220 g/kgH_2O, CH_4 up to 40-70 g/kgH_2O. T_H for datolite 265-420°C; danburite 310-420°C; quartz 265-400°C; calcite 155-365°C. (Abst. by A.K.)

MAL'KOV, B.A. and BOBOLOVICH, G.N., 1977, Conditions of formation of kimberlites on the basis of studies of inclusions in calcite and apatite: Akad. Nauk SSSR, Doklady, v. 234 no. 2, p. 436-439 (in Russian). First author at the Ukhtinskiy Industrial Inst.

Genesis of the calcite (or phlogopite-calcite) component of kimberlite is still discussed from two controversial points of view: primary magmatogenic and secondary hydrothermal (metasomatic). The authors found in calcite from Yakutian kimberlite pipes: "E. Udachnaya," "Obnazhonnaya" and "Olivinovaya," melt inclusions filled by brownish melt and one or several G bubbles, T_H about 700-750°C. Late, metasomatic calcite formed at 225-253°C (T_H of G/L inclusions). Early apatite from kimberlite of "Khrizolitovaya" pipe, Yakutia, bears inclusions: 1) light melt, partly crystallized, and dark translucent mass, occupying up to 60-70% of surface of section; at 800-850°C light part becomes dark, for a moment the boundary melt-gas is visible and next inclusion becomes almost completely opaque; 2) G inclusions of drop-like shape; 3) tubular inclusions with variable phase ratios (G + light and/or brownish glass ± calcite, T_H 680-750°C. Apatite formed from G-saturated melt, and, likewise calcite, in the final stage of crystallization of kimberlite magma. (Abst. by A.K.)

MAMCHUR, G.P., VYNAR, O.N., REMESHILO, B.G., and YARYNYCH, O.A., 1976,

^{13}C in CO_2 in inclusions in quartz from veins in the Ukrainian shield (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 183-184 (in Russian; translation by A. Kozlowski).

Isotopes were determined in CO_2 from pegmatites and vein quartz. CO_2 in quartz from rocks in the Kirovograd-Zhitomir complex bears heavier carbon ($\delta^{13}C$ from -0.54 to -1.99%) when compared with CO_2 from granites (from -1.3 to -3.4%) and from the embryonic pegmatites of the Korosty pluton (from -0.93 to -1.92%). $\delta^{13}C$ of the vein quartz is higher (-1.01%) than that of the vein pegmatites (from -1.24 to -1.99%). Formation of the quartz veins seemingly involved vadose waters, bearing heavier carbon of the sedimentary carbonates, and that of pegmatites occurred in a more closed system under the action of volatiles. (Authors' abst.)

MANGHNANI, M.H. and AKIMOTO, S.I., eds., 1977, High pressure research: Applications in geophysics: New York, Academic Press, 664 pp.

Includes 4 articles covering the form, amount, and effect of volatiles in upper mantle materials. (ER)

MANUCHARYANTS, B.O., and MARKOVA, E.A., 1976, Conditions of ore-formation at the gold-antimony deposit Syrylakh (Yakutia) (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 185 (in Russian; translation by A. Kozlowski).

Studies of inclusions in quartz from the early ankerite association and in quartz and antimonite from the final gold-antimonite association revealed:

1) The deposit formed at 320-145°C, and commercial ores at 230-180°C under stable T conditions; P varied from 1600 to 650 bar.

2) Ore-forming solutions had concentrations of CO_2 to 10-20 mol/kg H_2O, CH_4 to 0.2-1.5 mol/kg H_2O; N_2 and H_2 were present. (Authors' abst.)

MANUCHARYANTS, B.O. and TITOV, I.N., 1976, Conditions of ore formation of mercury deposits of Kamchatka and Koryak Upland (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 198-199 (in Russian; translation by A. Kozlowski).

Associations of quartz-dickite in the deposits, according to T data from G/L inclusions, formed at 360-90°C; at the deposits Lyapganay and Olyutor G/L inclusions yielded 210-145°C. The depth of formation of the deposits, from geological data, was ~ 1km. The opaline type is represented by strongly leached ore bodies in zones of secondary quartzites and argillites. They formed at T 230-130°C (general ranges 420-80°C). Tabular crystals of cinnabar from Chempura deposit have G/L inclusions with T_H 170-145°C, and prismatic crystals of Se-bearing cinnabar from Alney deposit, 150-145°C; the depth of formation: several hundred meters. Late ore associations of the listvenite type (quartz-magnesite or essentially quartz composition) formed at 325-80°C (T_H). P during formation of quartz-dickite and listvenite type deposits was estimated at 900-400 atm. Oxidized (CO_2) and reduced (CH_4) solutions were the main components of the hydrotherms. CO_2 concentration reaches

250-300g/1000g H_2O, CH_4-45g/1000g H_2O; these two components determined the Eh of the hydrothermal solutions. (From the authors' abst.)

MANUCHARYANTS, B.O., VLADIMIROV, V.G., and PRUSHINSKAYA, E.Ya., 1977, Certain data on the type of hydrothermal solutions forming gold and gold-antimony ore mineralization in the North-East Yakutia (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Sib. Branch, v. II, p. 125-126 (in Russian; translation by A. Kozlowski). First author at IMGRE.

The deposits formed at T 350-145°C (T_H) and P 1600-600 atm (method not specified). Gold-bearing quartz veins developed mostly at 280-220°C; contact metamorphism of those veins under action of granite intrusions was at 400-340°C. Quartz syngenetic with antimonite crystallized at 235-170°C; native Sb and berthierite precipitated at 350-280°C. CO_2 content varies from 1.5-5.0 (in inclusions in antimonite and berthierite) to 10-18 mol/l (in quartz); CH_4 ranges from 0.05 to 2.0 mol/l. Moreover, N_2, CO and H_2 were found in inclusions. Parent solutions of quartz-gold deposits have higher CH_4/CO_2 ratio (and Eh) than those of gold-antimony deposits. (From the authors' abst.)

MARKELOVA, Ye.Z., KUNTZ, A.F. and KHOROSHILOVA, L.A., 1977, Hydrothermal synthesis and properties of synthetic crystals of α-$CaAlF_5$: Trudy Inst. Geol., Komi Filial, Akad. Nauk SSSR, 1977, no. 23 ("Experiment in mineralogy and modelling of mineral-forming processes"; N.P. Yushkin, ed.), p. 73-77, in Russian.

Crystals of this phase grown at 300 ± 1°C, F of autoclave 0.7, P-70 kg/cm^2, Δt 0.5°/cm (length of autoclave 17 cm), time 234 hours, bear inclusions with T_H from 303 to 162°C. By spectral emission analysis, inclusions contain Ca, Al, Mg and Cu. (A.K.)

MARKHININ, Ye.K., URAKOV, V.A. and PODKLETNOV, N. Ye., 1977, Hydrocarbons in gases of basalt lava flows of Tolbachik fissure eruption 1975-1976: Akad. Nauk SSSR Doklady, v. 236 no. 5, p. 1214-1217 (in Russian). Authors at Inst. Volcanol. Far-East Sci. Center Acad. Sci. USSR, Petropavlovsk-Kamchatskiy.

Pertinent to composition of G in fluid inclusions. (A.K.)

MATJASH, I.V., LITOVCHENKO, A.S., PROSHKO, V.Ja., and BAGMUT, N.N., 1977, Water in feldspar inclusions by the data of proton magnetic resonance: Dopovidi Akad-Nauk Ukr. R.S,R., 1977, no. 1, series B p. 17-20 (in Ukrainian with English abstract). Authors at Inst. of Geochem. and Physics of Minerals, Acad. Sci. Ukr. R.S.R.

The state of water in some feldspars from the Volyn pegmatites was studied by means of the proton magnetic resonance (PMR). It is shown that water in feldspars is localized mainly in vacuoles and retains its liquid state down to a temperature of -40°C. It is completely frozen at -92°C. The results presented testify to the efficiency of the PMR method in studying liquid inclusions in minerals. (Authors' abstract)

MATKOVSKIY, O.I., 1976, Temperatures of (mineral) formation of greenschist and epidote-amphibolite facies (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 120-121 (in Russian; translation by A. Kozlowski).

Rocks of the lower Belyi Potok complex in the basement of the Marmarosh massif (W. Carpathians) formed under conditions of epidote-amphibolite facies, and rocks of the upper Delovets complex - greenschist facies. By T_H, T_D and several mineral geothermometers T 300-500°C were estimated for Delovets complex and 450-665°C for Belyi Potok complex. T 600-665°C for staurolite- and garnet-bearing rocks of the Belyi Potok complex agree with the upper T boundary of staurolite and muscovite stability in paragenesis with quartz; T 300-400°C for the Delovets complex are close to the upper range of stability of certain sedimentary minerals. Thus, lower T boundary of greenschist facies may be estimated as 350-400°C (Author's abst.)

MATSAPULIN, V.U. and KUCHER, M.I., 1976, Conditions of formation of the sulfide deposit Kizil-Dere (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 87-88 (in Russian; translation by A. Kozlowski).

T of formation of mineral associations were 420-130°C with T inversions between stages and inside stages. Inclusions bear H_2O, $\underline{CO_2}$, $\underline{N_2}$, $\underline{CH_4}$, $\underline{NH_3}$, Ar, O_2, H_2S, Cl_2, H_2, He (main components, underlined, occupy over 95 vol.%). CO_2 concentration changes (i.e., varies?) from 1.1 to 15.9 mol/l, H_2S from 0.07 to 1.21 mol/l, pH 8.2-4.0. In paleohydrotherms the following ions occur: $\underline{Ca}$, $\underline{Mg}$, Na, K, $\underline{HCO_3}$, $\underline{SO_4}$, F, Cl (main ones underlined). Gas content ranges from 50 to 500 mm^3 per 1 mg of water; pressure varied distinctly. During sulfide precipitation CO_2 concentration decreases and T increases, whereas pH becomes lower. Main metals were transported as hydrosulfide complexes.

Aureole of decrepitation was not found, but aureoles of increased concentration of H_2O and gases are apparent 5 to 10 m from the ore bodies. (...) (Author's abst.)

MAXWELL, R.J., 1977, The feasibility of Rb-Sr dating of sphalerite (abst.): Geol. Assoc. Canada-Min. Assoc. Canada Program with Abstracts, v. 2, p. 35. Author at Dept. of Geological Sciences, University of British Columbia, Vancouver, B.C., V6T 1W5.

MAZOR, E., 1977, Geothermal tracing with atmospheric and radiogenic noble gases: Geothermics, v. 5, p. 21-36. Author at Isotope Dept., The Weizmann Inst. Sci., Rehovot, Israel.

Meteoric water is tagged by its dissolved atmospheric neon, argon, krypton and xenon concentrations and isotopic compositions. These gases are kept in the groundwater unless it is subsequently heated in geothermal regions and a steam phase is produced. In such cases the noble gases pass quantitatively into the steam phase and the remaining water becomes depleted. Radiogenic helium, argon and radon enter deep-seated hot waters by flushing from country rocks in which they are formed.

The noble gases, being inert, serve as conservative tracers the concentrations and isotopic composition of which provide useful indications of geothermal phenomena. Available information includes: (a) indications of meteoric origin, (b) degree of mixing between shallow water and deep-seated water, (c) previous heating episodes which caused depletion of the noble gas contents in water, (d) the mechanisms by which steam is formed underground (hopefully deducible from the degree and mode of fractionation observed between light and heavy noble gases), (e) interconnections between adjacent producing wells and their optimal spacing in a steam field.

Systematic studies on geothermal systems necessitate proper sample collection of water sources over the entire geothermal region and its peripheries, collection from successive water horizons passed while drilling, and repeated sample collections in order to study seasonal and man-induced changes with time. (Author's abstract)

MAZUROV, M.P., 1977, Conditions of formation of hastingsite (dashkesanite)-magnetite ores in metasomatic iron ore deposits (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. I, p. 87-88 (in Russian; translation by A. Kozlowski). Author at Inst. Geol. Geophys. of Siberian Branch Acad. Sci. USSR, Novosibirsk.

T_H of P G/L inclusions in hastingsite from Tabratskoe and Odinochnoe deposits was 610-570°C, and in skarn pyroxenes--670-630°C. First (early) generations of subsequently formed dashkesanite crystallized from G solutions, T_H 580-540°C; similar T_H was found for PS inclusions in pyroxenes: 590-550°C, in dashkesanite from the dashkesanite-magnetite ore association G/L inclusions bear dm-halite, T_H 540-470°C (T_D 570-520°C). In large zoned grains of dashkesanite from cavities T_H decreases from 500°C in center to 460°C in the periphery. Lower T limit of dashkesanite crystallization is probably here 460-440°C; simultaneously this is the beginning of crystallization of the quartz-epidote-actinolite post-ore paragenesis, replacing all dashkesanite associations and most widely developed at 420-360°C. Deposits with Ca and Mg skarns, scapolite or hydrosilicate metasomatites as wall rocks are poorer in hastingsite and T is lower. T_H of inclusions in hastingsite-magnetite ores of the Irbin deposit are 430-380°C, epidote-hastingsite-magnetite ores of the Khabalyk deposit-480-360°C, hastingsite-garnet-magnetite ores of the Ampalyk deposit-440-390°C and apatite-hastingsite-magnetite ores of the Abakan deposit-390-420°C. (From the author's abst.)

MAZUROV, M.P., TRET'YAKOV, G.A. and TUMUROVA, Ts.T., 1977, Parameters of the metasomatic ore formation in albite-scapolite-magnetite iron ore deposits (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. I, p. 89-90 (in Russian; translation by A. Kozlowski). Authors at Inst. Geol. Geophys. of the Siberian Branch Acad. Sci. USSR, Novosibirsk.

In the deposits: Tayatskoe, Anzasskoe, Khayleol'skoe etc., the earliest pyroxene-K-spar and pyroxene scapolite rocks formed at 720-580°C; subsequently pyroxene-amphibole-scapolite rocks formed at 560-520°C. The maximum development of Fe ores was in the hastingsiteferroactinolite-magnetite stage (T_H 560-480°C). Post-ore paragenesis crystallized at T_H 450-340°C and lower, together with pyrrhotite-chalcopyrite-pyrite association. By cryometry of inclusions in scapolite of the Tayatskoe deposit is was found that at 620°C salt concentration in inclusion fluid was 44%, and at 380°C-26.3%; P 180-200 atm. (Abst. by A.K.)

MEDENBACH, O. and SCHREYER, W., 1977, Fluid inclusions in the Archean basement of the Vredefort-Dome, South Africa: Fortschritte der Mineralogie, v. 55, pt. 1, p. 93-94 (in German). Authors at Bochum, W. Germany.

See Schreyer et al., 1977, in this volume of Fluid Inclusion Research -- Proceedings of COFFI. (ER)

MELGUNOV, S.V., KULIK, N.A., and BAKUMENKO, I.T., 1975, Mineralogy and geochemistry of metamorphogenic segregative pegmatoids: "Nauka" Publ. House, Novosibirsk, 91 pp (in Russian).

Discusses petrography and chemistry of pegmatoids of two regions, the South-Chuyskiy range (Gornyi Altai), and the Bolshaya Mungun Toyga (S.W. Tuva). Includes some discussion of gaseous inclusions (p. 52-56). (A.K.)

MEL'NIKOV, F.P., 1976, Inclusions of hydrocarbons, petroleum and bitumens in endogenetic minerals, in Thermobarogeochemistry of mineral formation, N.P. Ermakov, ed.: Rostov, Rostov Univ. Press, p. 38-46 (in Russian).

Full paper corresponding to abstract in Fluid Inclusion Research volume 7, p. 139-140, 1974.

MEL'NIKOV, F.P. and SHAPENKO, V.V., 1976, Application of genetic information yielded by inclusions in minerals during prospecting for molybdenum-tungsten deposits in Transbaikalia (abst.): Problems of genetic information in mineralogy (Proceedings of the All-Union Mineralogical Seminar), Syktyvkar, June 1-4, 1976: Syktyvkar, Acad. Sci. USSR, Komi Div., p. 153-154 (in Russian; translation by A. Kozlowski). Authors at the Moscow State Univ., Moscow.

Dzhida and Bom-Gorkhon deposits were studied.

1) Mo-bearing granite-porphyry of the Pervomaiskiy intrusive bears inclusions of metasomatizing fluids in quartz. Higher alkalinity of granitic melt is supported by solidified muscovite inclusions.
2) High quartz of the barren dikes bears decrepitated melt inclusions with aureoles of G/L inclusions; the latter are filled by brines, water solutions and H_2O-CO_2 solutions.
3)(...)
4) Rare-metal ores were formed by $Cl-HCO_3-Na(K)$ hydrotherms, which were sometimes concentrated brines. Crystallization of molybdenum and huebnerite was connected with heterogenization of hydrotherms to form H_2O-salt and H_2O-CO_2 solutions. Fluorites from wolframite-bearing associations bear inclusions of H_2O-CO_2 solutions, whereas fluorites from quartz-molybdenite veinlets don't bear L_{CO_2} in inclusions. (From the authors' abst.)

MEL'NIKOVA, K.M., MESSERMAN, I.Z. and KRYUKOV, V.K., 1977, Physico-chemical conditions of ore formation at one of the gold ore deposits in NE Transbaikalia (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Sib. Branch, v. II, p. 35-36 (in Russian; translation by A. Kozlowski). Authors at the Moscow Geol.-Prospect. Inst.

The deposit belongs to the Au-Mo chain; wall-rocks are Proterozoic, Paleozoic and Mesozoic igneous rocks. Ore bodies form veins and vein zones. Hydrothermal ore formation developed in six stages, characterized in the table.

Stage of mineralization	T_H, °C		
	East side	West side	P, atm
Quartz-molybdenite	420-380	350-330	2000
Quartz-tourmaline	430-340	300-270	900-1000
Gold-quartz-pyrite-arsenopyrite	310-260	290-230	
Gold-quartz-polymetallic	300-230	270-220	950-700
Quartz-antimonite		220-150	
Carbonate-quartz	220-210	180-100	

(From the authors' abst.)

MEL'NIKOVA, L.V., 1976, Stages of mineralization of the gold ore deposit Belaya Gora (Lower Priamy'ye): Genetic types and regularities of distribution of deposits of gold in the Far East (Materials of Conference on Gold Potential of the Amur area and adjacent regions, Blaysveshchensk, May 1971), editor V.G. Moiseenko, Novosibirsk, Siberian Branch of "Nauka" Publishing House, p. 71-78 (in Russian). Author at the Far-East Geol. Inst. of Far-East Center of Acad. Sci. USSR, Vladivostok.

The deposit Belaya Gora is connected with a subvolcanic stock and dikes of feldspathic porphyry cutting a cover of andesite-basalts. Quartz of the pre-commercial gold-adularia-quartz stage has T_D 380-420°C; in solutions HCO_3/Cl=11.9, Na/K=1.8. The subsequent commerical stage yielded the following T_D for individual processes: sericitization 395-300°C, berezitization 300-200°C, pyritization 220-180°C; solutions were of HCO_3/Cl=24.2, Na/K=0.7). Post-commercial quartz and chalcedony (silicification) yielded T_D 240-150°C, and subsequently crystallizing calcite at 160-50°C. Commercial parageneses consist of quartz, gold, pyrite and argentite. (Abst. by A.K.)

MEL'TSER, M.L. and SILICHEV, M.K., 1977, Behavior of gold in hydrothermal process, exemplified by [deposits of] South-Verkhoyanskoe synclinorium (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Sib. Branch, v. II, p. 37-38 (in Russian; translation by A. Kozlowski). First author at Inst. Geol. of Yakutian Division of Siberian Branch of Acad. Sci. USSR.

Possible chemical composition of hydrothermal solutions is presented, using results of water leachate studies of fluid inclusions. Gold migrated as chlorine compounds in low-sulfide formation and as sulfide compounds in syn-granitic formation. (Abst. by A.K.)

MENYAYLOV, I.A., 1977, Volcanic gases at various stages of volcanic activity, in: Hydrothermal process in the areas of tectonic-magmatic activity, p. 126-140, "Nauka" Publ. House, Moscow (in Russian).

MENYAYLOV, I.A., NIKITINA, L.P., SHAPAR', V.N., GUSEVA, R.V., MIKLISHANSKIY, A.Z., KOLOTOV, V.P. and SAVEL'YEV, B.V., 1977, Chemical composition and metal capacity of magmatic gases from the new volcanoes of Tolbachik group in 1976: Akad. Nauk SSSR Doklady, v. 236 no. 2, p. 450-453 (in Russian). First author at the Inst. Volcanology of Far-East Sci. Centre Acad. Sci. USSR, Petropavlovsk-Kamchatskiy.

Components: H_2O, HCl, HF, CO_2, H_2, SO_2, H_2S, N_2, Na, K, O_2, Fe, Al, Br, B, Ca, As, Sb, Mg, Zn, Cu, Ti, Ga, Pt, Pb, Cd, Ni, Mn, Sn, Hf, Rb, Cs, La, Cr, Ag, Co, Ce, Sm, Au, Se, Hg, Eu, Yb, Lu, were determined quantitatively in volcanic gases and condensates. Pertinent to chemical composition of inclusion fluids. (A.K.)

METSON, N.A., and TAYLOR, A.M., 1977, Observations on some Rhodesian emerald occurrences: J. Gemmology, v. 15, no. 8, p. 422-434.

Some solid and liquid inclusions are described. (ER)

METZGER, F.W., KELLY, W.C., NESBITT, B.E., and ESSENE, E.J., 1977, Scanning electron microscopy of daughter minerals in fluid inclusions: Econ. Geol., v. 72, p. 141-152.

The scanning electron microscope (SEM) provides a powerful new tool for the study of daughter minerals in fluid inclusions, particularly when the instrument is equipped with a solid-state X-ray detector. The general character and abundance of inclusions is first established by conventional optical study of polished plates of the host crystal. These plates or other pieces of the same material are cleaned and then opened by chipping or cleaving. Under the SEM, open inclusions appear as pits in the newly broken surfaces. Upon enlargement, daughter crystal morphology is revealed in great detail and the electron beam produces characteristic X-ray spectra of the daughter mineral which are collected by an energy dispersive detector and visually displayed on a multichannel analyzer. The resulting chemical and morphological information, coupled with previous optical observations, defines or greatly limits the possible identity of the daughter mineral.

Three applications of the SEM technique are presented in this paper. The method is first applied to complex inclusions in fluorite of the Emmett mine, Jamestown, Colorado, in which nine previously unidentified daughter minerals were found. Dawsonite [$NaAl(CO_3)(OH)_2$] is confirmed as a daughter precipitate in inclusions in gold-quartz veins of the Oriental mine, Alleghany, California. Finally, the SEM is used to identify daughter minerals in both magmatic and hydrothermal inclusions from the carbonatite at Magnet Cove, Arkansas. (Authors' abstract)

MEYER, H.O. and TSAI, H.M., 1976, Mineral inclusions in diamond: Temperature and pressure of equilibration: Science, v. 191, p. 849-851.

Two distinct suites of minerals included in natural diamond occur and probably represent different physical and chemical conditions during diamond growth. Minerals of the ultramafic suite appear to have equilibrated in the range 1000° to 1300°C between 45 and 65 kilobars, whereas the temperature range for minerals of the eclogitic suite is 850° to 1250°C. At present, models relating the partitioning of magnesium and iron between coexisting phases are not sufficiently rigorous to determine a value for the pressure of equilibration of these eclogitic suite inclusions. (Authors' abstract)

MEYER, P. and SIGURDSSON, H., 1977, Interstitial acid glasses and chlorophaeite in Iceland basalts (abst.): Amer. Geophys. Union, Trans., EOS, v. 58, no. 6, p. 528-529.

The authors show that the chlorophaeite globules appear, from texture and gross composition, to be from liquid immiscibility, but trace element studies (Ba and Zr) preclude this origin. (ER)

MIKHAYLOV, M.Yu., and BAZAROV, L.Sh., 1976, Determination of content of CO_2 and H_2O in inclusions in minerals by means of fractionation on freezing: in Genetic studies in mineralogy, Yu.A. Dolgov et al., eds.: Novosibirsk, Inst. Geol. and Geophy. Sib. Branch Acad. Sci. USSR, p. 125-130 (in Russian).

New method of contemporaneous determination of CO_2 and H_2O was proposed, based on fractionation of previously frozen H_2O and CO_2 in vacuum. H_2O and CO_2 released on crushing of sample is collected in special vessel cooled in liquid nitrogen. Carefully measured volume of vessel is large enough that P in the system always is lower than P in triple point of H_2O. On slow, smooth heating of the vessel, CO_2-rich G sublimes by fractionation at first and P in the system increases. When the last crystal of CO_2 disappears, on a P-T plot an abrupt bend is noted. Having T of this point and using relations between P of saturated vapor of CO_2 and T, weight of the released CO_2 is determined from the Claplyron equation. Determination of H_2O weight is carried by similar way. The paper describes also technical equipment used for construction of the apparatus, unfortunately giving no technical parameters, but only commercial abbreviations of the Russian equipment. Ranges of correct determinations of H_2O are $2x10^{-6}$ to $2x10^{-4}$ g and of CO_2 - $2x10^{-6}$ to $1x10^{-3}$ g, error of determinations 2%. Also the number of opened inclusions during grinding of mineral is discussed. (Abst. by A.K.)

MILTON, D.J., 1977, Methane hydrate in the sea floor -- a significant resource? In The Future Supply of Nature-made Petroleum and Gas Technical Reports, First UNITAR Conference and Second IIASA Conference, 5-16 July 1976, R.F. Meyer, Ed.: New York Pergamon Press, Chapt. 53.

Includes a discussion of the physics and chemistry of gas hydrate formation pertinent to low temperature inclusion studies. (ER)

MIRONOVA, O.F. and NAUMOV, G.B., 1976, Sources of methane and other hydrocarbons during analysis of gas-liquid inclusions (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 170 (in Russian; translation by A. Kozlowski).

On the basis of various methods it was found that thermal opening of inclusions leads to formation of CH_4 etc. from dissociation of organic compounds. (From the authors' abst.)

MIROSHNIKOV, A.Ye., OKHAPKIN, N.A. and PROKHOROV, V.G., 1976, Decrepitation - index of metasomatic alteration (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 136 (in Russian; translation by A. Kozlowski).

Decrepitation of monomineral fractions and bulk samples from Gorevskoe, Tenegimskoe and Krutoe polymetallic deposits (in carbonate rocks) as well as from Lineynoe pyrite-polymetallic deposit (in quartz-sericite schists) proved, that for evaluation of hydrothermal alteration of rocks, the use of bulk samples is sufficient. T_D of non-metasomatized rock are in ranges 100-650°C, and decrepitation is weak, but altered rocks have distinct peaks at 300-500°C. Usually toward ore body activity of decrepitation increases, although exceptions were found. (From the authors' abst.)

MISHINA, N.B. and KHITAROV, D.N., 1976, Relations between aureoles of impregnation and geochemical anomalies of fluorite mineralization (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 134 (in Russian; translation by A. Kozlowski).

In Kazakhstan, a number of fluorite-bearing bodies do not crop out and are marked only by hydrothermal alteration. Thus, aureoles of ore bodies have special significance for prospecting. One of the largest is Eastern Taskaynar deposit at the marginal part of Zhamantiyskaya graben-synclinorium. Ores in contact breccias of limestones and sandstones form a cupola-shape body 400 x 600m. Rocks are silicified, fluoritized, carbonatized, sericitized, chloritized and enriched in metasomatic Fe minerals. (...) Aureoles of hydrothermal impregnation of rocks were studied by decrepitophonic method. These aureoles were found to have a thickness several times exceeding zones of hydrothermal alteration. (Authors' abst.)

MITCHELL, R.S. and GIARDINI, A.A., 1977, Some mineral inclusions from African and Brazilian diamonds: their nature and significance: Amer. Min., v. 62, p. 756-762. First author at Dept. Envir. Sci., Univ. Virginia, Charlottesville, VA 22903.

Totally-enclosed inclusions of barite, biotite + chlorite, chlorite + biotite + garnet, chlorite + calcite, omphacite, pyrrhotite, and pyrrhotite + chalcopyrite from well-crystallized African diamonds, and forsterite, enstatite, and quartz from well-crystallized Brazilian diamonds, have been identified by X-ray diffraction and microchemical analyses. Totally-enclosed included matter known to date is reviewed and interpreted as indicating a broad range in chemical and physical environments during natural diamond formation. The range of included matter is consistent with the Harris-Middlemost evolutionary model for kimberlites, which proposes deep magmatic origin and interaction with country rock and successive fractionations during ascension. (Authors' abstract)

MIYAZAWA, T., 1977, Contact-metasomatic deposits in Japan and Korea, in Problems of Ore Deposition, Fourth Symposium of the International Assoc. on the Genesis of Ore Deposits, Varna, 1974: Sofia, Bulgaria, Bulgarian Acad. of Sci., v. 3, p. 172-183.

A review of literature data on numerous deposits, involving fluid inclusion T_H and T_D determinations, concluding that some of these deposits are very similar to porphyry copper deposits, which, it had been said, do not occur in Japan (ER).

MOGAROVSKIY, V.V., MOROZOV, S.A., FAIZIYEV, A.R., ALIDODOV, B.A., IVAN-SHO, G.A. and GRIGOR'IEVA, E.P., 1976, Chemical composition of hydrotherms in the deposits of the Southern Tian'-Shan' and Pamirs, (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 67-68 (in Russian; translation by A. Kozlowski).

Deposits formed from 450-400 to 200-50°C in stages: 1) from 450-400 to 300°C, and 2) from 300-250 to 50°C (rock crystal, W, Mo, Au and partly Sb and Hg). In some deposits the mineralization formed only during the second stage (fluorite, celestite, main part of Sb and Hg); pressure 800-100 bar. Triple water leachates yielded composition of hydrotherms: Au ore deposits - HCO_3 and $SO_4 > Cl$, Cl increased in the final stage of ore formation, cation composition changed from $(Na + K) > Ca, Mg$ to $Ca, Mg > (Na + K)$; total salts ranged from 100-250 to 3-100 g per l in the post-ore stage.

In solutions from W and Mo deposits $Na>Ca>K>Mg$ and $Cl>HCO_3>SO_4$, with a significant role for SiO (sic; SiO_2? - AK) and minor F, high concentration of bitumens, and $CO_2>H_2>N_2>CH_4$. Total salts 50-200 g per l in ore stage, 15-25 g per l and less in post-ore, pH~7.

Solutions bearing Sb and Hg changed from $HCO_3>Cl>SO_4$ to $SO_4>Cl>HCO_3$, with almost stable content of F and from $(Na + K) > Ca, Mg$ to $Ca, Mg > (Na + K)$; H_2, N_2, CO_2, He, O_2 were present, with H_2 or $N_2>CO_2$(+He), and some increase in the latter (i.e., CO_2?) during ore stage. Total salt concentration is up to 150 g per l, pH from weakly alkaline to weakly acid.

Solutions from fluorite deposits have high HCO_3 concentration; Cl and SO_4 vary strongly, depending on type of deposit. Essentially fluorite and sulfide-fluorite deposits have $Cl>SO_4$, optical fluorite $SO_4=Cl$, fluorite at Hg and Sb deposit $SO_4>Cl$. F content is approximately the same for all the types of deposits; $Ca > (Na + K) > Mg$.

For rock crystal $Cl>HCO_3>SO_4$, with significant amount of SiO_2, $(Na + K) > Ca, Mg$, and at the end of the process $Ca, Mg > (K + Na)$; H_2, N_2, CO_2, O_2(H_2, N_2 usually prevail) were found. Total salt concentration from 200-300 g per l at the beginning of crystallization to 4-40 g per l at the end. Celestite deposits, with stable $Ca(Sr) > Na>K$, differ in anion ratios: $SO_4>Cl>HCO_3$, $Cl>SO_4>HCO_3$, pH weakly acid. Bitumens are typical for celestite deposits. Most of the celestite deposits have decreasing K, Na content from the beginning to the end of ore process and Ca, Mg, HCO_3 and SO_4 - increase . (Authors' abst.)

MOISEENKO, V.G., Ed., 1976a, Genetic types and regularities of distribution of deposits of gold of the (Soviet) Far East: Novosibirsk, "Nauka" Press, Siberian Branch, 121 pp. (in Russian).

Consists of 19 papers by individual authors, five of which bear fluid inclusion data (pp. 3, 45, 64, 71, and 78). (A.K.)

MOISEENKO, V.G., 1976b, Conditions of formation of gold-ore deposits of the Southern part of (Soviet) Far East: Genetic types and regularities of distribution of deposits of gold in the Far East, (Materials of Conference on Gold Potential of the Amur area and adjacent regions, Blagoveshchensk, May 1971), editor V.G. Moiseenko: Novosibirsk, Siberian Branch of "Nauka" Publishing House, p. 3-19 (in Russian). Author at the Far-East Geol. Inst. of Far-East Sci. Center of Acad. Sci. USSR, Vladivostok.

Most gold deposits in the Soviet Far East occur in two ore belts: Mongolo-Okhotskiy (W-E) and Coastal (N-S) along the Pacific shoreline.

Two essential zones were distinguished in the Mongolo-Okhotskiy belt: northern Stanovaya and southern Main (Priamutskaya). The studied deposits occur in the Main Zone. Deposits formed in the crossings of meridional with parallel and diagonal faults. T_H of G/L inclusions in the Tokurskoe deposit are as follows: 1) metasomatic quartzites 350-250°C, 2) low-gold quartz veins with arsenopyrite and pyrite 350-200°C, 3) gold-quartz veins 250-180°C, 4) late quartz-carbonate veins 140-90°C. Inclusions are of G, G/L and L/G types. Hydrothermal solutions of the commerical stage differ from pre-ore solutions in high content of alkalies (to 84% of total cations), high Na/Na+K ratio (0.75) and high concentrations of Cl. Post-ore solutions are of HCO_3-Ca type.

Chemical composition of inclusions in quartz from the gold ore deposits, in g per 1000 g H_2O

Component	Tokurskoe deposit			Kirovskoe deposit commerical stages:			Commercial stages of deposit		
	Pre-ore stage	Commercial stage	Post-ore stage	tournaline magnetite	bismuthinite	galena-sphalerite	Bukhtyanka	Belaya Gora	Soyuznoe
Na	22.953	15.382	0.117	56.289	33.224	15.084	27.696	13.817	3.415
K	54.664	8.976	3.976	25.240	13.290	16.854	20.059	13.055	2.409
NH_4	—	0.033	—	3.380	0.792	—	—	—	—
Mg	9.925	0.884	2.166	—	—	7.584	—	—	1.784
Ca	46.191	1.960	28.532	17.035	2.955	5.478	—	2.723	—
Total Cations	133.733	27.235	34.891	102.004	50.261	45.000	47.755	29.595	7.628
HCO_3	188.173	40.425	74.461	50.330	42.021	110.520	84.875	55.158	14.286
Cl	13.705	6.922	6.610	120.248	48.622	10.534	4.992	2.698	3.123
Total S	60.374	10.951	—	14.587	—	21.910	—	—	—
Total Anions	263.778	58.296	81.071	185.165	96.643	142.964	89.867	57.965*	17.409
CO_2	417.5	59.92	389.6	214.98	182.3	262.0	444.45	165.22	5.06
CH_4	6.14	1.87	7.25	2.39	1.93	1.26	0.1	1.31	0.78
N_2	14.90	5.30	45.0	18.55	9.02	10.7	0.2	3.20	2.11
H_2O, wt.%	0.055	0.194	0.059	0.068	0.087	0.071	0.054	0.181	0.134
pH	7.49	7.35	6.36	7.21	6.91	6.35	6.27	6.63	6.36
Eh, V	-0.777	-0.726	-0.238	-0.746	-0.654	-0.549	-0.494	-0.548	-0.525
$\frac{Na}{Na+K}\cdot 100$	41.65	74.50	4.67	—	—	—	70.14	64.28	70.62
No. of analyses	2	5							

*includes 0.109g F per 1000g H_2O
Boron was not found.

Kharginskoe deposit was formed in four stages with respective T_H: 1) low-gold metasomatic quartzites 400-260°C, 2) low-gold quartz-feldspar veins 350-230°C, 3) commerical gold-quartz veins 250-180°C, 4) post-commercial quartz-carbonate veins 150-90°C; Na/Na+K for commercial stage 0.8.

Water leachates from vein quartz from the Berikul'skoe gold-ore deposit yielded following composition of fluid inclusions (mg/l of water leachate, prepared from 2g of quartz in 50 ml of water):

Association	Na	K	Ca	Mg	Cl	HCO_3	Total mineraliz.	No. of analyses
White quartz	1.84	0.54	43.7	2.3	3.1	144.8	196.4	5
Pytthotite-pyrite	1.0	0.9	46.9	2.0	2.1	176.9	223.0	3
Quartz-pyrite-arsenopyrite	2.3	0.8	6.9	1.8	6.3	23.5	44.2	7
Commerical	2.3	0.7	7.3	1.8	6.2	27.1	45.3	11
Carbonate	6.0	1.0	21.5	2.2	1.8	114.0	147.0	2

G/L inclusions in early quartz have T_H >400 to 315°C, salt concentration <10 wt.%. Subsequent generation of quartz with pyrite and arsenopyrite (380-240°C) bears sylvite or halite dms, salt concentration 20-25 wt.%. Quartz finishing this generation (290-240°C) crystallized from more dilute solutions, ≤∿15 wt.%. Carbonate-sulfide commercial generation (220-140°C) initially also formed from concentrated solutions, ∿30wt.% (inclusions bear cubic dms), then became diluted. Last, carbonate stage, formed from cool solutions (122-70°C). Gold concentration in the solutions filling inclusions are as follows (mg/ℓ): early quartz-0.05, quartz + pyrite + arsenopyrite 0.4, commercial -1650(sic.), 14.12, 2.79, 2.44 and 0.74, carbonate -0.0n to 0.n. G composition changes also from early to late associations (in vol.%, analysis of individual inclusions):

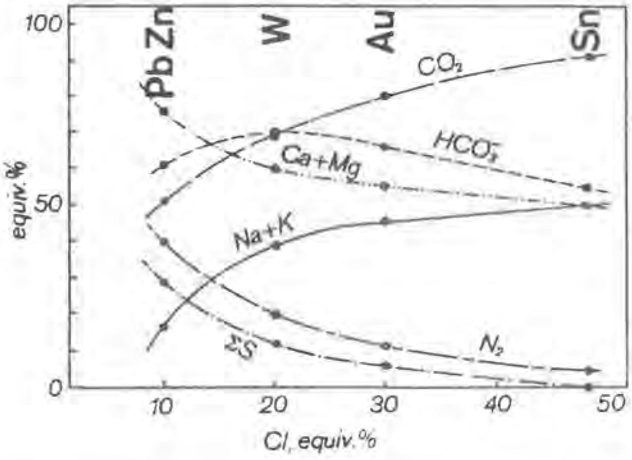
Association	Increase of V of bubble	H_2S, SO_2, SO_3 HCl, HF, NH_3	CO_2	O_2	H_2	N_2 + rare G
White quartz	very large	0.0- 7.2	33.3-59.7	0.0	0.0	33.1-66.6
Quartz-pyrite-arsenopyrite	very large, 28.9 -575	2.2-17.0	51.0-85.0	0.0	0.0-7.6	12.8-44.9
Commercial	6.61-110.0	3.6- 9.4	33.2-60.6	0.0-13.0	0.0	28.5-47.4
Carbonate	4.65- 6.57	0.0- 4.8	39.0-45.4	9.9-12.5	0.0	39.9-48.5

CO and hydrocarbons were not found. (Abst. by A.K.)

MOISEENKO, V.G., FAY'YANOV, I.I. and MALAKHOV, V.V., 1977, Evolution of the hydrothermal systems during forming of the endogene deposits of the Circumpacific Belt (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. I, p. 19-20 (in Russian; translation by A. Kozlowski). Authors at the Far-East Geol. Inst. of the Far-East Sci. Center of the Acad. Sci. USSR, Vladivostok, USSR.

P-T conditions of formation of the endogene deposits of the Circumpacific Belt were strongly variable as indicated by fluid inclusion data. Commercial associations of minerals precipitated in narrow ranges of T from typical hydrotherms of each genetic group of the deposits: Zn-Pb from alkaline earth-HCO_3 type, W--from alkaline-alkaline earth-HCO_3 type, Au--from alkaline-Cl-HCO_3 type. Hydrotherms also contained gases: CO_2, CO, CH_4, H_2, N_2. Post-magmatic fluids of volcanites of the island arcs were rich in sulfur compounds; volcanites of the marginal and continental belts developed hydrotherms poor in S and rich in Cl. The evolution of hydrothermal solutions is presented in figure (water leachate data). (Abst. by A.K.)

Figure: The course of changes in the composition of hydrothermal solutions during formation of the endogene deposits of the Pacific belt.



MOISEENKO, V.G., SAKHNO, V.G. and MALAKHOV, V.V., 1976, Role of deep-formed fluids in evolution of magmatism and mineralization of the Pacific belt (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 123-124 (in Russian; translation by

A. Kozlowski).

Volcanic and ore-forming activity of the Soviet Far East were studied. G composition was determined by G chromatography, Cl and F by ion-selective electrodes, other components by atomic absorption spectrometry. In lavas a correlation was found between ratio of oxidized to reduced gases and K/Na ratio. (...) In subsurface deposits, where Au and Ag associate with K, oxidized plus weakly reduced compounds of carbon (CO_2+CO? - A.K.) prevail in G phase of inclusions; in internal zones, where Au associates with Na, similar regularities in composition of G phase were not observed. Evolution of magma depends either on possibility of appearance of G phase (CO_2, Cl and other hardly soluble gases), or on possibility of linking volatiles in silicates and alumosilicates (F,B etc.). Activity of Cl sharply increases in post-magmatic processes, causing extraction and transport of ore components with fluids. (...) (From the authors' abst.)

MOLCHANOV, V.P., 1976, Conditions of formation of one of the gold ore deposits of the Eastern Yakutia (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 186 (in Russian; translation by A. Kozlowski).

Inclusions in minerals of the gold-quartz low-sulfide formation were studied by the water leachate and gas chromatography methods. K,Na,Ca,Mg,F,B, total S, Cl, & HCO_3 were found. Solutions in metasomatic quartz are of alkaline - alkaline earth - HCO_3 type. In the commercial stage (310-180°C) hydrotherms become of the alkaline - HCO_3 type. The higher the percentage of Na in total alkalies, the higher the percentage of pure gold in the native gold. During quartz-carbonate stage hydrotherms are essentially of CO_2 composition. Gases consist of CO_2, CO, CH_4, N_2, and H_2. In the pre-ore stage, H_2 and CO are present, but they disappear in the commercial stage. On the basis of equilibria in the C-O-H system the conditions in the early stage may be considered to be more reducing. (Author's abst.)

MOORE, A.E. and ERLANK, A.J., 1977, Olivine compositional complexity in olivine melilitites from Namaqualand, South Africa, and its bearing on kimberlite genesis, in Second International Kimberlite Conference 1977, Extended Abstracts (unpaginated).

A microprobe investigation of the olivines in a suite of olivine melilitites from Namaqualand, Soth Africa (previously described by Moore, 1973) reveals a complex and unusual pattern of chemical variation. Petrographic and chemical criteria make it possible to distinguish three distinct olivine sub-populations in this and other samples studied, of which the dominant one (95% of all olivines) population of euhedral (and sometimes skeletal) olivines will be termed "hoppers" as they bear a striking resemblance to the growth forms described by Donaldson (1976), with sharply defined crystal edges and corners in contrast to the rounding that would be expected from resorption processes. Some of the olivines enclose groundmass minerals that have apparently crystallized from trapped liquids, which would seem most likely to have been included during rapid crystal growth. Hopper morphology is best developed in the Mg-poor volcanics, possibly reflecting compositional control on growth forms. The interiors of the hoppers define a compositional trend of decreasing Mg/Fe with decreasing Ni, while the olivine margins are characterized by a narrow (100μm) rind that shows continued Ni depletion, but strong reversed zoning with respect to Mg/Fe together with marked Ca-enrichment. The margin compositions correspond to those of late-crystallizing olivine microphenocrysts, and apparently reflect equilibration of the hopper margin in response to late-stage changes in the magma composition or conditions of crystallization. (From the authors' abstract)

MOORE, J.G., BATCHELDER, J.N., and CUNNINGHAM, C.G., 1977a, CO_2-filled vesicles in mid-ocean basalt: J. Volcanol. Geotherm. Res., v. 2, p. 309-327. First author at U.S. Geological Survey, Menlo Park, CA 94025.

Volatile-filled vesicles are present in minor amounts in all samples of mid-ocean basalt yet collected (and presumably erupted) down to depths of 4.8 km. When such vesicles are pierced in liquid under standard conditions, the volume expansion of the gas is 0.2 ± 0.05 times the eruption pressure in bars or 20 ± 5 times the eruption depth in km. Such expansion could be used as a measure of eruption depth.

A variety of techniques: (1) vacuum crushing and gas chromatographic, freezing separation, and mass spectrographic analyses; (2) measurements of phase changes on a freezing microscope stage; (3) microscopic chemical and solubility observations; and (4) volume change measurements, all indicate that CO_2 comprises more than 95% by volume of the vesicle gas in several submarine basalt samples from the Atlantic and Pacific. The CO_2 held in vesicles is present in quantities about equal to or greater than that presumed to be dissolved in the glass (melt) and amounts to 400-900 ppm of the rock. The rigid temperature of the glass is 800-1000°C and increases for shallower samples. A sulfur gas was originally present in subordinate amounts in the vesicles, but has largely reacted with iron in the vesicle walls to produce sulfide spherules. (Authors' abstract)

MOORE, J.G., BATCHELDER, J.N., and CUNNINGHAM, C.G., 1977b Carbon dioxide in vesicles of mid-ocean ridge basalt (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 1100-1101. (See preceding abstract)

MOROZOV, S.A., and GRIGOR'YEVA, E.P., 1976, Chemical composition of hydrotherms forming gold ore deposits of central Tadzhikistan (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 186-187 (in Russian; translation by A. Kozlowski).

1. Quartz precipitates before gold, arsenopyrite with it, and calcite after it.

2. Water leachates from quartz have a $Cl-SO_4-HCO_3$ composition. K and Na are the main cations, frequently with K > Na; sometimes Ca, Mg, BO_3, Br, and NO_2 (sic, A.K.) display a significant role. In the dried residues of water leachates As, Cu, F, Mo, Pb, Zn, Al, W, Mn, Si, and Ba were found. Total salts in inclusions range from 50 to 200 g/l, usually not more than 150 g/l. Leachates from arsenopyrite show high concentrations (100 - 250 g/l) and they have a $HCO_3-SO_4-Ca-Mg$ composition. In several samples higher amounts of Na, Cl, B, Br, K and I. were found; dried residues consist of As, Fe, Cu, Al, Si, Ti, Ni, Ca, Ag, Au, Sn, and Ba. Water leachates from late calcite contain extremely variable ratios of components: most often Na and Ca prevail,

K and Mg are important, NH_4, Br, I, and H_2S are characteristic. Anions are present in approximately equal amounts. In the dried residues there are present Si, Al, Ti, Mn, Cu, Sr, and Ba. Total salts vary from 2.7 to 100 g/l.

3. In the early stages solutions were of $Cl-SO_4-HCO_3$ type, with Na > Ca > Mg and in the sulfide commercial stages -- SO_4-HCO_3 with Mg and Ca. (Authors' abst.)

MOTORINA, I.V., 1976, Conditions of crystallization of allochthonous granites of plutons (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 107-108 (in Russian; translation by A. Kozlowski).

1. Khamnigadayskiy pluton (Buryatia) is an isometric body formed in one intrusive act and consists of leucocratic medium-grained granites. T_H of melt inclusions in quartz is 950-920°C, in granite-porphyries of zone adjacent to contact — 990-880°C, but in quartz of the main mass of rocks, rare inclusions with T_H 790-750°C were found.

2. Dungalinskiy massif (Kalba) formed in several phases. Main phase is coarse-grained, porphyric biotite granite. Late intrusive phases formed medium-grained porphyritic biotite granite and fine-grained granite (T_H of melt inclusions in quartz 700-660°C).

3. Tigerekskiy massif (Altai) consists of leucocratic medium-grained biotite granite. In boreholes, decrease of T_H of melt inclusions in quartz was found from 850-820°C at depth 1100m to 820-700°C at surface. (Author's abst.)

MOTTL, M.J. and SEYFRIED, W.E., 1977, Experimental basalt-seawater interaction: rock- vs. seawater-dominated systems and the origin of submarine hydrothermal deposits (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 1104.

MUENOW, D., DELANEY, J.R., MEIJER, A., and LIU, N., 1977, Water-rich glass-vapor inclusions in phenocrysts from tholeiitic pillow basalt rims in the Marianas Back Arc Basin (abst.): Amer. Geophys. Union, Trans., EOS, v. 58, no. 6, p. 530.

Fresh glassy rims of four tholeiitic pillow basalts from the Marianas Back Arc Basin (dredge depths 2500-3800 m) contain between 1.5 and 2.5 wt. % H_2O, about 0.1 wt. % CO_2, and about 0.05 to 0.13 wt. % sulfur. Glass-vapor inclusions in phenocrysts quenched in the same glassy rims exhibit $H_2O:CO_2:SiO_2$ ratios of 2.7:1.0:1.0. The presence of abundant water in the inclusions is in sharp contrast to otherwise identical glass inclusions in tholeiitic basalts from open ocean basins which are virtually anhydrous. At the depth of quenching, the matrix glass surrounding the phenocrysts was saturated with respect to the total volatile content and water was a major component of this vapor phase. These data permit, but do not require, water to be a major component in petrogenetic models for these basalts. (Authors' abstract)

MUENOW, D.W., GRAHAM, D.G., LIU, N.W.K. and DELANEY, J.R., 1977, Anhydrous glass-vapor inclusions in phenocrysts from Hawaiian tholeiitic pillow basalts (abst.): Amer. Geophys. Union Trans., EOS, v. 58, p. 1250.

High temperature mass spectrometric studies have been made to determine the distribution of volatiles within glassy rims of submarine pillow basalts from the east rift zone of Kilauea Volcano, Hawaii. The CO_2:H_2O mole-ratio for inclusions within olivine phenocrysts is greater than 30:1 compared to 0.06 for matrix glasses. Enclosing matrix glasses contain 0.53-0.74 wt.% H_2O, 0.02-0.04 wt.% carbon and 0.08-0.12 wt.% sulfur. These data and previously observed anhydrous phenocrysts from glassy rims of Mid-Atlantic Ridge basalts suggest that significant amounts of water enter magma moving through the earth's hydrous crust and that few magmas arrive at the surface without an uncontaminated water complement. (Authors' abstract)

MUKHIN, A.M. and PONOMAREV, V.V., 1977, Synthesis and evolution of organic substance in volcanoes and hydrotherms, in: Hydrothermal process in the areas of tectonic-magmatic activity, p. 104-110, "Nauka" Publ. House, Moscow (in Russian).

MULLIS, Josef, 1976a, The quartz crystals of Val d'Illiez-Indicators of late-Alpine movement: Eclogae geol. Helv., v. 69, no. 2, p. 343-357 (in German). Author at Inst. Mineral. und Petro. der Univ, CH-1700 Frieburg, W. Germany.

Quartz crystals from Val d'Illiez comprise prismatic individuals, prismatic quartzes with a white stripe, sceptres and skeletal forms (Porretta Type). These different habits have been collected from Alpine clefts in Parautochthonous Val d'Illiez Flysch. Crystal growth (4 generations) and contemporaneous fluid inclusions are closely related to the tectonic evolution of the Alpine clefts. Crystal morphology reflects even small tectonic movements of Alpine clefts, and fluid inclusions record quite precisely the original composition of solutions in the clefts. Fluid inclusions have been analyzed by gas-chromatography and microthermometry. Minimum pressures and temperatures of formation for the different growth generations of quartz have been calculated using PTX-diagrams for H_2O, H_2O-NaCl and CH_4.

Starting conditions (P, T) for growth of prismatic quartz with a white stripe (T: 249 ± 3°C; P: 1530 ± 165 bars) coincide with the stability field of alumontite which has been found in this region. Between the beginning of quartz growth and the end of the second generation of growth, pressure rose about 300 bars; this could be the result of buildup of tangential stress. Each time that the limit of rupture was exceeded, an important pressure decrease in the cleft resulted (70-1200 bars); thus opening and enlarging processes were a consequence of tectonic events. (Author's abstract)

MULLIS, Josef, 1976b, The growth environment of quartz crystals from Val d'Illiez, Wallis, Switzerland: Schweiz. mineral. petrogr. Mitt., v. 56, p. 219-268 (in German). Author at Inst. Mineral. und Petro. Univ., CH-1700 Freiburg, W. Germany.

Alpine cleft quartz crystals generally grew from aqueous (hydrothermal) solutions. Inclusion studies have shown that quartz with a white stripe, sceptres and skeletal quartz crystals from Val d'Illiez (Western Switzerland) have grown in a methane-rich and a water-rich phase.

Mother liquor composition changed several times, concomitantly with crystal lattice contamination and variation of both crystal growth rate and crystal morphology.

We deduce 1) rapid growth of sceptres and skeletal quartz in a methane-rich environment; 2) less rapid growth of quartz with a white stripe in a methane- and a water-rich environment; and 3) slow growth of prismatic quartz in a water-rich environment.

The more rapid growth of quartz with a white stripe, sceptres and skeletal quartz, marks the start of a generation, whereas the slower growth of prismatic quartz marks the end. In Val d'Illiez alpine clefts grew four generations of quartz.

The lack of continuity of quartz growth may be explained by the periodic opening of the clefts, which occurred towards the end of the Alpine orogeny. Pressure drop in the clefts took place after a rapid increase of cleft volume. Methane diffused into the cavities more rapidly than water, and the equilibrium between the growing crystal and the solution was disturbed; sceptres and skeletal quartz then grew rapidly. Water compensated the pressure drop by filling the cavities and thus created new equilibrium conditions which allowed the growth of prismatic quartz.

Val d'Illiez quartz crystals are favourable for fluid inclusion studies. The methane and methane-water systems are shown to be applicable as a geological barometer. (Author's abstract)

MUNOZ, J.L. and LUDINGTON, S., 1977, Fluorine-hydroxyl exchange in synthetic muscovite and its application to muscovite-biotite assemblages: Amer. Miner., v. 62, p. 304-308.

MUSIN, R.A., MORGENSHTERN, L.Ye., and BARKHUDAROV, V.A., 1977, Thermometric parameters of some ore-bearing metasomatites of the Middle and Southern Tyan'-Shan (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Sib. Branch, v. II, p. 127-128 (in Russian; translation by A. Kozlowski). First author at Inst. Geol. Geophys. of Acad. Sci. Uzbek SSR.

By means of homogenization and in part, decrepitation of inclusions in garnet, calcite, quartz, ankerite, wollastonite, epidote, barite, fluorite, sphalerite, hydromuscovite, pyrite and antimonite, T were measured for various ore-bearing deposits, listed in the table:

Metasomatites	Range of T,°C		Ore mineralization
Skarns	550-358	Kuramin chain, Chadak region	Barren
Propylites	380-225	Do.	Rare Au
Berezites	220-160	Do.	Au
Propylites	300-180	Kuramin chain Almalyk region	Rare Au
Berezites	260-160	Do.	Au
Skarns	600-300	Alay chain, Abshir region	Pyrrhotite
Propylites	375-210	Do.	Rare fluorite and cinnabar
Berezites	260-100	Do.	Sb, fluorite, rare admixture of Au
Argillites	225- 90	Do.	Do., but scarce

(From the authors' abst.)

MYAZ', N.I., POPIVNYAK, I.V., LAZ'KO, Ye.Ye. and KHAR'KIV, A.D., 1976, On classification of inclusions in minerals of kimberlites (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad Sci. USSR, Inst. of Geol., p. 127 (in Russian; translation by A. Kozlowski).

Inclusions were studied in olivines and garnets from kimberlite pipes "Obnazhonnaya", "Aykhal", "Udachnaya" and "Vostochnaya". Each mineral bears its own typical inclusions, and there are inclusions typical for both minerals. Various fractures in the same mineral may bear either only crystallized or only glass inclusions. Often inclusions of the same composition, T_H, etc. are S in one mineral, whereas in another mineral they are PS. Great variability of morphology and genesis of inclusions was seen. (Authors' abst.).

MYAZ', N.I., and SIMKIV, Zh.A., 1976, Peculiarities of the bulk analysis of inclusions in cinnabar (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 179 (in Russian; translation by A. Kozlowski).

One, two, and multiple water leachates were made under various conditions. Cinnabar from the Transcarpathians is characterized by inclusions bearing HCO_3-Mg-Ca solutions, pH of leachate 5.36; that from the Levo-Sakindzhinskiy ore field - HCO_3-Ca solutions, pH of leachate 6.28-7.05; that from the Chauvay deposit was similar but had pH 6.34-5.62. Solutions have high amounts of salts, mainly HCO_3 and Ca, regardless of the region. Detailed data may be obtained only by studies of leachates from clean crystals of cinnabar. Such crystals from the Chauvay deposit (triple leachate) gave a F-Ca-Na composition of weakly mineralized solutions with Na/K=2, Na/Ca=1, without HCO_3; prevalence of F six times (over what?-A.K.); pH of leachates 4.87-5.08. (Authors' abst.)

MYSEN, B.O., 1977a, The solubility of H_2O and CO_2 under predicted magma genesis conditions and some petrological and geophysical implications: Reviews of Geophysics and Space Physics, v. 15, no. 3, p. 351-361. Author at Geophy. Lab., Carn. Inst. Wash., Washington, DC 20008.

Available data on the solubility of H_2O and CO_2 in silicate melts at high pressures and temperatures reveal that (1) the solubility of H_2O is several times greater than that of CO_2 and (2) the solubility of H_2O depends strongly on pressure and, compared to that of CO_2, depends only to a small extent on temperature. It has been suggested that the species in silicate melts can be chosen so that the molar solubility of H_2O may not depend on the bulk composition of the melt. The solubility of CO_2, on the other hand, varies significantly with pressure, temperature, and bulk composition of the melt. Solution of volatiles at high pressure affects the structure of the silicate melts. Water depolymerizes the melt, the result being lowered viscosity. The same depolymerization is manifested in the enhanced stability of silicate minerals on the liquidus, which are less polymerized than the minerals precipitating from the same melt composition at the same pressure under volatile-free conditions. Carbon dioxide, on the other hand, enhances polymerization of the melt, the result being increased viscosity and increased stability of liquidus minerals which are more polymerized than those that would precipitate under volatile-free conditions.

Because of the large difference in the solubilities of CO_2 and H_2O in silicate melts, partial melting of an $(H_2O + CO_2)$-bearing mantle results in enrichment of H_2O in the liquid, whereas the residual mantle becomes enriched in CO_2. At $P \lesssim 20$ kb the CO_2 may be retained in a vapor phase. At higher pressures, carbonate is likely to be the stable phase. Therefore it would be expected that as the result of partial melting throughout geological history the upper mantle would be heterogeneous with respect to vapor components. (Author's abstract)

MYSEN, B.O., 1977b, Solubility of volatiles in silicate melts under the pressure and temperature conditions of partial melting in the upper mantle: in Magma Genesis; Proceedings of the American Geophysical Union Chapman Conference on Partial Melting in the Earth's Upper Mantle, Oreg. Dep. Geol. Miner. Ind. Bull. 96, p. 1-14.

Similar to previous abstract. (ER)

NABOKO, S.I., and SUGROBOV, V.M. (eds.), 1977, Hydrothermal process in the areas of tectonic-magmatic activity: Moscow, "Nauka" Publ. House, 263 pp (in Russian).

Consists of 30 individual papers, in three parts:

Part I - Heat flow and hydrothermal activity, p. 3-103

Part II - Geochemical and mineral-forming role of hydrotherms, p. 104-202

Part III - Hydrothermal processes and problems of structural controls of ore formation. (AK)

NAGANO, Ken-ichi, TAKENOUCHI, Sukune, IMAI, Hideki, and SHOJI, Tetsuya, 1977, Fluid inclusion study of the Mamut porphyry copper deposit, Sabah, Malaysia: Mining Geology, (Japan), v. 27, p. 201-212. First author at Nippon Steel Corp.

The fluid inclusion study of the Mamut porphyry copper deposit, Sabah, Malaysia was carried out as part of studies of the ore-forming fluids and mineralization of porphyry copper deposits from the Southwestern Pacific island arcs. Polyphase fluid inclusions which contain halite, sylvite, hematite, anisotropic unidentified minerals, and opaque minerals, are observed abundantly in the vein quartz. Gaseous inclusions are also abundant, but liquid inclusions are few. It is inferred from the disappearance temperature of halite that the salinity of fluid would have been in a range between 35 to 55 wt.% NaCl equivalent concentration. The homogenization temperature of polyphase inclusion ranges from 300° to 480°C, whereas that of liquid inclusions is between 280° and 325°C. The "boiling" of the fluid is manifested by an intimate coexistence of gaseous and polyphase inclusions in some samples. The numeral ratio of polyphase inclusions to the total number of inclusions becomes higher in the ore-shell or biotite zone, and at lower levels of the orebody. A low value of the ratio from the core of the orebody is attributable to the abundance of gaseous inclusions. An intimate relation between the abundance of chalcopyrite in sulfide minerals and polyphase inclusions suggests an important role of highly saline fluids in the copper mineralization. It is concluded that the ore-forming fluids at the Mamut porphyry copper deposit were rich in non-volatile materials including chlorides and that the pressure of the fluids was low enough to emanate the vapor phase. Such characteristics of fluids at the Mamut deposit are similar to those of the porphyry copper deposits in the southwestern United States. (Authors' abstract)

NAMBU, Masateru, SATO, Toshio, HAYAKAWA, Norihisa, and OHMORI, Yasuo, 1977, On the microanalysis of fluid inclusions with the ion microanalyzer (abst.): Mining Geology (Japan), v. 27, p. 40 (in Japanese; see translations).

NASLUND, H.R. and WATSON, E.B., 1977, The effect of pressure on liquid immiscibility in the system K_2O-FeO-Al_2O_3-SiO_2-CO_2 (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 1110.

NAUMOV, G.B., 1976, Utilization of gaseous-liquid inclusion analyses and thermodynamic calculations to characterize the ore-forming fluids, in Thermobarogeochemistry of mineral formation, N.P. Ermakov, ed.: Rostov, Rostov Univ. Press, p. 46-54 (in Russian).

Full paper corresponding to abstract in Fluid Inclusion Research volume, 6, p. 110, 1973.

NAUMOV, G.B. and NAUMOV, V.B., 1977, Influence of temperatures and pressures on the acidity of endogenic solutions and the stages of ore formation: Geol. Rud. Mest., 1977, no. 1, p. 13-23 (in Russian).

NAUMOV, G.B., SALAZKIN, A.N., MOTORINA, Z.M. and NIKITINA, A.A., 1977, Composition and features of ore-forming fluids from hydrothermal deposits of E. Transbaikalia: (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. II, p. 84 (in Russian; translation by A. Kozlowski). Authors at GEOKHI, Acad. Sci. U.S.S.R., Moscow.

Both from literature data and the authors' studies, essential regularities of conditions of formation of the rare metal, polymetallic and fluorite deposits in E. Transbaikalia were established. Mo deposits are the highest-T (450-400°C), and fluorite deposits had the lowest T of origin (230-100°C). High content of CO_2 in inclusions is typical. P usually exceeds lithostatic P of overlying rocks, and abrupt P changes are common, being usually associated with heterogeneisation of fluids. Klikchinskoe ore field differs from the others in highest T and presence of greisen, pegmatitic and skarn bodies. (From the authors' abst.)

NAUMOV, V.B., ANDRUSENKO, N.I., POGODIN, Yu.V. and KUZNETSOV, V.A., 1976, Thermometric study of gas-liquid inclusions in synthetic crystals of calcite and sphalerite, in Synthesis of minerals and methods of their investigation, editors V.P. Butusov and L.N. Khetchikov: Moscow, "Nedra" Publ. House, p. 82-84 (in Russian).

T_H in synthetic calcite and sphalerite were determined in a heating stage of Kalynzhnyi's construction. All T_H < T of growth; for P 300-350 kg/cm^2 the difference was 15-17°C, for 1200 kg/cm^2--95°C etc. T_H for H_2O was calculated for each run by using PTV plots for pure water to obtain the specific volume for the T and P of that run. Hence T_H was found on the two-phase equilibrium line of pure water with this specific volume. T_H of water-salt solutions trapped in fluid inclusions are almost always higher than that calculated T_H for pure water. Corrections for T_H of salt-water systems differ only slightly from corrections for pure water, thus for weakly concentrated water solutions in the first approximation, PVT plots for pure water may be applied.

If T was the same in various runs, but P was different, e.g., at T 400° P 600-640 and 1200 kg/cm^2, T_H was 358-365 and 305°C, respectively, i.e., lower P is connected with higher T_H.

If in natural crystals T_H of inclusions in an external zone is greater than T_H in internal zones (e.g., over 30°C), usually one may conclude that T of growth increased over this T interval. But such T increase also may appear as a result of P decrease. Hence run No. 2 is interesting (Table 19). T of growth was constant (520°C), but due to leakage of autoclave P decreased from 1200 to 600 kg/cm^2. This influenced T_H, increasing from 425 to 485°C, with all intermediate values. (Abst. by A.K.)

Table 18. Results of thermometric studies of inclusions in crystals of synthetic calcite

Run No.	P,kg/cm^2	T, °C	$T_H(H_2O)$	T_H(solution)	Number of inclusions studied	$T-T_H$, °C
1	75	290	290	288	8	+ 2
2	280	280	261	266	27	+14
3	300	263	243	247	6	+16
4	340	265	243	248	42	+17
5	340	275	253	256	2	+19
6	350	272	249	255	48	+17
7	360	290	266	273	25	+17
8	410	232	206	208	95	+24
9	650	285	240	243	16	+42
10	650	290	245	252	17	+38
11	650	295	250	254	4	+41
12	650	300	254	263	16	+37

NOTE: P and T--values for growth of calcite, $T_H(H_2O)$--calculated T_H for pure water, T_H--measured for inclusions.

Table 19. Results of thermometric studies of inclusions in crystals of synthetic sphalerite

Run No.	P,kg/cm^2	T, °C	$T_H(H_2O)$	T_H(solution)	$T-T_H$	Concentration of solution, %
1	600-640	400	340-336	365-358	+(35-42)	40
2	1200→600	520	355inL→ →371inG	425→ →485	+(95→35)	36
3	1200	400	295	305	+ 95	7
4	1500	395	274	288	+107	10
5	1600	430	303	310	+140	7

NOTE: explanation as for Table 18.

NAUMOV, V.B. and CHKHARTISHVILI, T.A., 1976, Inclusions of melt in quartz from Kelasur massif (Caucasus)(abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 109 (in Russian; translation by A. Kozlowski).

Block quartz from aphite-orthotectites in the region of Great Skhapach Mt. bears P melt inclusions with anisotropic dms. At 650-670°C some dms begin to melt after 0.5-1 hour run, at 700-710°C inclusions bear melt and G, T_H 780-760°C, and rarely 800°C in 1 hour runs. Aplite-orthotectites crystallized thus at T>740°C. (Authors' abst.)

NAUMOV, V.B. and FIN'KO, V.I., 1976a, Inclusions of melt in phenocrysts from the alkaline pumices of Primor'ye (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 102 (in Russian; translation by A. Kozlowski).

Quaternary pumices (refractive index of glass 1.506 ± 0.002) have composition similar to alkali liparites, but with Na>K and high concentrations of Nb, Zr and REE. Phenocrysts, mainly sanidine, magnetite and ferrohedenbergite, make up 2-3 wt.% of the rock. Apatite and magnetite are the earliest minerals, next ilmenite, chevkinite, zircon, olivine, plagioclase, ferrohedenbergite and sanidine crystallized. P melt inclusions contain usually G + glass, but in large inclusions (40-280 μm) in olivine and apatite the glass is partly crystallized. Inclusions in apatite and zircon have T_H >>1300°C, in plagioclase 1240-1150°C, in ferrohedenbergite 1150-1000°C, in sanidine 930-780°C. Olivine contains inclusions with L CO_2 (density 0.63 g/cm^3), Ps calculated for 1200°C are ≥3 kb. (Authors' abst.) (See also next abstract)

NAUMOV, V.B. and FIN'KO, V.I., 1976b, Conditions of crystallization of phenocrysts in Cenozoic alkaline pumices in Primor'ye: Akad. Nauk SSSR Izvestia, Geol. Series, no. 12, p. 91-95 (in Russian). First author at Inst. Geochem. and Analytical Chem. of Acad. Sci. of the USSR, Moscow.

Pumice fragments occur in alluvial level of Tyumen'-Ula (Tumangan) River, erupted from the Pektusan (Baytoushan') volcano. Pumice with refractive index 1.506 + 0.002 has chemical composition (wt. %): SiO_2 68.65, TiO_2 0.29, Al_2O_3 12.42, Fe_2O_3 3.62, FeO 0.89, MnO 0.09, MgO 0.10, CaO 0.22, Na_2O 5.02, K_2O 4.43, ZrO_2 0.29, Nb_2O_5 0.10, ΣTR_2O_3 + ThO_2 0.15, H_2O + 2.63, H_2O - 0.48, ignition loss 1.06, total 100.44. Pumice has the characteristics of agpaitic pantellerites, with an age of 1.5 ± 0.5 myr. Sanidine and ferrohedenbergite are the most common phenocrysts. Melt P inclusions were found in apatite, zircon, olivine, ferrohedenbergite and sanidine, but G/L inclusions were not found; size of inclusions sometimes reaches 50-70 μm, and in apatite up to 350 μm. In zircon, ferrohedenbergite and sanidine inclusions are two-phase (glass + G), and in apatite in the three biggest inclusions partial crystallization of glass was observed. In plagioclase inclusions are opaque, in olivine some grains bear completely recrystallized inclusions, other grains have quenched glass with several G bubbles. Thermometric studies were made by the quenching method, with an accuracy of ±10°C. T_H (number of inclusions in parentheses): apatite > 1300°C (22); zircon > 1300°C (5); olivine 1270-1040°C (120); ferrohedenbergite 1150-1000°C (27); sanidine 930-780°C (85); plagioclase 1240-1130°C. Three L_{CO_2} inclusions were found in olivine, with T_H 29.0°C; that proves a high density, 0.63 g/cm^3, hence the pressure, at 1040-1270°C, was 2600-3300 bars (possibly depth 10-13 km). (Abst. by A.K.)

NAUMOV, V.B., IVANOVA, G.F., and MOTORINA, Z.M., 1977, Conditions of formation of tungsten, tin-tungsten and molybdenum-tungsten deposits (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. I, p. 131 (in Russian; translation by A. Kozlowski). Authors at GEOKHI AN USSR, Moscow.

The deposits from Zabaikal'ye and Mongolia were studied. Ore minerals formed from L solutions at 450-250°C, but essentially at 360-260°C; 50 samples yielded 1700-2500 bars. Post-ore minerals crystallized at lower T and P: 250-100°C (mainly 170-120°C), 450-170 bars. Chloride solutions caused ore mineralization at Ts 50-100°C higher than those of HCO_3-CO_2 type. The latter ones frequently boiled due to P decrease. (Abst. by A.K.)

NAUMOV, V.B., KOVALENKO, V.I., IVANOVA, G.F., and VLADYKIN, N.V., 1977, Genesis of topazes according to data of a study of microinclusions: Geokhimiya, 1977, no. 3, p. 323-331 (in Russian; translated in Geochem. Internat., v. 14, p. 1-8).

As a result of studying microinclusions, peculiarities of the state of aggregation of mineral-forming media and crystallization temperatures of topazes of various genesis, from ongonites, rare-metal granites, pegmatites, greisens and hydrothermal veins, have been examined. A substantial range of temperatures of topaz formation, from 1000 to 300°C has been established. The possibility of topaz crystallization from various mineral-forming media: melts, brines and solutions is shown. (Authors' abstract)

NAUMOV, V.B. and UCHAMEISHVILI, N.E., 1977, Thermometric investigation of inclusions in minerals of magmatic rocks of the Tyrnyauz region (Northern Caucasus): Geokhimiya, 1977, no. 4, p. 525-532 (in Russian). Authors at V.I. Vernadsky Inst. Geochem. and Anal. Chem., USSR Acad. of Sci., Moscow.

Primary inclusions of melts in quartz and apatite of magmatic rocks of the Tyrnyauz region (Northern Caucasus) have been studied. T_H of inclusions in quartz are 880-790°C for leucocratic granite, 840-730 for Eldzhurtinsk granite, 940-790 for liparites, 830-750 for vitrophyres and 1220-1030 for liparites of the Kyrtyk massif; in apatite 1250-1050°. In inclusions in quartz of liparites magmatic water has been found. Its amount is about 0.5-1 wt.% and the partial pressure was 250-300 bar. Postmagmatic fluids according to studies of inclusions in quartz of the Eldzhurtinsk granite represented high-temperature (750-200°) highly concentrated chloride solutions (brines) at a pressure of not less than 2-3 kbar. (Authors' abstract)

NAUMOV, V.B. and VLADYKIN, N.V., 1976, Inclusions in topaz from lithium-fluorine granites and ongonites, (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 108-109 (in Russian; translation by A. Kozlowski).

Granites from Yugodzyr massif (Mongolia) and ongonites from Ary-Bulak massif (Transbaikalia) were studied. The first ones bear topaz, cassiterite, columbite and zircon. The second ones, in the central part porphyritic, in zones adjacent to contact — aphyric with distinct fluidal textures, are of composition of the amazonite-albite Li-F granite. In topaz from Li-F granite very rare P crystallized inclusions were found. These inclusions consist of G and mostly anisotropic dms. Dms begin to melt at 480-550°C; at 600°C inclusions bear only melt and G(~5 vol.%); T_H 600-650°C in melt of very low viscosity (quenching time <3 sec; when >3 sec., crystal phases appear). The second homogenization of such inclusions needs only 15-20 sec. Topaz from ongonite bears more inclusions, filled with G and semitransparent fine-crystalline phases;

beginning to melt at 460--50°C; T_H 580-930°C in melt. Viscosity ot melt decreases together with T_H: when T_H is 580-750°C, glass becomes soft in several sec. to several min., whereas in high T inclusions the time equals several hours. Inclusions with low T_H have also a low T of heterogenization as 300°C. (Authors' abst.)

NAYBORODIN, V.I. and GONCHAROV, V.I., 1977, Temperature conditions of two-stage formation of gold-silver deposit (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Sib. Branch, v. II, p. 41 (in Russian; translation by A. Kozlowski). Authors at NE Complex Sci.-Res. Inst. of the Far-East Sci. Center of Acad. Sci. USSR.

The studied deposit occurs in the Okhotsk-Chukotka volcanogenic belt. Wall-rocks are propylitised. Ores occur in Au-Ag adularia-quartz veins poor in sulfides (up to 0.5%) or in rarer sulfide-quartz veins with polymetallic mineralization. Stages of mineralization developed at T (T_H, °C): 1) adularia-quartz 420-140; 2) hydromica-chlorite (commercial Au-Ag stage) 220-130; 3) sulfide-quartz 330-140. The first two stages formed in pre-intrusive time, and are characterized by rhythmic precipitation of mineral aggregates and varying T values. Propylitization of wall-rocks developed at 380-340°C (epidote, prehnite, garnet, wollastonite). (Abst. by A.K.)

NEHRING, N.L., BOWEN, P.A. and TRUESDELL, A.H., 1977, Techniques for the conversion to carbon dioxide of oxygen from dissolved sulfate in thermal waters: Geothermics, v. 5, p. 63-66. Authors at U.S. Geol. Survey, Menlo Park, CA 94025, U.S.A.

The fractionation of oxygen isotopes between dissolved sulfate ions and water provides a useful geothermometer for geothermal waters. The oxygen isotope composition of dissolved sulfate may also be used to indicate the source of the sulfate and processes of formation. The methods described here for separation, purification and reduction of sulfate to prepare carbon dioxide for mass spectrometric analysis are modifications of methods by Rafter (1967), Mizutani (1971), Sakai and Krouse (1971), and Mizutani and Rafter (1969). (Authors' abstract)

NENASHEV and SHILIN, 1976 (See next page)

NERONSKIY, G.I. and DOBRAYA, V.T., 1976, Hallmark of gold and its variations in several gold-ore regions of Priamur'ye, in Genetic types and regularities of distribution of deposits of gold in the Far East (Materials of Conference on Gold Potential of the Amur area and adjacent regions, Blayoveshchensk, May 1971), editor V.G. Moiseenko, Novosibirsk, Siberian Branch of "Nauka" Publishing House, p. 45-58 (in Russian). Authors at the Far-East Geol. Inst. of Far-East Sci. Center of Acad. Si. USSR, Vladivostok.

T_D of quartz in gold-ore bodies in zeolite facies at Tokurskoe-Kharginskoe-type veins is 330-350°C in the first mineral-forming stage, 190-220°C in the second stage and 100-130°C in the third stage; same type of veins in the epidote-amphibolite subfacies-350-355°C, 215-235°C, and 120°, respectively. Alpine-type veins of biotite-chlorite subspecies have T_D 350°C, of epidote-amphibolite subfacies-380-420°C. (Abst. by A.K.)

NENASHEV, N.I. and SHILIN, A.I., 1976, Time and temperatures of origin of granitoids in Yakutia (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 111-112 (in Russian; translation by A. Kozlowski).

Time of origin of the isolated pluton with horizontal section 250 km^2, thickness 20 km and overlying rocks 2 km thick was calculated as more than 20 m.y. If minerals, applied for geothermometers (see table), did not grow contemporaneously, determinations are wrong. Determinations on the basis of petrochemical calculations (T_K) have value only of preliminary evaluation. Most perspective evaluation can be derived from T_H of P melt inclusions.

Temperature of origin of the Tarbagannakh massif, S. Verkhoyan'ye

Rock	Temperatures on the basis of various geothermometers, °C					
	amphibole-plagioclase	amphibole-biotite	plagioclase-K-spar	Temperature of magma (TK) after Kudinov, 1971	Temperature of magma crystallization, Oftedal, 1943	T_H of P melt inclusions in quartz
	after Perchuk, 1970					
Granodiorites	520-640	600-800	490-800	716-900	560-725	850-910 (720-820)
Medium-grained granites	440	710-790	580-600	716-764	550-560	840-950 (720-800)
Fine-grained granite				600		870-890 (710-780)
Aplites				652		770-900 (720-760)

In parentheses = beginning of melting. (Authors' abst.)

NESBITT, B.E. and KELLY, W.C., 1977, Magmatic and hydrothermal inclusions in carbonatite of the Magnet Cove Complex, Arkansas: Contrib. Mineral. Petrol. v. 63, p. 271-294. Authors at Dept. of Geol. and Min., The Univ. of Mich., Ann Arbor, MI 48109.

The carbonatite at Magnet Cove, Arkansas, USA contains a great variety and abundance of magmatic and hydrothermal inclusions that provide an informative, though fragmentary, record of the original carbonatite melt and of late hydrothermal solutions which permeated the complex in post-magmatic time. These inclusions were studied by optical and scanning electron microscopy.

Primary magmatic inclusions in monticellite indicate that the original carbonatite melt contained approximately 49.7 wt% CaO, 16.7% CO_2, 15.7% SiO_2, 11.4% H_2O, 4.4% FeO + Fe_2O_3, 1.1% P_2O_5 and 1.0% MgO. The melt was richer in SiO_2 and iron oxides than the carbonatite as now exposed; this is attributed to crystal settling and relative enrichment of calcite at shallower levels. The density of the carbonatite melt as revealed by the magmatic inclusions was approximately 2.2-2.3 g/cc. Such a light melt should separate rapidly from any denser parent material and could be driven forcibly into overlying crustal rocks by buoyant forces alone. Fluid inclusions in apatite suggest that a separate (immiscible) phase composed of supercritical CO_2 fluid of low density coexisted with the carbonatite magma, but the inclusion record in this mineral is inconclusive with respect to the nature of any other coexisting fluids. Maximum total pressure during CO_2 entrapment was about 450 bars, suggesting depths of 1.5 km or less for apatite crystallization and supporting earlier proposals of a shallow, subvolcanic setting for the complex.

Numerous secondary inclusions in the Magnet Cove calcite contain an intriguing variety of daughter minerals including some 19 alkali, alkaline earth and rare earth carbonates, sulfates and chlorides, few of which are known as macroscopic phases in the complex. The exotic fluids from which the daughter minerals formed are inferred to have cooled and diluted through time by progressive mixing with local groundwaters. These fluids may be responsible for certain late veins and elemental enrichments associated with the complex. (Authors' abstract)

NETHERTON, R., PIWINSKII, A.J., and CHAN, M., 1977, Viscosity of brine from the Salton Sea geothermal field, Califronia, from 25°C to 90°C at 100 kPa (abst.): Amer. Geophys. Union Trans., EOS, v. 58, p. 1248.

NEWTON, M.G., MELTON, C.E., and GIARDINI, A.A., 1977, Mineral inclusions in an Arkansas diamond: Am. Mineral., v. 62, p. 583-586.

NEYKUR, T.L., 1976, Role of Na and CO_2 in formation of rock-crystal-bearing quartz veins (abst), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 202-203 (in Russian; translation by A. Kozlowski).

Rock-crystal-bearing quartz veins of a deposit of piezoquartz in the S. Urals formed by repeated Na metasomatosis of the local zones. During the first two stages vein quartz was formed, and during the third stage, four generations of quartz crystals. All generations of quartz differ in composition of G/L inclusions. Microchemical analyses of water leachates shows an increase of Na_2O in the wall rocks up to the third stage of the process. This causes the conditions suitable for forming of large euhedral crystals of quartz. Sharp increase of H_2/CO_2 ratio in fluid inclusions was noted during change from coarse-grained vein quartz to euhedral quartz crystals, against a background of generally rising CO_2 content. The removal of CO_2 from wall rocks in I and II stages changed to accumulation of CO_2 in stage III. This proves the separation of CO_2 in the zone of rock-crystal origin due to P decrease. By filling of fractures with carbonates the system became closed. Increase of SiO_2 and salt concentrations causes decrease of CO_2 solubility and thus a closed system P_{CO_2} increases and subsequently P_{CO_2} increase leads to oversaturation of solution with SiO_2. Hence P_{CO_2} controls the speed of crystallization of quartz in closed system, and this P_{CO_2} depends on P-T conditions of process, composition of the initial solutions and wall rocks. (Author's abst.)

NIKANOROV, A.M., 1977, Gas-liquid inclusions in minerals as the basis for paleohydrogeological reconstruction: Akad. Nauk BSSR, Doklady, v. 21, no. 9, p. 839-842 (in Russian).

NORDSTROM, D.K. and JENNE, E.A., 1977, Fluorite solubility equilibria in selected geothermal waters: Geoch. Cosmo. Acta, v. 41, p. 175-188. Authors at U.S. Geol. Survey, Menlo Park, CA 94025.

Calculation of chemical equilibria in 351 hot springs and surface waters from selected geothermal areas in the western United States indicate that the solubility of the mineral fluorite, CaF_2, provides an equilibrium control on dissolved fluoride activity. Waters that are undersaturated have undergone dilution by non-thermal waters as shown by decreased conductivity and temperature values, and only 2% of the samples are supersaturated by more than the expected error. Calculations also demonstrate that simultaneous chemical equilibria between the thermal waters and calcite as well as fluorite minerals exist under a variety of conditions.

Testing for fluorite solubility required a critical review of the thermodynamic data for fluorite. By applying multiple regression of a mathematical model to selected published data we have obtained revised estimates of the pK (10,96), ΔG°_{f} (-280.08 kcal/mole, ΔH°_{f} (-295.59 kcal/mole), S° (16.39 cal/deg/mole) and C°_{p} (16.16 cal/deg/mole) for CaF_2 at 25°C and 1 atm. Association constants and reaction enthalpies for fluoride complexes with boron, calcium and iron are included in this review. The excellent agreement between the computer-based activity products and the revised pK suggests that the chemistry of geothermal waters may also be a guide to evaluating mineral solubility data where major discrepancies are evident. (Authors' abstract)

NORMAN, D.I., 1977, Geology and geochemistry of Tribag Mine, Batchawana Bay, Ontario: Ph.D. dissertation, Univ. Minn., 257 pp.

The Tribag breccia pipes are associated with Keweenawan felsic intrusives and contain disseminated copper and molybdenum sulfides, or high grade chalcopyrite and pyrite ore bodies.

Mineralization of the breccias was divided into three periods: Period I was typified by the deposition of disseminated chalcopyrite-molybdenite sulfides in association with magnetite, pyrite, epidote and quartz. Fluid inclusion studies indicated mineral deposition by fluids which had temperatures over 400°C and salinities ranging from 55-4%.

Period II resulted in the mineralization of the breccia matrix with quartz, carbonate, and minor sulfides, and in the later mineralization of high grade ore bodies. Fluid inclusion data indicated fluid temperatures of over 400°C to 330°C and salinities of 14-7%. Boiling of fluids was indicated for $T > 360°C$.

Period III fluids deposited quartz, carbonates and sulfides in veins cutting across the breccias and along several domal fractures in the breccia, forming ore bodies. Fluid inclusion data indicated fluid temperatures of 330-250°C (with a possible pressure correction of 40°C) and salinities of 17-1.5%.

Depth during mineralization was estimated to be 1780 m and the pressure estimated to range between 400-150 bars.

Analyses of the fluids in inclusions indicated the early highly saline fluids to be Ca-rich chloride brines with Cu values as high as 8000 ppm and containing appreciable sulfate. Period II and III fluids were chlorine-bearing Na-Ca sulfate solutions with the amount of copper averaging 560 ppm in Period II waters and 280 ppm in Period III.

Analyses of gases in inclusions definitely detected CO_2, H_2, H_2S, He, and Ar. CO_2 was the principle gas, averaging 1 mol% and H_2S averaged 0.01-0.001 mol/kg H_2O. On the basis of the gas data the following average fugacities were calculated.

f_{O_2}: -22 (Period I) -26.5 (Per. II) -33 (Per. III)
f_{CO_2}: 5.2 (Period I) 1.1 (Per. II) 1.1 (Per. III)
f_{S_2}: -6.3 (Per. II)-10.2 (Per. III)

The calculated oxygen fugacities indicate the fluids to be relatively oxidized with the f_{O_2} above that expected from buffering by py-po-mg. Thermodynamic calculations based on the analytical data were internally consistent and gave results compatible with observation with the exception of the prediction of anhydrite in the ore. The gas measurements are highly experimental; therefore, consistent results from thermodynamic calculations based on experimental data is considered a good indication that the analyses accurately reflect the fluids originally trapped.

During most of the paragenesis mineralizing fluids contained considerable H_2S and Cu but only a low grade, disseminated ore was deposited. It is suggested that this occurred because the fluids underwent little physical or chemical change as they migrated up the breccia pipe. The data suggest high grade ores were deposited when fluids of different composition flowing up domal fractures mixed with fluid moving in the pipes. (Modified from author's abstract)

NORMAN, D.I., LANDIS, G.P. and SAWKINS, F.J., 1977, H_2S and SO_2 detected in fluid inclusions (abst.): Econ. Geol., v. 72, no. 4, p. 734-735.

See <u>Fluid Inclusion Research</u> -- <u>Proceedings of COFFI</u>, v. 9, p. 98 (ER)

NORTON, D. and KNAPP, R., 1977, Transport phenomena in hydrothermal systems: the nature of porosity: Am. Jour. Sci., v. 277, p. 913-936.

NORTON, D. and KNIGHT, J., 1977, Transport phenomena in hydrothermal systems: cooling plutons: Am. Jour. Sci., v. 277, p. 937-981.

NOSIK, L.P., DOLOMANOVA, Ye.I., GROSHENKO, A.R., and ROZHDESTVENSKAYA, I.V., 1976, CO_2, SO_2, and H_2O from vacuoles in minerals of the tin ore deposits as indicated by mass-spectrometry* (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 195-196 (in Russian; translation by A. Kozlowski).

1. CO_2, SO_2, H_2O and isotopic composition of carbon in CO_2 from vacuoles in quartz, cassiterite, topaz, beryl, fluorite, calcite, arsenopyrite, and sphalerite, were determined. The isotopic composition of S was determined in arsenopyrite, pyrite, pyrrhotite, sphalerite, chalcopyrite, and galena.

2. In different formations the amount of CO_2 decreases and H_2O increases in inclusions from early (topaz) to late (fluorite) minerals. Cassiterite is the exception, since it usually bears CO_2, but H_2O is rare. $CO_2 > SO_2$ in inclusions of all minerals.

3. The behavior of SO_2 is less regular: its highest concentration was found in ore-bearing vein quartz; lowest - in barren quartz. Vein quartz from granites contains more SO_2 than vein quartz from silty shales, and dolomites. Topaz from various deposits contains similar amounts of SO_2. SO_2 content in inclusions in cassiterite increases with drop of T_H, but in sulfides it varies irregularly.

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* After printing of the Ufa abstract volume the authors changed the title to: "Peculiarities of formation of the tin ore deposits... etc." (A.K.)

4. CO_2 in inclusions is rich in ^{13}C in the low-T minerals (-2.92% in beryl to -0.23% in calcite). Vein quartz in granite contains CO_2 low in ^{13}C, but CO_2 from vein quartz in sandy shales and carbonate rocks is richer in ^{13}C. Cassiterite and arsenopyrite crystallizing after quartz contain CO_2 that is lower in ^{13}C.

5. S in SO_2 from inclusions in vein quartz and topaz is poorer in ^{34}S than in late sulfides. In sulfides from various deposits δS varies strongly, but in the same deposit minerals become richer in ^{34}S from early to late. (Authors' abst.)

NOVGORODOV, P.G., 1977, On the solubility of quartz in $H_2O + CO_2$ and H_2O + NaCl at 700°C and 1.5 kb pressure: Geokhimiya, 1977, no. 8, p. 1270-1273 (in Russian; translated in Geochem. Internat., v. 14, no. 4, p. 191-193.)

Solubilities up to 0.93 wt.% are reported. (ER) ✓

OBOLENSKIY, A.A. and BORISENKO, A.S., 1977, Physico-chemical parameters and main factors of ore formation in the epithermal deposits of antimony, mercury and arsenic (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Sib. Branch, v. II, p. 129-130 (in Russian; translation by A. Kozlowski). First author at Inst. Geol. Geoph. of Siberian Branch of Acad. Sci. USSR, Novosibirsk.

Mineral-forming process in the studied deposits developed at T 280-50°C and under P 1500-10 atm, on the background of the continuous decrease both T and P. Quartz-antimonite deposits formed at 280-50°C, Hg and Hg-Sb deposits--250-50°C, and As (realgar-orpiment)--<200-50°C. Three types of parent solutions were distinguished: 1) S-Cl, 2) S-Cl-CO_2, 3) S-CO_2, cations are Na, K, Ca and Mg; total salts range from 0.11 to 40 wt.%. Sulfide ion is always present in the hydrotherms. (From the authors' abst.)

OHMOTO, Hiroshi and KERRICK, Derrill, 1977, Devolatilization equilibria in graphitic systems: Amer. Jour. Sci., v. 277, p. 1013-1044. Authors at Dept. Geosciences, The Penn. State Univ., University Park, PA 16802.

Using recent data for the fugacities of gases at elevated pressures and temperatures, the proportions of species in a C-O-H-S fluid in equilibrium with graphite + pyrite + pyrrhotite were calculated over a wide range of P, T, and f_{O_2}. Under typical metamorphic conditions, H_2O, CO_2, and CH_4 are the principal fluid species. At moderate-to-high metamorphic grades, X_{H_2O} is less than 0.9 in the presence of graphite, thus weakening application of the petrogenetic grid for graphitic pelites based on a model of $P_{H_2O}=P_{fluid}$. These calculations permit location in P_f-T-f_{O_2} space of the stability curves of devolatilization equilibria important to metamorphosed shales and marls, the lithologies most commonly containing graphite. On an isobaric log f_{O_2}-T diagram, the stability fields of hydrous phases and hydrous phases+quartz+carbonates are confined by parabolic equilibrium curves roughly centering about QFM buffer. Such assemblages provide excellent monitors of f_{O_2} in graphitic rocks. Decarbonation equilibria confine assemblages such as calcite+quartz and dolomite+quartz to a very narrow zone of P-T-f_{O_2} space directly adjacent to the stability boundary for graphite. Assemblages defining isobaric invariant points, as have been described for some natural occurrences, are particularly useful in defining P_f-T-f_{O_2} conditions. Application of T-X_{CO_2} topologies with a binary H_2O-CO_2 fluid is valid for invariant point assemblages stable at high X_{CO_2}, whereas the fluid in equilibrium with isobarically invariant assemblages at low X_{CO_2} markedly deviates from a binary H_2O-CO_2 mixture because of the presence of significant amounts of CH_4.

Prograde buffering provides an effective mechanism for the production of anatectic migmatites in carbonate-free pelites; however, the stability relations of carbonate equilibria in graphite-bearing assemblages suggest that, in general, anatexis will not occur in calc-pelites. Buffering of the fluid by devolatilization equilibria in graphitic systems provides an effective mechanism for controlling the Fe/Mg ratios of ferro-magnesian minerals involved in redox reactions and, consequently, the bulk-rock Fe^{+2}/Fe^{+3} ratio. (Authors' abstract)

OKRUGIN, V.M., 1976, Inclusions of melts in minerals from the Kamchatka volcanites (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept. 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 98 (in Russian; translation by A. Kozlowski).

Extrusive and effusive liparite-dacites, dacites, andesite-dacites and andesites from Alney-Chashakondzha, Uksichan, Novyi dome (volcano Bezymyannyi) and megaplagioporphyritic basalts from the Yuzhnyi rupture of the Tolbachik volcano were studied. Inclusions in phenocrysts of plagioclase, biotite, amphibole and olivine are one-phase (glass), two-phase (G + glass) and polyphase (G + glass + dms: transparent and opaque). Sometimes inclusions bear one G bubble and one euhedral opaque dm, or G and dms may form numerous tiny masses in glass matrix of inclusion. Ore minerals: magnetite, ilmenite, pyrite, pyrrhotite and chalcopyrite were determined in the inclusions; T of crystallization of phenocrysts was evaluated (i.e., measured?) at 1410-890°C. (Author's abst.)

OLADE, M.A., 1977, Nature of volatile element anomalies at porphyry copper deposits, Highland Valley, B.C., Canada: Chemical Geology, v. 20, p. 235-252.

OLSON, E.R., 1977, Water-rock ratios and fluid mixing in the Salton Sea Geothermal Field (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 1119-1120. Author at Institute of Geophysics and Planetary Physics, University of California, Riverside, CA 92521.

New oxygen isotope measurements for minerals from three wells in the Salton Sea Geothermal Field place limits on the extent of water-rock interaction in this system. (From the author's abstract)

OLSON, R.A., 1977, Genesis of stratabound zinc-lead deposits, Baffin Island, N.W.T. (abst.): Geol. Assoc. Canada — Min. Assoc. Canada Program with Abstracts, v. 2, p. 40. Author at Trigg, Woollett and Associates, Ltd., 1310-10024 Jasper Avenue, Edmonton, Alberta.

Economically important Mississippi Valley type zinc-lead deposits exist in late Proterozoic Society Cliffs Formation dolomite. Society

Cliffs Formation is underlain disconformably by shale and overlain discomformably by either shale or red clastic rocks. Society Cliffs Formation has undergone at least four temporally distinct episodes of karstification since its deposition. During the second karst episode a holokarst developed and a large integrated cave system of the Mammoth Cave-Flint Ridge Cave System type was formed. During a later period of deep burial the caves were infilled with sulphide and carbonate minerals. The meteoric waters which formed the caves did not form the zinc-lead deposits because the temperature of ore deposition was between 200°C and 150°C, the calculated oxygen isotope composition of the ore fluid is +12.8 per mil, and mineral stability and isotopic data indicate the oxygen fugacity decreased during ore deposition. The sulphide sulphur isotope composition of the zinc-lead deposits has a narrow range about +26.0 per mil, similar to that of sulphate evaporite (+23.7 per mil) which exists locally within Society Cliffs Formation. Lead isotope data indicate the lead in the deposits was derived by a two-stage process.

The ore fluid and contained metals are postulated to have been derived during a late stage dewatering of the shale underlying Society Cliffs Formation. Sulphide deposition may have been caused by chemical reduction of sulphate existing in the ore fluid when the fluid entered hydrocarbon-filled caves. The hydrocarbons were probably derived from the same underlying organic-rich shale during an earlier stage of thermal metamorphism and dewatering. (Author's abstract)

O'NEIL, J.R., SHAW, S.E., and FLOOD, R.H., 1977, Oxygen and hydrogen isotope compositions as indicators of granite genesis in New England Batholith, Australia: Contrib. Mineral. Petrol., v. 62, p. 313.

ONTOEV, D.O., KANDINOV, M.N., KORYTOV, F.Ya., 1977, On temperatures of mineral-formation of the apatite-fluorite-rare earth ores in S. Mongolia: Akad. Nauk SSSR Doklady, v. 234 no. 5, p. 1164-1166 (in Russian). First author at the Inst. Geol. Ore Deposits, Petrogr. Mineral, and Geochemistry of the Acad. Sci. USSR.

A new type of apatite-fluorite-REE ores found in the Central Gobi, at Mushugay-Khunduk, is connected with the Upper Mesozoic volcano-plutonic, alkaline-basic complex (trachite, trachite-liparite, liparite, tuff, tuffobreccia). Ores consist of 1) titanomagnetite + biotite + apatite; 2) fluorite + celestite + apatite + (titanomagnetite); 3) quartz + fluorite, celestite + fluorite, carbonate + celestite + fluorite; 4) cataclastic syenite, trachite and aleurolite with ores; 5) quartz + carbonate (both as veins); 6) monominerallic, coarse-crystalline celestite (veins). Apatite bears 2-13% of REE oxides; bastnaesite and REE-bearing fluorite also occur. Results of studies of fluid inclusions are presented in the table:

Mineral Association	No. of determinations	Host mineral	Type of inclusion	T_H, °C	Type of homogenization	Mineral-forming medium
Accessory minerals from trachite and syenite	3	apatite	melt	1150-1100	in melt	silicate melt
Magnetite-apatite with carbonate	5	apatite	melt*	1100-1000	in melt	silicate-salt melt
Carbonate-fluorite	9	fluorite	G+L H_2O+dms	380-350	in brine	salt brine
Barite-celestite-fluorite	23	fluorite	G/L, filling 30-35 vol.% (with 1.7 A.K.)	190-150	in L	L solution
Celestite from veins and cavities in lavas	14	celestite	G, G/L, L/G, L	150- 80	in L, in G	boiling L solution

*Similar inclusions were found in carbonate, but T_H was not measured.

Dms are both isotropic and anisotropic, of cubic or short-prismatic habits. Evolution of mineral-forming medium from silicate-salt melt through salt melt-solution (brine) to hydrothermal solution and T_H are similar to those found in F-bearing carbonatites from Soviet Union. (Abst. by A.K.)

ONTOEV, D.O., KANDIDOV, M.N., KORYTOV, F.Ya. and GUNDSAMBUU, Ts., 1977, On temperature conditions of formation of fluorite-rare earth-iron ore deposits (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. I, p. 97-98 (in Russian; translation by A. Kozlowski). Authors at IGEM Acad. Sci. USSR, Moscow.

Apatite, fluorite, celestite etc. from the Central Asian fluorite-rare earth-iron ore deposit (name not given) bear numerous inclusions of various types: e.g., apatite contains amorphous and crystallized tubular inclusions of silicate-salt melts; fluorite has polyphase inclusions of melts-solutions and G/L inclusions of various genesis. Early stages yielded inclusions with T_H >600°C, P > 1000 atm, then apatite, magnetite, fluorite, britholite and monazite crystallized from silicate-salt melt. At 400-150°C and P equal several hundred atm but < 1000 atm, main part of fluorite, barite, celestite, siderite, hematite, bastnaesite and parisite formed. Final stage of mineralization (T 105-80°C and P several tens atm) consists of calcite, late celestite, late quartz etc. (Abst. by A.K.)

ORLOVA, L.M., 1976, [Studies of a series of] successive water leaches and changes of chemical composition of mineral-forming media (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 168-169 (in Russian; translation by A. Kozlowski).

A new method was applied to multiple water leachates made from inclusions opened by decrepitation at T close to T_H. Five to ten successive leaches were used on inclusions opened at increasing temperatures. The results were calculated for the contents of H_2O and CO_2 in each T interval, as determined by fractional freezing. Water phase in G/L inclusions in beryl, spodumene and tourmaline from the rare metal granite pegmatites were studied. (Author's abst.)

ORLOVA, L.M., MIKHAYLOV, M.Yu. and BAZAROV, L.Sh., 1976, Composition of solutions in inclusions (in minerals, A.K.) of rare-metal pegmatite (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 128-129 (in Russian; translation by A. Kozlowski).

By several successive leachates after decrepitation at 300, 400, 500, 600 and 700°C, the composition of L phase of inclusions was investigated in quartz from zones: 1) aplite (1040-800°C, 1500-4000 atm), 2) apographic (780-690°C, 1000-3000 atm), 3) block quartz-feldsparthic (720-600°C, 1000-3000 atm), 4) inner (quartz) core (650-520°C, 1000-3000 atm), 5) quartz-muscovite (520-460°C, 1000-3000 atm). Contents of Li, K, Na, Ca, Mg, Al, Ta, Nb, Cl, F, HCO_3, SO_4 were determined by chemical analysis, and CO_2 and H_2O by fractional freezing. Results are given in the table. (Authors' abst.)(Continued on next page)

Zones ↘ *Component	Concentration, wt. % (in water)				
	aplite	apographic	block	core	quartz-muscovite
Li	0.076 - 1.02	0.032 - 1.60	0.0015- 0.01	0.097 - 0.334	0.009 - 0.039
Na	3.49 - 6.18	0.23 - 8.34	0.0074- 0.122	0.73 - 6.64	0.147 - 2.635
K	0.27 - 1.29	0.05 - 3.87	0.0 - 0.017	0.078 - 3.76	0.017 - 0.431
Nb	0.004 - 0.062	0.0001- 0.0198	0.007 - 0.011	0.0044- 0.7517	0.0001- 0.0007
Ta	0.0012- 0.00520**	0.0001- 0.0046	0.0 - 0.0006	0.0009- 0.052	traces
F	0.53 - 2.68	0.05 - 3.45	0.0 - 0.15	not found	0.198 - 0.337
HCO_3	7.67 -17.23	0.72 -30.185**	0.03 - 0.34	3.39 -23.49	0,419 - 4.493
SO_4	traces	0.156 - 6.334	not found	0.0 - 1,57	0.053 - 1.766
CO_2	25.06 -45.04	2.59 -31.12	18.4 -42.5	22.06 -40.97	9.563 -20.829

*(The other 4 components listed in abstract are not mentioned further. A.K.)

** sic.

OSTROVSKIY, V.Ye. and LEVITSKIY, Yu.F., 1976, Microthermometric studies of quartz from Precambrian rocks of the Pripyat' rift (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 125-126 (in Russian; translation by A. Kozlowski).

Ts were determined by decrepitation, occasionally controlled by homogenization and by mineral geothermometer (biotite, amphibole, garnet, feldspars). One-phase, most common two-phase ($G>LH_2O$ and $G< LH_2O$), polyphase ($L\ H_2O + G \pm L\ CO_2 \pm$ dms) and rare inclusions of amorphous volcanic glass were found. Three to six T intervals from 500 to 100°C were recorded. All types of inclusions (except of P in quartz of the first generation, are connected with tectonic and magmatic activation during platform stage of development of the region. Maximum T_H and T_S (sic., T_D?-A.K.) are comparable with T obtained from mineral geothermometers. (...) (Authors' abst.)

OTKHMEZURI, Z.V. and DOLIDZE, I.D., 1977, Composition and features of ore-forming solutions of the antimony-mercury-arsenic deposits (exemplified by Georgia) (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Sib. Branch, v. II, p. 131-132 (in Russian; translation by A. Kozlowski). First author at Geol. Inst. of Acad. Sci. of Georgian SSR.

Chemical composition of the parent fluids (by water leachates from quartz, carbonates and antimonite) may be described as solutions of Na, K, Ca, Mg, Cl, HCO_3 and SO_4. Early solutions were of HCO_3-Na-(K) type, later ones forming quartz-antimonite veins of HCO_3-SO_4-Ca type. Subsequent parent fluids of quartz-carbonate-cinnabar and cinnabar-realgar associations had composition Cl<HCO_3-Ca. The latest realgar-orpiment ores precipitated from Cl-HCO3-Na-Ca solutions. Measured pH of water leachates were weakly alkaline, except of that made from antimonite, being weakly acid. (From the authors' abst.)

OVCHINNIKOV, L.N., and MASALOVICH, A.M., 1976, Special points of mineral crystallization in the processes of hydrothermal ore forming, in Thermobarogeochemistry of mineral formation, N.P. Ermakov , ed.: Rostov, Rostov Univ. Press, p. 29-38 (in Russian).

Full paper corresponding to abstract in Fluid Inclusion Research volume 6, p. 115-116, 1973.

OVCHINNIKOV, L.N. and MASALOVICH, A.M., 1977, Polymorphism of water and its role in hydrothermal mineral formation: Vses. Mineral. Obshch. Zapiski, v. 106, no. 2, p. 178-192 (in Russian). Authors at

Inst. Mineral., Geochem. and Crystallochem. of Rare Elements, Moscow.

The paper deals with the discrete structural changes of water depending on T called polymorphism, and the role of the changes in the behavior of dissolved substances and hydrothermal mineral-formation. T of structural changes of water is named the "critical" point, and existence of such point, e.g., at $T \sim 350$°C, is evidenced by variations of Cl ions per 1 ion of Pb^{2+}, variations of dielectric constant, specific volume of water, solubility of galena etc. (A.K.)

PADALINO, Giorgio and VALERA, Roberto, 1977, Fluid inclusions in fluorite from Oridda, southwest Sardinia: Rend. Soc. Ital. di Min. e Pet., v. 33, no. 2, p. 809-819 (in Italian with English abstract).

In Oridda (South-west Sardinia, Italy) fluorspar occurs either in skarn-type rocks, near the contact between granite and different Cambrian formations, or in karst filling in Cambrian limestones (« Metallifero »).

Strong differences have been found in fluid inclusions belonging to the fluorspar of both types: 1) Fluorspar in skarns: very abundant primary fluid inclusions as negative crystals; usual daughter minerals include halite and others; average homogenization temperature 300°. The crystallization processes of this fluorspar are clearly related to the skarn genesis; and 2) Fluorspar in karst fillings: rare fluid inclusions as negative cristals; no daughter minerals; homogenization temperature 110°-150°.

The coexistence of primary fluid inclusions with homogenization temperature 110° and secondary ones with 150°, together with other data, point to the existence of an ancient fluorspar in karst fillings, which has undergone a late thermal event, very probably identified in Hercynian metamorphism. (Authors' abstract)

PAGEL, M., 1977, Microthermometry and chemical analysis of fluid inclusions from the Rabbit Lake uranium deposit, Saskatchewan, Canada (abst.): Inst. Mining and Met., Trans., Sect. B, v. 86, p. B157-158.

See Fluid Inclusion Research -- Proceedings of COFFI, v. 9, p. 102-103 (ER)

PAGEL, Maurice and JAFFREZIC, Henri, 1977, Chemical analyses of inclusions in quartz and dolomite from the Rabbit Lake uranium deposit (Canada): C.R. Acad. Sc. Paris, v. 284, ser. D, p. 113-116. In French with English abstract.

Ionic ratios in brines from fluid inclusions in euhedral quartz and dolomite from the Rabbit Lake uranium deposit were studied first by atomic absorption and colorimetry and second by neutron activation. Results obtained by the two methods agree closely. Quartz and dolomite contain a Na-Ca-Cl brine with a low Cl/Br weight ratio, respectively 55 and 65. The K/Na atomic ratio for quartz is 0.09. These brines are considered to be diagenetic fluids derived from the Athabasca sandstones, modified by reactions with rocks from the basement. (Authors' abstract).

PAGEL-THEISEN, V., 1976, Laser-treated diamonds: Goldschmiedeztg, v. 74, p. 106-110 (in German).

Since about 1970 laser irradiation has been used to improve the grade of diamonds. Through special optical systems a laser drill can be focussed exactly on the surface to drill a tiny hole into an inclusion. Dark-looking fissures are lightened through the penetration of air. Liquids can be introduced into the drill hole to bleach, corrode or dissolve inclusions. The canals are later filled with high-refracting wax and sealed. Abstract from Zent. f. Min., 1977, pt. 1, Jahrgang 76/2, p. 278-9; trans. by H.A. Stalder.

PAL'MOVA, L.G., 1976, Decrepitation in evaluation of fine-grained ores (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 145-146 (in Russian; translation by A. Kozlowski).

Fine-grained ores were studied from the following associations: 1) pitchblende I-chlorite, 2) molybdenite II - pitchblende II - hydromica, 3) coffinite III - pitchblende III - jordisite and calcite-sulfide. Monominerallic samples of one generation (weight 0.5-1.0 g) were accepted as standard samples. Minerals of various generations were characterized by decrepitation curves with one maximum. Decrepitation analysis was carried out by comparison of decrepigraph with standard decrepigraphs and with decrepigraphs made from mixed samples, and with microscopic observations. For type III ores T_D (beginning of decrepitation) of pitchblende III was compared with T_H and T_D of G/L inclusions in calcite, respectively 90-160, 120-190 and 90-150°C. There is good reproducibility of decrepitation curves for each type of ores. (Author's abst.)

PALMOVA, L.G. and KOPNEVA, L.A., 1977, Physicochemical conditions of formation of vein and metasomatic gold ore deposits: Izv. Vyssh. Uchebn., Geol. Razved, v. 20, no. 7, p. 48-51 (in Russian).

See previous item. (ER)

PAL'MOVA, L.G., KOPNEVA, L.A., IVANOV, P.A., and PRUSAKOV, A.M., 1976, Gold-bearing solutions as indicated by studies of gas-liquid inclusions (abst), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 184 (in Russian; translation by A. Kozlowski).

Deposits of gold-quartz with low sulfide content were studied. Hydrotherms are of the CO_2-Na-K-Cl type, with CH_4. The contents of Na and K in the solutions are relatively stable (140-300 g/kg H_2O). Cl was always found (50 to 200 g/kg H_2O). Concentrations of CH_4 and CO_2 in inclusions vary widely, sometimes by several tens of times in the same deposit. Hence, along with a relatively stable salt composition during the process of ore formation, pH and Eh vary widely. Seemingly these factors were the essential ones determining trasport and precipitation of gold in hydrothermal solutions.

Thermodynamic analysis shows that at these deposits gold-chloride complexes are the most probable; this is supported by the constant presence of Cl in high concentration in the ore-forming solutions.

Chemical composition of inclusion fluids was compared with Au content in quartz samples.

Free energy of formation of gold ions was calculated, as well as for $AuCl_2$ and $AuCl_4$ in water solutions at elevated temperatures. Analysis of equilibria was made for the reaction: $8AuCl_2 + CH_4 + 2H_2O \rightarrow 8Au^\circ + 16Cl + CO_2 + 8H$. (Authors' abst.)

PAMPURA, V.D., 1977, Mineral formation in hydrothermal systems (physical and physico-chemical conditions): Moscow, "Nauka" Pub. House, 203 pp. (in Russian).

Consists of three chapters: 1) Peculiarities of geological structure and geothermic conditions of recent hydrothermal systems; 2) Mineral-forming solutions of hydrothermal systems; and 3) Heat and mass exchange inside hydrothermal systems. (A.K.)

PANICHI, C., FERRARA, G.C., and GONFIANTINI, 1977, Isotope geothermometry in the Larderello geothermal field: Geothermics, v. 5, p. 81-88. Authors at Ist. Internaz. Ricerche Geotermiche-CNR, Pisa, Italy.

The isotope geothermometers based on the $^{13}C/^{12}C$ fractionation between carbon dioxide and methane and on the $^{18}O/^{16}O$ fractionation between carbon dioxide and water vapour have been applied in Larderello geothermal field. The CO_2-CH_4 thermometer gives temperatures which are 50-200°C higher than those measured at the well head. The distribution of the isotopic temperatures within the field follows more or less similar patterns to those given by the well-head temperatures. They are believed to reflect the temperatures of formation of CO_2 and CH_4.

The CO_2-H_2O thermometer gives the temperature of the geothermal reservoirs tapped, and the difference between the isotopic temperature and the temperature measured at the well head is a measure of the cooling undergone by geothermal fluid on its way up to the surface. (Authors' abstract)

PANINA, L.I., 1977, Crystallization temperatures of several structural-textural varieties of alkaline rocks of Turii Cape (Kola Peninsula): Geolog. i Geofiz., Akad. Nauk SSSR, Sib. Otdel., no. 6, p. 45-51 (in Russian).

The presence and homogenization of inclusions of silicate melts (760-1320°C) in the rock-forming minerals of all structural-textural varieties of ijolite-melteigites of Turii Cape distinctively indicates their crystallization from magmatic melts. This relates also to the alkaline rocks of corroded and granoblastic structures and schlieren-taxitic textures as well as to monomineral i.e., pyroxene and nepheline schlieren segregations. It is stressed that the structural-textural rock peculiarities cannot usually serve as the basis for genetic conclusions. It has been found that the structural interrelation of minerals and the degree of their idiomorphism do not commonly correspond to the temperature succession of mineral separation. The latter is always constant in the alkaline rocks, with higher crystallization temperature for pyroxene compared to nepheline even though the mafic minerals enter the finegrained groundmass and the feldspathoid occurs as large idiomorphic phenocrysts. (Author's abstract)

PANINA, L.I. and KOSTYUK, V.P., 1976, Temperatures of formation of rocks of jacupirangite-ijolite series (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 105-106 (in Russian; translation by A. Kozlowski).

1. Alkaline rocks crystallized from melts or melt-solutions, see

table.

2. Minerals were replaced by melt activity: rims of aegirine-augite around phenocrysts of diopside-augite formed at 1240-1230°C (Odikhincha intrusion), although T of origin of diopside-augite was 1260-1220°C.

3. T of origin of the jacupirangite-ijolite series is close to the Ts of ultrabasic rocks, and less to basic rocks, bearing alkaline earths (see table). (Author's abst.)

T of crystallization of melts, °C

Province	Massif	Rock	Pyroxene	Nepheline
Maymecha-Kotuy	Guli	ijolite-melteigite	1150-1140, ms*	1100- 870, ms*
	Odikhincha	same	1260 ± 20, m	1210-1170, m
	Essey	jacupirangite-melteigite	1210-1100, m	1170-1150, m
Sayan	Beloziminskiy	ijolite-melteigite	1260-1190, m	1060-1030, ms
Kola-Karelia	Intrusions of Tur'iy cape	ijolite-porphyry	1320-1270, m	1210-1080, m
		pegmatoid ijolite	1320-1250, m	1190-1130, m
		fine- and medium- grained melteigite	1270, m	1190, m
		medium-grained ijolite	1310-1260, m	1190-1150, m
	Salmogorskiy	ijolite	1250-1220, m	1180-1120, m

*m = melts; ms = melt solutions

PANINA, L.I. and PODGORNYKH, N.M., 1975, Inclusions of melt in minerals from carbonatite of the Beloziminskiy pluton: Akad. Nauk SSSR, Doklady, v. 223, no. 6, p. 1447-1450 (in Russian; translated in Doklady Acad. Sci. USSR, Earth Sci. Sects., v. 223, p. 165-167, 1977). Authors at Inst. of Geol. and Geoph., Sib. Div., USSR Acad. Sci., Novosibirsk.

Olivine from forsterite-phlogopite-magnetite carbonatite bears only S incs. filled with silicate-salt melt-brine, T_H = 900-760°C. In pyroxene melt incs. occur: in augite from ijolite-urtites such incs. are P, filled by glass and xline phases, G bubble is not visible, but it appears at T = 1030-1050°C, occupying 4-5 vol. % of vacuole, at 1150°C most of incs. decrepitate, remaining have T_H = 1260-1190°C in ijolite-urtites and in diopside from carbonatites same P incs. - 1260-1200°C. S incs. in pyroxenes from carbonatites homog. at 1140-1080°C. P incs. in nepheline from ijolite-urtites are filled by silicate-salt melt-brines(solids:L:G = 80:15:5), T_H = 1060-1030°C in melt; S G/L incs. homog. in L at 210-60°C. Ankerite from carbonatites bears P incs. of melt-brines and S G/L incs., sometimes with solid phase. P incs. could be observed up to 670-730°C and further observations were precluded since ankerite became opaque; probable T_H = 900-950°C. T_H of S incs. in ankerite = 120-130°C (G/L) and 250-270 (three-phase incs.). Authors suppose that either alk. rocks and carbonatites formed at the same Ts ~1260°C, or more cold carbonatite magma (melt-brine) formed at late stage of development of magm. chamber, at T between 730 and 1000°C. (Abst. by A.K.)

PANINA, L.I. and PODGORNYKH, N.M., 1976a Temperatures of crystallization of the ultrabasic alkaline complex of Tur'iy cape, (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 107-108 (in Russian; translation by A. Kozlowski).

Results studies of melt inclusions in various rocks are given in the table:

Rock	Pyroxene	Melilite	Nepheline
Peridotite	1320-1280		
Pyroxenite	1310-1230		
Nepheline-bearing pyroxenite	1310-1300		1190
Uncompahgrite	1260 ± 20	1230-1210	
Turjaite	1260 ± 20	1230-1210	1130-1100
ljolite-porphyry	1320-1270		1140-1090
ljolite	1320-1260		1190-1150
Melteigite	>1270		1190
Nepheline-pyroxene carbonatite			1190

Carbonatite melt, saturated with water and salts, separated during crystallization. (Authors' abst.)

PANINA, L.I. and PODGORNYKH, N.M., 1976b Ultramafic alkaline magmatism of platforms, in Genetic studies in mineralogy, Yu. A. Dolgov et al., eds.: Novosibirsk, Inst. Geol. and Geophy. Sib. Branch Acad. Sci. USSR, p. 33-41 (in Russian).

The article covers geology, mineralogy and T_H of melt, melt-solution, and melt-brine inclusions in minerals of ultramafic alkaline rocks from the USSR: Maymecha-Kotuy province (massifs: Gulin, Odikhincha, Essey, Magan, Yllakh), Karelia-Kola province (Salmogorshiy massif), Turia Peninsula, E. Sayan. (Beloziminskiy massif), Enisey area (Riyskaya intrusion),+ covers essentially the same material as in papers abstracted in Fluid Inclusion Research - Proceedings of COFFI, v. 6, p. 118, 1973; v. 7, p. 162-164, 1974; v. 8, p. 139-140, 1975.

PANKRAT'YEV, P.V. and MIKHAYLOVA, Yu. V., 1977, Temperatures of ore formation of the polymetallic ores of the Southwest Gissar (Central Asia) (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. II, p. 87-88 (in Russian; translation by A. Kozlowski). Authors at Inst. Geol. Geophys. of Acad. Sci. of the Uzbek SSR.

Pyrite-polymetallic ores of the SW Gissar formed during volcanogenic-sedimentary and hydrothermal-metasomatic processes, connected with the Lower Carboniferous submarine liparites. Wall-rocks are quartz-sericite-chlorite and apocarbonate quartz-ankerite metasomatites of berezite formation. Also propylites developed widely. Minerals from berezites have initial T_D 220-240 to 250-280°C; and T of maximum decrepitation 220-380 to 370-400°C (quartz); same for propylites 220-240°C and 280-290°C (quartz); same for ores 180-320°C and 370-380°C, respectively. Late cutting ore-bearing veinlets are characterized by T_D 150-270°C (quartz, calcite, barite, sulfides). (From the authors' abst.)

PARILOV, Yu. S. and MIKHALEVA, V.A., 1977, Conditions of formation of sulfide-lead-zinc ores of some deposits of Kazakhstan (abst.), in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977):

Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. II, p. 89-90 (in Russian; translation by A. Kozlowski). Authors at Inst. Geol. Sci. of Acad. Sci. of Kazakh SSR.

Inclusions in minerals of the following deposits were studied: Shalkiya (hydrothermal-sedimentary ores consisting of galena, sphalerite and pyrite), Tekeli (metamorphosed hydrothermal-sedimentary ores -- same minerals), Zhayrem (hydrothermal-sedimentary ores consisting of sphalerite and pyrite with late endogene sphalerite-galena-barite mineralization) and Maykain (endogene polymetallic-pyrite ores). Hydrothermal-sedimentary ores formed at 40-80°C in shallow marine basins. Brines contained 4-30 g of G/kg (H_2S, SO_3, CO_2, N_2, rarely NH_3) and 225-280 g of salts/kg (SO_4, HCO_3, Br, F, Cl, Na, NH_4, Fe, Mg, Ca, $HSiO_3$); in the zones of hydrothermal flows G content reached 55 g/kg and salts -- 540 g/kg. During folding ores were metamorphosed at at T 100-120°C; G content increased up to 80 g/kg and salts -- up to 670 g/kg. At Tekeli deposit two stages of dynamic-thermal metamorphism were recognized, 500 and 300°C. At Zhayrem and Maykain deposits endogene ore formation began with metasomatic alteration of rocks at 400-500°C under action of solutions consisting of 820-600 g H_2O/kg, 25-130 gG/kg (H_2S, CO_2, N_2, Ar, sometimes CO, SO_3, NH_3, H_2) and 115-180 g of salts/kg (rarely up to 550 g/kg). Subsequent precipitation of sulfides was at T 150-490°C, from three kinds of fluids 1) supercritical hydrothermal solutions, 2) gas-water solutions at $T > 450°C$, 3) highly concentrated heterogene solutions or melts of sulfides in water-saline melts (H_2O 10-50 g/kg, G 20-100, rarely up to 300 g/kg, salts 680-970 g/kg, mainly HCO_3, SO_4, Fe, Ca, Na, rarely NaCl). The latter formed massive ores by way of recrystallization. (From the authors' abst.)

PARRY. W.T., BALLANTYNE, G.H. and WILSON, J.C., 1977, Chemistry of biotite and apatite from a vesicular quartz latite porphyry plug at Bingham, Utah: Econ. Geol., v. 73, p. 1308-1314.

Log f_{H_2O}/f_{HF} during crystallization of the vesicle filling was about 5. (ER)

PASHKOV, Yu.N., 1976, Decrepitobarophonic set (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 171 (in Russian; translation by A. Kozlowski).

Contemporaneous measurements were made of the acoustic and pressure effects and both curves were recorded together with T scale. Comparison of the curves permits distinguishing of effects connected with the breaking of inclusions. (From the author's abst.)

PAVLOV, A.V., 1976a, On the problem of connection of sulfide mineralization with acid volcanites of the S. Urals (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 85 (in Russian; translation by A. Kozlowski).

1. Composition of melt in P glass inclusions in phenocrysts of quartz from acid volcanites at the Ozernoe Cu sulfide deposit permits one to distinguish two series of rocks. The first one has a relatively high gradient (i.e., values?) of Mg/Fe (from + 0.23 in andesite-dacites to 0.18 in liparite-dacites) and a Ca increase during melt evolution.

The second series is characterized by relatively low values of Mg/Fe (from 0.18 in andesite-dacites to -0.02 (sic.) in liparite-dacites) and a decrease of Ca content during melt evolution. Hence, porphyry rocks formed in two stages from melts flowing from separate magmatic chanbers.

2. In certain varieties of volcanites of the second series, by laser microanalysis, an increased amount of Cu was found in P melt inclusions. This fact, together with the geological data, testifies to the paragenetic connection of the sulfide ores with acid volcanogenic rocks. (Author's abst.)

PAVLOV, A.V., 1976b Laser microprobe analysis of the composition of inclusions of solidified melts (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 175 (in Russian; translation by A. Kozlowski).

The LMA-1 analyser of "C. Zeiss, Jena" was used with high-voltage spark. Lower electrode is made in the shape of plate with hole ∿0.1 mm dia. and hence the impulse goes between upper and lower electrode, and does not contaminate the sample.

Silicon, as common element in melts, is used as the internal standard. Several (>10) parallel determinations are necessary, and results should be calculated by statistical methods. Analysed area has dia. ∿50μm. The method is rapid. (From the author's abst.)

PAVLOV, A.V., BOBOKHOV, A.S. and KHAIRETDINOV, I.A., 1976, Composition of inclusions of solidified melts in quartz of porphyries of the S. Urals (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 100-101 (in Russian; translation by A. Kozlowski).

Composition of solid phases of P melt inclusions was determined by laser microanalysis. Composition of melt inclusions is comparable with composition of bulk rock samples. In relatively fresh varieties, the petrochemical parameter (b) is in significant correlation with $\Sigma\Delta W = \Delta WMg + \Delta WAl + \Delta WCa + \Delta WFe$; this correlation is a diagnostic feature. Serious differences appear in analyses of rocks altered by regional and near-ore metamorphism. From the value of correlation index between element contents in inclusions and in bulk samples, a sequence of mobility was found: Al(0.61), Ca (0.49), Mn (0.45), Fe (0.4), Ti (0.2), Mg (0.15). (...) (From the authors' abst.)

PERCHUK, L.L., 1977a Improvement of the two-pyroxene geothermometer for deep-seated peridotites: Akad. Nauk SSSR Doklady, v. 233 no. 3, p. 456-459 (in Russian). Author at the Inst. of Exper. Mineralogy of the Acad. USSR, Chernogolovka, Moskovskaya obl.

PERCHUK, L.L., 1977b Pyroxene barometer and "pyroxene geotherms": Akad. Nauk SSSR Doklady, v. 233 no. 6, 1196-1199 (in Russian). Author at the Inst. of Experimental Mineralogy of the Acad. Sci. USSR, Chernogolovka, Moskovskaya obl.

PEREPELITSIN, Yu.A., TRUFANOV, V.N. and TIMCHENKO, N.A., 1976, Synthesis of fluid inclusions under conditions of an extremal thermogradient (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 162 (in Russian; translation by A. Kozlowski).

During synthesis of the various modifications of silica under extreme T and P gradients, in crystals of quartz and Z-phase[*] of SiO_2 fluid inclusions were found that are different than those described earlier in the literature. The following were distinguished a) globular and elliptical vacuoles filled with gas which is soluble in typical "inert" media such as castor oil, glycerine, etc., b) tubular and skeletal vacuoles "filled" with vacuum, c) isometric vacuoles surrounded by "satellite" inclusions filled by L phase under high pressure and having high viscosity. Peculiarities of the inclusions are explained by microcavitation effects. (Authors' abst.)

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[*] "Z phase" is any intermediate phase between silica gel and quartz, but not chalcedony - A.K.

PERNA, G., 1969, A new apparatus for the decrepitation method: Rendiconti Soc. It. Mineral. Petrol., v. 25, p. 107-119 (in Italian). Author at via Marsala 13, 38100 Trento, Italy.

In the view of a fluid inclusion study on Ba-F-(Zn)-(Pb) deposits of Trentino, (N. Italy), the scarcity of transparent minerals (sic. - P.L.) suggested the application of the decrepitation method. For this purpose, a decrepitation amplifier-recorder was expressly designed, and is described. The sample is heated in a ceramic furnace. The temperature is recorded by a thermocouple directly in contact with the sample. Decrepitation is recorded by a microphone, which in turn operates a pen recorder, giving a decrepitation vs. temperature plot. A fluorite sample, the fluid inclusions of which gave $T_H = 150\pm1$°C (no experimental detail given - P.L.), was found to decrepitate at 240 ± 20°C. Heating rate was 25 to 100°C/min., but seemingly did not affect T_D. Problems and applications of the equipment are discussed. (Abstract by Piero Lattanzi)

PETERSON, Ronald and FRANCIS, Donald, 1977, The origin of sulfide inclusions in pyroxene megacrysts: Amer. Min., v. 62, p. 1049-1051. Authors at Dept. Geol. Sci., McGill University, Montreal, Canada.

Clinopyroxene megacrysts in alkaline volcanic rocks commonly contain spherical sulfide inclusions of uncertain origin. In an augite megacryst from Nunivak Island, Alaska, numerous spherical sulfide inclusions define several sets of distinct planes corresponding to the common growth faces $(\bar{2}21)$ and $(\bar{1}11)$ of clinopyroxene. The sulfide spheres consist of pyrrhotite with chalcopyrite rims, and are interpreted as immiscible droplets which coated the rapidly growing faces of the pyroxene crystal. During crystal growth, local sulfide immiscibility may have been caused by the concentration of sulfur in the boundary layer between the crystal and the melt, due to crystal growth rates which exceeded melt diffusion rates. (Authors' abstract)

PETROV, R.P., (ed.), 1977, Textures and structures of the uranium ores of the endogene deposits: Moscow, "Atomizdat" Publishing House (in Russian).

Useful in studies of the origins of inclusions in such deposits. (ER)

PETROVSKII, V.A., 1977, Formation of inclusions in crystals during the overgrowth of gas bubbles, in Experiments in mineralogy and the modelling of mineral-forming processes: Inst. Geol. of Komi Filial, Acad. Sci. USSR, Trudy, v. 23, p. 64-72 (in Russian).

PETRUCHA, L.M. and CHOCHLATSCHEW, A.P., 1976, Some specific physical-chemical restraints on the formation of quartz crystal vugs in amphibolite of the southern Urals: Sammelwerk: Geol. Poiski i Raswedka nerud. polesn. Isokapajem, (Leningrad), v. 2, 34-42 (in Russian; German abstract in Zentral. für Mineralogie, 1977, Teil 1, Jahrgang 76/2, S. 136, translated by H.A. Stalder).

Veinquartz has been formed (according to the fluid-inclusion-studies) at relatively high temperatures. The aqueous solutions in the inclusions consist of hydrocarbons, chlorine, calcium and sodium, the gasphase of H_2S, CO_2, H_2, N_2 and rare gases.

PFEIFER, Hans-Rudolf, 1977, A model for fluids in metamorphosed ultramafic rocks: observations at surface and subsurface conditions (high pH spring waters): Schweiz. mineral. petrogr. Mitt., v. 57, p. 361-396.

PHILLIPS, R. and SMITH, F.W., 1977, Structural ore controls and palaeocirculation in fluorite veins in the North Pennine orefield, England, in Problems of Ore Deposition, Fourth Symposium of the International Assoc. on the Genesis of Ore Deposits, Varna, 1974: Sofia, Bulgaria, Bulgarian Acad. of Sci., v. III, p. 17-22 (in English).

Full paper corresponding to abstract in Fluid Inclusion Research -- Proceedings of COFFI, v. 7, p. 169, 1974. (ER)

PIERRET, R.F., GANTES, M. and GARREC, J.P., 1977, Fluorine and chlorine in the Etna plume and the resultant on surrounding vegetation (abst.): EOS, v. 58, p. 920.

PINNIKER, Ye.V., 1977, Forming of the recent hydrotherms in the areas of former volcanism (isotopic data), in: Hydrothermal process in the areas of tectonic-magmatic activity, p. 38-43, "Nauka" Publ. House, Moscow (in Russian).

PIPEROV, N.B., PENCHEV, N.P., and BONEV, I.K., 1977, Primary fluid inclusions in galena crystals. II. Chemical composition of the liquid and gas phase: Mineral. Deposita (Berl.)v.12, p. 77-89. Authors at Bulgarian Academy of Sciences, Sofia.

The chemical composition of primary individual inclusions in large galena crystals from the Madan ore district, Bulgaria was studied (See Bonev, 1977, this volume). The liquid phase was analysed for Na, K, Ca, Fe, Mn, Mg, NH_4^+, Pb, Cu, Zn, Al, Cl^-, F^-, SO_4^{2-}, HCO_3^-, and HS^- ($+ S^{2-}$); pH was also determined. The following analytical methods were used: atomic-absorption spectrophotometry, emission spectral analysis, spectrophotometry, nephelometry, microcrystalloscopic and drop reactions. The gas phase was analysed by mass spectrometer after opening the vacuoles in vacuum. It was found to consist of water vapour and CO_2 only. It was also found that the solutions are chloride-sodium-potassium with a total salinity of 4-4.5%. They do not contain measurable amounts of sulphur components. The CO_2/H_2O ratios vary strongly between the various vacuoles, which is explained by the crystallization in boiling solutions. The problems of the hermeticity of inclusions, the partial pressure of CO_2, the temperature of crystallization, and of the possible role of boiling in the ore-forming process are discussed. (Authors' abst.)

PIZNYUR, A.V., 1976, Thermobarogeochemistry of the molybdenum deposits (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 74-75 (in Russian; translation by A. Kozlowski).

Cu-Mo, Mo, and W-Mo deposits formed during several stages. P-T-X conditions of molybdenite precipitation: 1100-800 atm, 420-350°C, highly-concentrated chloride solutions. Tungsten and copper minerals formed at lower T (wolframite 350-280°C, chalcopyrite 300-240°C) from fluoride-rich and $Cl-CO_2-CO_3$ solutions. Salt concentration decreased from early to late stages. Initially pneumatolytic solutons condensed into hydrothermal ones, which boiled several times, resulting in formation of coexisting salt H_2O and CO_2-H_2O inclusions. Thermobarogeochemical criteria were applied for prospecting at Shirga, Zhireken and E Kounrad deposits. (Author's abstract.)

PIZNUR, A.V., 1977a, The sodium chloride and carbon dioxide solutions in gas-fluid inclusions: Mineralog. Sborn., v. 31, no. 1, p. 26-34 (in Russian).

The homogenization of inclusions from vein quartz to form homogenous fluids of H_2O+CO_2+NaCl was studied. The temperature and pressure of homogenization was determined to be above 315-335°C and $1500x10^5$-$1600x10^5$Pa. (Modified from the author's abstract)

PIZNYUR, A.V., 1977b, Essential parameters of formation of molybdenum deposits and their evolution in time (abst.) in Main parameters of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. I, p. 161-162 (in Russian; translation by A. Kozlowski). Author at the L'vov State Univ., L'vov.

Cu-Mo deposits are of pneumatolytic-hydrothermal type formed at elevated and moderate T. Salt concentration varied from 60-50 to 33-25% NaCl equiv.; composition varied from Cl-Na to $F-HCO_3-Mg-Ca$, occasionally with CO_2. Isotopic composition of O_2 and H_2 in fluid inclusions suggests the participation of meteoric waters in hydrotherms. Gases are mainly "acid group", CO_2 and in late solutions N_2.

Type of deposit	General T interval, °C	T of boiling solutions °C	General P, atm	T of Mo-bearing stages, °C	T of molybdenite crystallization, °C	P of molybdenite crystallization, °C	Name of deposit
Cu-Mo	730-50	450-400	1800-180	470-320	380-350	1250	Kounrad
		400-375			470-390	740	Sor
		350-315			450-355	1120	Bingham
		300-295			350-315?	--	Kadzhara
Mo	530-60	420-400	2600-220	470-340	380-340	1125-1000	Shakhtama
		400-350			400-360	900	Climax
		330-310			420-370	1000- 900	Zhireken

		240-230			370-340	—	Bugdaya
					380-370	—	Davenda
					380-350	--	Shirga
W-Mo	700 (including skarns)- 50	410-380	1500- 50	470-240	455-350	1150	Tyrnyauz
		380-340			420-360	1100	E. Kounrad
		340-300			425-385	1000	Akchatau
		300-260			400-370	--	Karaoba
					440-340		Dzhida

(From the author's abst.)

PLATONOVA, E.L., KOVALISHIN, Z.I., SASIN, G.G., and BRATUS', M.D., 1976, Conditions of formation of barite in Transcarpathians (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 200 (in Russian; translation by A. Kozlowski).

Barite mineralization in the Beregovo region is connected with formation of secondary quartzites and in several places it is a member of a vertical zoning (from the bottom): polymetallic, barite-polymetallic and barite ores. T_H 250-100°C. Barite of the barite-polymetallic ores formed at 180-230°C (Byegan'); platy barite crystals from sandstones at Muzhievo and Loposh have inclusions with lower T_H. Inclusions in barite from Byegan' bear CO_2 (3.54 to 39.70 vol. %), and Loposh - 22 to 87 vol. % of CO_2. Platy barite from tuffs contains the maximum CO_2 content, plus 2-6 vol. % of H_2 and up to 13 vol. % of CH_4. Solutions bear Na, K, Ca, Mg, Cl and occasionally SO_4; CO_3 and HCO_3 are almost completely absent; total salts 3-5 %.

Barite from quartz-barite veins of the Vyshkovo ore field, Vyhorlat-Gutinskaya horst, contains inclusions with T_H 170-250°C. In G phase in inclusions in barite and quartz, CO_2 prevails (66-76 vol. %), and solutions are of Ca + Mg > Na + K type. (From the authors' abst.)

PLUSNINA, L.P. and LIKHOYDOV, G.G., 1977, Prehnite stability in the system $Ca_2Al_2Si_3O_{12}$-H_2O-CO_2-NaCl, experimental data: Akad. Nauk. SSSR Doklady, v. 236 no. 3, p. 719-721 (in Russian). Authors at the Inst. Exper. Mineral. Acad. Sci. USSR, Chernogolovka, Moskovskaya obl.

POIROT, J.-P., 1974, Application of observations on inclusions in gem stones: Rend. Soc. Ital. Miner. Petrol., v. 30, p. 417-422 (in French).

The observation of inclusions brings to the jeweller the proof of a natural or an artificial origin of a cut stone. (Author's abstract, translated by H.A. Stalder)

POKALOV, V.T. and BOLOKHONTSEVA, S.V., 1977, Thermobarogeochemical conditions of forming of the tungsten-molybdenum deposit Malyi Oynogor (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. I, p. 163-164 (in Russian; translation by A. Kozlowski). Authors at VIMS, Moscow.

The deposit Malyi Oynogor consists of stockwork above a pluton of leucocratic granite. The first molybdenite-quartz stage formed from solutions of following parameters: T_H 360-440°C, P inclusions - G, G(40-50%)-L, polyphase with 1-3 dms (halite, sylvite and others); the second molybdenite-quartz stage-T_H 320-380°C, P inclusions-G, G(20-

30%)-L, LCO_2. Succeeding stages are characterized by the following features: scheelite-fluorite-quartz-accessory beryl-T_H 280-350°C, P inclusions G(15-25%)-L and LCO_2; pyrite-quartz-T_H 250-310°C, P inclusions G(15-20%)-L, LCO_2; galena-sphalerite-arsenopyrite-quartz-carbonate-T_H 240-290°C, P inclusions G(10-15%)-L, LCO_2; quartz-pyrrhotite-T_H 140-200°C, P inclusions G(5-10%)-L, G+L+sylvite (up to 10%); quartz-carbonate-T_H 60-120°C, P inclusions G(3-5%)-L and L. During precipitation of molybdenite P was >>1000 bars, scheelite-900 to 1000 bars, quartz-pyrrhotite-300-350 bars. (From the authors' abst.)

POLYAKOV, V.O., 1976, Ontogenic study of amazonite pegmatites from Il'menshiye Mtns (abst.): Problems of genetic information in mineralogy (Proceedings of the All-Union Mineralogical Seminar Syktyvkar, June 1-4, 1976: Syktyvkar, Acad. Sci. USSR, Komi Div., p. 109-110 (in Russian; translation by A. Kozlowski). Author at Il'menskiy Reservation of the Ural Sci. Center of Acad. Sci. USSR, Miass.

Topaz, crystallizing in pegmatites with last crystals of amazonite and up to the beginning of crystallization of tourmaline; T_H of P inclusions in topaz 300-250°C. Accessory phenakite, in part paragenetic with topaz, bears inclusions with T_H 270-250°C. (A.K.)

POLYKOVSKIY, V.S., ELINSON, M.M., and SHUVALOV, V.B., 1976, Gases in hydrotherms of the endogene deposits in the Western Tyan'-Shan' (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 183 (in Russian; translation by A. Kozlowski).

1. With the sequence of formation the gas content in quartz decreases: pegmatites 400.0, quartz-feldspar veins 223.8, rock-crystal bearing quartz veins in skarns, quartz veins in greisens 124.1, quartz-fluorite veins 93.8 cm^3/kg.

2. N_2,CO_2,H_2 prevail in inclusions, and sometimes CH_4, Ar and He are present, with the following relationships: $N_2>CO_2>H_2$ in pegmatites and quartz-feldspar veins, $N_2>H_2>CO_2$ in rock-crystal-bearing veins, $H_2>N_2>CO_2$ in veins in greisens and quartz-fluorite veins. Garnets from skarns bear $N_2>CO_2>H_2$ and fluorites from veins, $N_2>H_2>CO_2$.

3. In granites N_2 prevails, in skarns, CO_2 ($N_2>CO_2>H_2$ (sic.)), and in zones of quartz-greisen, chlorite and quartz-fluorite mineralization, $N_2>H_2>CO_2$. H_2 dominates in solutions from silicfied, muscovitized granites and greisens.

4. Ar, He and CH_4 were found in inclusions in pegmatites, quartz-feldspar veins and skarns. Maximum Ar contents were in garnets from skarns, in pegmatites and in rock-crystal-bearing veins (3.6-3.6 cm^3/kg). He content in quartz from pegmatites was 0.0650 and in quartz-feldspar veins, 0.0034 cm^3/kg. CH_4 was found in quartz from pegmatites (3.4cm^3/kg) and rock-crystal-bearing veins in skarns (1.0) and granites (1.1), chloritized granite-porphyries (3.2), granites close to quartz-feldspar veins (0.7).

5. Higher concentrations of H_2 in quartz from skarns, greisens and quartz-feldspar veins suggests that it may form during skarn-forming and greisenization processes under the action of F-bearing solutions. (Authors' abst.)

POLYKOVSKII, V.S. and KOZ'REV, V.N., 1977, On temperature conditions of formation and minor elements in fluorite: Mineralog. obshch.

Uzbekistanskoe otdel., Zapiski, v. 28, p. 166-167 (in Russian).

Author attempts to relate T_H (320-80°C) with other variables. (ER)

PONNAPERUMA, Cyril, ed., 1977, Chemical evolution of the early Precambrian: New York, Academic Press, 234 pp.

Includes discussions of release of volatiles to form the atmosphere, carbon and hydrogen (& their isotopes) in Precambrian organic matter, etc. (ER)

POPIVNYAK, I.V., 1976, Peculiarities of ontogeny of inclusions at elevated temperatures (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 103-105 (in Russian; translation by A. Kozlowski).

Decrepitated crystallized inclusions were studied in olivine and garnet from kimberlite pipes "Mir" and "Udachnaya." Daughter inclusions formed over a wide T range with lower T limit 750-650°C. Comparison of thermal expansion, compressibility, resistivity etc. of host mineral and inclusion filling supports the assumption of natural decrepitation caused by cooling. (sic.) (Author's abst.)

POPOV, V.A., 1977, Morphological series of calcite: Vses. Mineral. Obshch. Zapiski, v. 106, no. 2, p. 222-226 (in Russian). Author at Il'menskiy State Reserve of the Urals Sci. Center, Acad. Sci. USSR, Miass.

Calcite with tabular habit is not always a high-T variety; at Dal'negorsk deposits T_H of G/L inclusions in such calcite is 340-150°C. (A.K.)

POPOV, V.S., 1977, Geology and genesis of copper- and molydbenum-porphyry deposits: Akad. Nauk SSSR, Ministerstvo geologii SSSR, Institut mineralogii, geokhimii i kristallokhimii redkikh elementov; Izdatel'stvo "Nauka", Moscow, 203 pp. (in Russian).

Pages 119-124 constitute a summary of the results of a study of gas-liquid inclusions in porphyry deposits, and includes a table (no. 34), giving data from the literature on 14 deposits. Temperatures as high as 800° are noted (Kal'makyr), and very high salt concentrations. The pressure determinations are characterized as high and "not very reliable." (ER)

POTTER, R.W., II, 1977, Pressure corrections for fluid-inclusion homogenization temperatures based on the volumetric properties of the system $NaCl-H_2O$: Jour. Research U.S. Geol. Survey, v. 5, no. 5, p. 603-607. Author at U.S. Geol. Survey, Menlo Park, CA 94025.

A series of pressure correction diagrams for 1-, 5-, 10-, 15-, 20-, and 25-percent NaCl solutions has been generated from the volumetric data for NaCl by R.W. Potter II and D.L. Brown in 1975. The diagrams cover the temperature range from 20° to 400°C at pressures up to 200 mega-pascals (2000 bars). These data can be used to correct fluid inclusion homogenization temperatures for pressures greater than the liquid-vapor pressure-temperature curve. (Author's abstract)

POTTER, R.W., II, BABCOCK, R.S., and BROWN, D.L., 1977, A new method for determining the solubility of salts in aqueous solutions at elevated temperatures: Jour. Research, U.S. Geol. Survey, v. 5, no. 3, p. 389-395. First author at U.S. Geological Survey, Menlo Park, CA 94025.

A new method for measuring the solubility of simple salts in water at elevated temperatures involves heating assemblages of salt crystals plus solution + vapor at a constant rate in a platinum-lined bomb. The dissolution of the last salt crystal is evidenced by a distinct discontinuity in the pressure-temperature curve. Studies of the solubilities of NaCl and of KCl in water yielded equations expressing the solubility as functions of temperature, t in °C, at the vapor pressure of the solutions as follows:

$$\text{weight percent NaCl} = 26.218 + 0.0072t + 0.000106t^2 \pm 0.05 \text{ weight percent NaCl}$$

$$\text{weight percent KCl} = 27.839 + 0.0794t + 0.000027t^2 \pm 0.10 \text{ weight percent KCl}$$

The NaCl and KCl data were measured over the temperature range 148° to 425°C and 148° to 371°C, respectively. However, the equation for NaCl appears to be valid over the range 0° to 800°C and the KCl equation appears valid over the range 100° to 450°C. (Authors' abstract)

POTTER, R.W., II, CLYNNE, M.A. and MAZOR, Emanual, 1977, Noble gas partition coefficients applied to the conditions of geothermal steam formation (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 1132-1133. First author at U.S. Geol. Survey, Menlo Park, California 94025.

Geothermal systems are recharged by meteoric waters that contain dissolved atmospheric He, Ne, Ar, Kr, and Xe that are recognizable from their isotopes. The original noble gas concentrations can be reconstructed from observed values for ambient temperatures and altitudes of the assumed intake areas. Previous studies have revealed that groundwaters retain their atmospheric noble gases in closed systems, but, where waters boil, the noble gases partition into the steam phase. A variety of fractionation patterns and varying amounts of noble gas depletion are found in liquid and steam phases obtained from hot springs and geothermal production wells.

For the inert gases, partitioning coefficients between steam and liquid, up to the critical temperature of water, have recently been determined and can now be applied to the behavior of noble gases in nature to: (a) check whether samples reequilibrated with air prior to collection; (b) establish whether a water has boiled and what fraction of steam has formed; (c) calculate an effective boiling temperature; and (d) recognize mixing of steam either with water that has not boiled or with lower temperature steam.

Thus, according to measured noble gas concentrations, steam from a fumarole at Bumpass Hell, Lassen Park, California, is a mixture of higher temperature steam and colder groundwater. At Larderello, Italy, two categories of wells are encountered, those which tap waters depleted in noble gases and those which tap separated steam. The first category represents a state of advanced exploitation. For the second category the noble gas contents indicate boiling temperatures of 250° ± 20°C compared with measured temperatures of 222° to 242°C. (Authors' abstract)

POTTER, R.W., II, SILBERMAN, M.L., NISSENBAUM, A. and MATHEWS, A., 1977, Mineralogy and isotope geochemistry of the Kennecott massive copper sulphide deposits, Alaska (abst.): Geol. Assoc. Canada-Min. Assoc. Canada Program with Abstracts, v. 2, p. 42. First author at U.S. Geological Survey, Menlo Park, California.

The Kennecott massive sulphide deposits were initially deposited as a pyrite-chalcopyrite-bornite-covellite-luzonite assemblage, implying a low formation temperature. Textural evidence suggests complex multistage processes were responsible for replacement of the original assemblage by chalcocite-djurlite-digenite-anilite-blaubleibender covellite-covellite. The latter assemblage indicates formation temperature below 93°C. Fluid inclusions from calcite veins containing sulphides have homogenization temperatures of 50°C and salinities of 15%. (From authors' abstract.)

POTY, Bernard, 1977, Intragranitic uranium ore deposits at Limousin and Forez, France (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 1133-1134. Author at Centre de Recherches Petrographiques et Geochimiques, C.O. No. L, 54500--Vandoevre-les-Nancy, France.

Uranium deposits at Limousin are located in the Saint Sylvestre two-mica granite, which is 318±15 m.y. old. At the end of the Hercynian orogeny (285±10 m.y.) lamprophyric and microgranitic dikes were injected into ENE fractures. They produced heat and caused circulation of hydrothermal solutions along ENE and E-W fractures. Episyenite alteration was produced at that time. New fractures trending NW received CO_2- and U-rich fluids. Pitchblende was deposited with pyrite during unmixing of this CO_2-H_2O fluid, probably caused by decrease of pressure, at close to 345°C in one ore body. Following pitchblende deposition, solutions were again exclusively aqueous and temperature decreased regularly: 330 to 140°C for quartz deposition, 150 to 140°C for coffinite, and 135 to 85°C for fluorite. The Bois Noirs uranium vein at Forez is located in an Hercynian biotite granite (335±8 m.y.) which is characterized by magmatic differentiation followed by intense postmagmatic alteration. The more differentiated granites are leucogranitic and enriched in uraninite. A paragenetic sequence of six steps has been established in the uranium vein and the evolution of fluids from step to step documented. Two main types of uranium mineralization have been distinguished. Primary pitchblende was deposited with iron sulfides and quartz in reopened old E-W trending fractures in the late Hercynian from CO_2-bearing hydrothermal solutions at about 85°C and 100 bars. Secondary ore (black oxides and U^{6+} minerals) was deposited in NW-trending structures during uplift of the Forez horst in the Oligiocene. The Limousin and Forez uranium deposits will be compared from the point of view of granite formation, tectonics, and mineral-solution reactions. (Author's abstract)

PRICE, L.C. and RUMEN, L.L., 1977, Possible new deep source of energy (abst.): Geological Research 1977, U.S. Geol. Survey Prof. Paper 1050, p. 23-24.

A solubility study on crude oil in water as a function of temperature, pressure, and the presence of organic and inorganic gases showed that oil and methane have very high solubilities at temperatures above 275°C. Organic geochemistry studies of deep wells (as much as

9,450 m deep) showed that the generation of hydrocarbons can occur at such depths and that hydrocarbons are thermally stable at much greater depths and higher temperatures than investigators had believed previously. The thermal stability of hydrocarbons was also documented in laboratory cracking experiments. (From the authors' abstract)(Pertinent to many inclusion fluid compositions. E.R.)

PRICE, W.F., HUNTINGDON, A.T., and BAILEY, D.K., 1977, The effect of crushing on the release of volatile components from heated obsidian: Min. Mag., v. 41, p. 551-553.

PROKOPOV, N.S. and TIMCHENKO, N.A., 1976, Comparison of determinations of temperatures of mineral-formation from inclusion studies with their true values (laboratory data) (abst.): Problems of genetic information in mineralogy (Proceedings of the All-Union Mineralogical Seminar, Syktyvkar), June 1-4, 1976: Syktyvkar, Acad. Sci. USSR, Komi Div., p. 76-77 (in Russian; translation by A. Kozlowski). Authors at the Rostov State Univ., Rostov.

T_D of minerals, grown under known conditions were studied.

Mineral	T of growth, °C	T_D, °C	Conditions of experiment	$P_{initial}/P_{final}$ (atm?-A.K.)
Chalcocite	320	280-320	Cooling	1200/1
do.	320	{ 40-140 160-220	Explosion	1200/1
do.	320	{ 40-120 180-240	do.	1200/1
do.	320	{ 40-120 160-260	do.	1200/1
Sphalerite	280	160-260	Cooling	900/1
do.	280	240-270	do.	900/1
do.	280	{ 40-120 180-240	Explosion	900/1
Galena	250	180-240	Cooling	800/1
do.	250	190-250	do.	800/1
Quartz	300	{ 40-120 160-320	Explosion	600/1
do.	300	{ 40-140 180-260	do.	500/1

Modal values of T_D are close to T of growth with differences of -10 to -100°C. T_D depends on the speed of cooling and decrease of P (during crystal growth? E.R.). When cooling was very fast, like an explosion, there appear additional, low-T decrepitation effects, connected seemingly with adiabatic increase of volume during opening of the autoclave. (From the authors' abst.)

PROKOPTSEV, N.G., 1977, On dynamics of the fluid phase (transmagmatic solutions) in alkali-basalt melt: Akad. Nauk SSSR Doklady, v. 234 no. 6, p. 1441-1444 (in Russian). Author at the South Division of the Inst. of Oceanology of the Acad. Sci. USSR, Gelendzhik.

Pertinent to separation of solutions from melt. (A.K.)

PRONIN, A.P., BESPAEV, Kh.A. and POLKOVNIKOVA, T.N., 1977, P-T parameters of hydrothermal mineral-formation at the pyrite-polymetallic deposits of the Rudnyi Altai, in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci.

Council on Ore Formation, Sib. Branch, v. II, p. 91-92 (in Russian; translation by A. Kozlowski). Authors at Inst. Geol. Sci. of Acad. Sci. of Kazakh SSR.

T_D (beginning of decrepitation) ranges for quartz of berezites, ores and sulfide-quartz veins from 240 to 380°C but most frequently it is 300-340°C. T_H (in liquid) of inclusions in quartz, barite, sphalerite varies from 220 to 370°C (commonly 260-310°C). At Zyryanovskoe and Irtysh polymetallic ore deposits P_{CO_2} evaluated by the Naumov and Malinin method was 950-1100 atm. (From the authors' abst.)

PROSKURYAKOV, A.A., SOTNIKOV, V.I. and KHRENOV, V.A., 1977, On composition and PT-parameters of mineral-forming solutions in gold-ore deposit Charmitan (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Sib. Branch, v. II, p. 44-45 (in Russian; translation by A. Kozlowski). First author at Novosibirsk Univ.

Charmitan deposit, belonging to the Au-quartz low-sulfide formation of moderate depth, occurs in the North-Nuratin gold ore belt (W. Uzbekistan) and is connected with the SE margin of the Koshrabad granitoid massif. Four stages of mineralization were distinguished: 1) gold-quartz, 2) pyrite-arsenopyrite, 3) gold-sulfide-polymetallic, 4) quartz-carbonate. Fluid inclusions were studied in quartz, scheelite, sphalerite, calcite and fluorite. Veins began to form at 550-450°C, together with feldspathic metasomatites in wall rocks, from solutions of low density rich in CO_2. Au-Bi-telluride (+ early scheelite) association formed at ~400°C under high P. The second and beginning of the third stage associations crystallized at 1000-1250 atm, and 360-250°C and 300-120°C, respectively. At T interval 400-250°C CO_2 concentration increased up to 95% and its density became as high as 1.3 g/cm^3 at 280-250°C, causing berezitization in the margins of gold ore bodies.

CO_2-rich solutions were followed by Cl-HCO_3-Na and Cl-Na solutions forming Au-sulfide-polymetallic associations. Abrupt decreases of P were found in the course of mineral-forming process, from 1200 down to 500-300 atm, caused by tectonic movements. (From the authors' abst.)

PSHENICHNYI, G.N., 1976, Vertical extent and depth of the sulfide ore formation at the Gaiskoe deposit (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 85-86 (in Russian; translation by A. Kozlowski).

P in inclusions in quartz, collected at 200 m below the present surface, are close to 560 atm. Vertical extent of sampling is 1200 m, and the difference in the P value between upper and lower end of section is 250 atm. This value is similar to the mean lithostatic pressure 250 atm/km. Hence, the vertical extent of ore mineralization probably ranged from 1800-2000 m to 3600-3800 m. T of precipitation of sulfides and paragenetic minerals (T_H and T_D) vary from 190-200 to 370-380°C. Early associations formed at 400-350°C and late ones at 120-150°C. (Author's abst.)

PSHENICHNYI, G.N., KHAYRETDINOV, I.A. and ANDRYANOVA, N.A., 1977, Temperatures and depth of ore formation in the deposits of the pyrite type of the Southern Urals (abst.), in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Sib. Branch, v. II, p. 93-94 (in Russian; translation by A. Kozlowski). Authors at the Inst. Geol. of Bashkir Division of Acad. Sci. USSR, Ufa.

The deposits formed during Caledonian and Variscan cycles in several stages. Ores are of 1) epigenetic hydrothermal-metasomatic, 2) exhalation-sedimentary, and 3) hydrothermal-sedimentary origin. Studies of T_D and T_H were carried at Uzel'ga, Podol'skoe, Gay, Uchaly and the XIX Party Congress deposits. Quartz from pre-ore associations bears inclusions with T_H <100-140°C, rarely up to 170-200°C in metasomatites with common pyrite. T_H for early pyrite associations equals 200-250°C (up to 270-350°C at Gay deposit); P -- 80-120 atm at the deposits: Uchaly, XIX Party Congress Uzel'ga and 650-800 atm at Podol'skoe and Gay (all data for quartz). Inclusions in quartz, fluorite, barite, calcite of the commercial ore stage have T_H 310-390°C; P at Gay and Podol'skoe 600-800 atm; T_H in quartz of late ore associations ≤260-280°C. Mg-Fe carbonates accompanying pyrrhotite ores of Uzel'ga, and overlapping all commercial ores of Cu and Zn, T_H is 170-200°C. Post-ore associations have T_H]50-200°C, exceptionally reaching 300-350°C (both in quartz). General T_H interval of inclusions in gangue minerals is 140-380°C. The probable depth of formation of ores was evaluated as 1700-3800 m (Gay deposit). (From the authors' abst.)

PUCHKOV, Ye.V., 1977, Parameters of formation of the porphyry copper deposits of Kazakhstan (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. I, p. 165-166 (in Russian; translation by A. Kozlowski). Author at the Kazakh Inst. Mineral Raw Materials of Ministry of Geology, Tashkent.

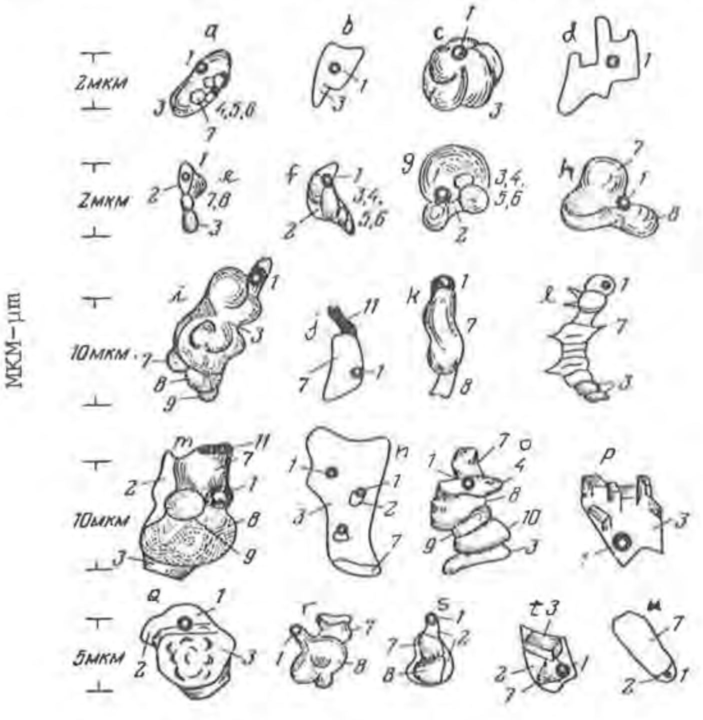
T by homogenization and decrepitation method: chalcopyrite-molybdenite 360-430°C, chalcopyrite-enargite-tetrahedrite 220-340°C, bornite-chalcocite-polymetallic 100-210°C, P reaches 1000 atms. (Abstract by A.K.)

PUZANOV, L.S., 1977, On the origin of fluorite mineralization in carbonatites of the Bol'shetagninskiy massif (E. Sayan): Akad. Nauk SSSR Doklady, v. 233 no. 3, p. 463-466 (in Russian). Author at the All-Union Sci.-Research Inst. of Natural Raw Materials, Moscow.

Previous studies of inclusions in fluorite from the fluorite-barite-hematite-siderite ores in the Karasug and Choakhol'skiy carbonatite massifs yielded T_H >720°C in melt and P 4-6 kb. Similar inclusions were found in fluorite from the Bol'shetagninskiy massif. Coarse-crystalline late fluorite bears P inclusions (G 30-70 vol.%), T_H 500-550°C and S inclusions (G <10 vol.%), both homogenizing in L. Finely-crystalline early fluorite bears numerous P inclusions: 1) solid (minerals), 2) crystals + G, 3) polyphase, 4) G/L. Solid inclusions, both isotropic and anisotropic formed by nucleation of crystals in melt (euhedral ones) or by precipitation simultaneously with growth of (the host) mineral (drop-shaped ones), dimensions from <1 to 10-15 μm; isotropic solids: Na and K chlorides; anisotropic: biotite, apatite, aegirine, actinolite, riebeckite, ore minerals. Crystal + G inclusions bear iso- and anisotropic dms, but without dark, strongly pleochroic ones. Isotropic dms are Na and K chlorides (Fig. 1: a-phases 4-6, d-3, p-3, q-3, t-3), and anisotropic ones--seemingly carbonates and sulfates; G 3-5 vol.%. In tubular inclusions, microliquation (i.e., melt immiscibility) is very distinct (Fig. 1 j,k,l). Number of phases varies from 1 to 7, sometimes solid phases bear vacuoles with G + L (Fig. 1n). P inclusions bear 70-80 vol.% of solids, 5-10 to 30 vol.% of L and 5-10 vol.% of G. PS inclusions bear no more than 2 solid phases (up to 40-50 vol.%), L (40-50 vol.%) and G (5-10 vol.%, see Fig. 1t). S G/L inclusions bear G from 5-10 to 60-70 vol.%.

Crystal + G inclusions have T_H 720-680°C, polyphase P inclusions--670-600°C, polyphase PS ones--550-500°C, G/L S ones--440-270, 240-150 and 130-90°C. Thus fluorite formed in two stages: a) from halide-alkaline earth-alkali melts, b) from hydrothermal solutions. (Abst. by A.K.)

Fig. 1. Types of G + crystal and polyphase inclusions in early fluorite from the Bol'shetagninskiy carbonatite massif; 1-G, 2-L, 3-6--isotropic dms, f-10--anisotropic dms, 11-ore dm (see also abstract).



PUZANOV, L.S. and KANDINOV, M.N., 1976, Condition of formation of fluorite in various ore formations (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 199 (in Russian; translation by A. Kozlowski).

Fluorite-bearing carbonatites connected with ultrabasic complexes (fluorite-barite-siderite and fluorite-barite-hematite ores with accessory rare-earth fluorine-carbonate mineralization) are of magmatic origin. Ores formed from melt-solutions at $T_H > 700°C$ and $P > 4-6$ kbar. CO_2 + hydrocarbons occupy > 30 vol. % of the inclusions.

The pneumatolytic-hydrothermal type consists of fluorite-bearing greisens and albitites with rare-earth mineralization. Fluids in inclusions are saturated with halides and CO_2; T_H 400-550°C; P 700-750 bar.

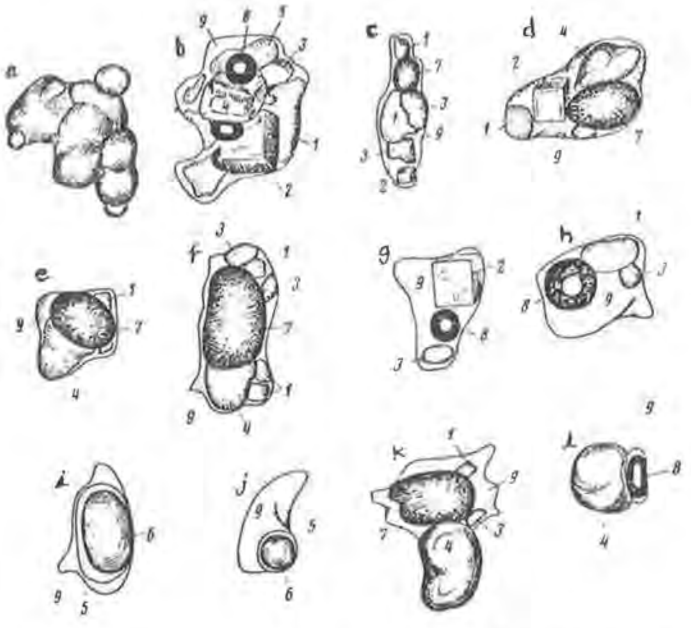
Hydrothermal deposits of type I (rare-metal-fluorite formations) bear feldspar-phenakite-fluorite, leucophane-fluorite and feldspar-fluorite ores. Fluids in inclusions are highly concentrated; T_H 350-450°C. Type II fluorite formations contain carbonate-fluorite, quartz-fluorite and quartz-barite-carbonate-fluorite associations. Fluorite is the main ore mineral, T_H 90-250°C, crystallization in hydrothermal deposits was both from real and colloidal solutions. Supergene fluorite is connected with vadose waters; commercial ores formed at T 120-200°C. (Authors' abst.)

PUZANOV, L.S., PARTSEVSKIY, A.I. and BEBIK, A.N., 1977, On magmatic type of fluorite ore mineralization in Aldan: Akad. Nauk SSSR Doklady, v. 236 no. 3, p. 704-707 (in Russian). Authors at the All-Union Sci.-Research Inst. of Mineral Raw Materials, Moscow.

Samodumovskoe deposit is connected with monzonite-syenite and leucitite-alkali syenite formations of Lower Jurassic to Upper Cretaceous age. Magmatic rocks typically bear accesory fluorite and apatite. Fluorite ores occur in Lower Cambrian limestones. Quartz-fluorite ores bear P, PS and S 1-5 μm long inclusions of magmatic origin, filled with melt and/or several crystal phases. Dms include hornblende, apatite, quartz, ore mineral and Na and K chlorides. Individual drop-like inclusions and their aggregates consist of quartz glass (sic.) and carbonate (Fig. 1a). Polyphase inclusions are divided into 2 groups: 1) solids 70-90%, G $\leq$ 10%, LH_2O 10-20% (Fig. 1b), T_H 870-800 in melt; 2) a. solids 70-80%, $L(CO_2 + H_2S) + G(CO_2 + H_2S)$ 10-20%, LH_2O 10-20% (Fig. 1c); b. solids 25-30%, $L(CO_2 + H_2S) + G(CO_2 + H_2S)$ 60-70%, LH_2O 5-10% (Fig. 1f); both a. and b., and intermediate between them (Fig. 1d-e) have T_H 790-730°C, but when LCO_2 >50%-in fluid, and when LCO_2 <50%-in melt. Inclusion types 2a-2b form by boiling of melt. Freezing point of L phase (-68°C) is between triple point of CO_2 (-56.6°C) and triple point of H_2S (-86°C), hence the determination of the qualitative composition. P inclusions also formed close to droplets of carbonate; the latter caused the trapping (Fig. 1k-l).

PS inclusions are filled with: 1) solids 30-35%, G10-15%, LH_2O 50-60% (Fig. 1g), T_H 480-450°C; or 2) solids 20-25%, G 20-30%, LH_2O 45-60% (fig. 1h), T_H 520-500°C. Early S inclusions bear LCO_2 (Fig. 1i-j): LCO_2 10%, G 20-25%, LH_2O 65-70% or LCO_2 10-20%, G 60-75%, LH_2O 15-20%, homogenizing in L at 325-250°C or in G at 380-325°C, respectively. Late G/L S inclusions yield T_H 150-130°C. Thus, fluorite formed from a melt consisting of Si, Ca, Na, K, F, Cl, CO_2, H_2S (subordinate P, Mg, Fe), injecting fractures and causing melting of edges of carbonate wall rocks. In the bottom part of the ore body, a melt split due to liquation into quartz and fluorite phases, forming banded ores. (Abst. by A.K.)

Fig. 1. Types of inclusions in fluorite and quartz from Samodumovskoe deposit (authors' drawings from micrographs): P inclusions, a-aggregate of carbonate droplets, x350; b-polyphase without LCO_2, x700; c-f-polyphase, CO_2-bearing (c,d-x1300, e-x2800, f-x1050); PS polyphase inclusions without LCO_2, g-x4500, h-x2800; S $LCO_2 + LH_2O$ + G inclusions, i-x1700, j-x2100; k,l-anomalous inclusions, x900. 1-isotropic dm, 2-halite, 3-anisotropic dm, 4-carbonate, 5-LCO_2, 6-$G(CO_2)$, 7-$L(CO_2 + H_2S) + G(CO_2 + H_2S)$, 8-G, 9-$LH_2O$.



PYOTROVSKIY, V.A., 1976, Formation of spatial defects in crystals near a trapped particle (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 161 (in Russian; translation by A. Kozlowski).

1. Trapping of solid inclusions in crystals of K-Al alum was studied under thermostatic conditions. Supersaturation of solution (ΔT) varied from 0.5 to 12°C. Influence of those inclusions on internal structure and faces was investigated especially carefully.

2. Solid inclusions are trapped mostly on faces almost parallel to the direction of flow; bottom faces are inclusion-free.

3. On vertical faces, solid inclusions are surrounded by layers of growth at a very early stage of crystallization, even when ΔT is very low. Center of growth, with dividing layers, usually may be observed below the solid particle. Later layers become dentate with G/L inclusions perpendicular to the edge of layer. When growth in the shadow of particle lasts a long time, part of a negative crystal is formed, and flat inclusions of mineral-forming solution are trapped. The speed of overgrowing of particles depends on their shape. (Author's abst.)

PYOTROVSKIY, V.A., 1977, Formation of inclusions in crystals during overgrowing of gas bubbles: Trudy Inst. Geol., Komi Filial, Akad. Nauk SSSR, 1977, no. 23 ("Experiment in mineralogy and modelling of mineral-forming process"; N.P. Yushkin, ed.), p. 64-72, in Russian.

Alum crystals growing from supersaturated solution in stream of ascending gas bubbles were used as model of mineral-formation under conditions of boiling. Stream of bubbles causes characteristic hydrodynamic flow transporting dissolved substance. Bubbles 0.01-0.1 mm dia., formed by dividing of larger bubbles, stick to the bottom faces of growing crystal and migrate on their surface until they stay in defects of growing face. Maximum dia. of such bubbles that may be stuck depends on the peculiarities of relief of face. Next bubbles are trapped by crystal and form G/L inclusions with varying F. When under cooling (Δt) of solution is small (0.5-2°C), the strictly horizontal bottom face of the crystal has only 1-3 vicinal faces. G bubble is overgrown with formation of distinct, big steps. When Δt is 8-10°C bubble gives a "shadow", and due to this the vacuole is curved. In the area of the "shadow," flat L inclusions form. When volume of G bubble changes during trapping, if Δt is 0.5-2, the morphology of the inclusion becomes complicated, and the vacuole enlarges in diameter due to accretion of new bubble to that just being trapped. Even under a uniform rate of growth, volume of vacuole changes unevenly. Tubular vacuoles also occur, when rate of growth and increase of G bubble are balanced. If Δt is 8-10°C, vacuoles change their direction and they may even join one another. All complicated vacuoles become simpler during a period of time after having been sealed, if they are filled by L; G inclusions do not change their morphology. Since the geometry of convection flow is established, causing various patterns of supply to the same growing face, there are various inclusion vacuoles in different parts of the same face. (Abst. by A.K.)

RAKHMANOV, A.M., 1976, Stages of formation of the deposit Takfon (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 80 (in Russian; translation by A. Kozlowski).

Sn-W deposit Takfon, occurring between limestones and shales of the Upper Silurian, consists of pyroxene, garnet-pyroxene and actinolite - pyroxene skarns with overlapped scheelite-cassiterite and sulfide mineralization. T_H of skarn stage (pyroxene, garnet, actinolite) varies from 620 to 400°C, pneumatolytic-hydrothermal stage (quartz-rare metal substage)-550-250°C, quartz-sulfide stage - 470-290°C, quartz-carbonate stage - 360-290°C.

In water leachates from pyroxene, garnet, arsenopyrite, and pyrrhotite, the following ions were found: CO_3 (only in pyroxene), HCO_3, Cl, SO_4, Ca, K, Na, Mg. (Author's abst.)

RAMSAY, J.G., 1977, Fluid inclusions as an indication of metamorphic grade in the Swiss Alps (abst.): Inst. Mining and Met., Trans., Sect. B, v. 86, p. B160.

(Abstract not printed)

RANKIN, A.H., 1977, Fluid-inclusion evidence for the formation conditions of apatite from the Tororo carbonatite complex of eastern Uganda: Mineralogical Magazine, v. 41, p. 155-164. Author at Div. of Mining Geology, Royal School of Mines, Imperial College, London S.W.7.

Portions of the carbonatitic fluids responsible for the deposition of apatite from the Tororo carbonatite complex are trapped and preserved as minute (<100 µm) inclusions within the apatites. These fluids consist predominantly of alkali-carbonate-bearing brines and demonstrate that water and alkalis played an important role in the formation of the carbonatites from this complex. Furthermore, the opinion that carbonatite "magmas" are richer in alkalis and water than the chemistry of the carbonatites themselves reveal is clearly substantiated. The mean minimum formation temperature of the apatites from five separate carbonatite samples were determined from the homogenization temperatures of 200 primary aqueous inclusions. The results from Limekiln Hill samples (328°C, 321°C, 359°C) are similar to those from samples of the separate carbonatite mass at Tororo Rock (353°C, 365°C). (Author's abstract)

RATMAN, I.P., AREVADZE, D.V. and YAROSHEVICH, V.Z., 1976, Temperatures of formation of the sulfide and copper porphyry ores of the Kedabek ore region (Azerbaidzhan) (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 89-90 (in Russian; translation by A. Kozlowski).

(...)

2. Typical are two-, rarely three-phase, halite-bearing inclusions, homogenizing in L. T_D of ore minerals is close to T_H of quartz, carbonates and sphalerite.

3. Central, deepest zones bear poor, quartz-magnetite and quartz-molybdenite mineralization, T_H 100-360°C (deposits Kedabek, Khar-khar, Parakend). T_H of skarns, quartz-feldspathic metasomatites, epidote-actinolite propyllites, greisen-like andalusite and tourmaline rocks equals 340-280°C (deposits Kedabek, Novogorelovka, Khar-khar).

5. In upper parts of the ore sequences, barite-polymetallic ores occur, connected with hydromica-quartz and sericite-kaolinite-quartz metasomatites. T_H of inclusions in their minerals is 220-160°C (Kumlu, Shekerbeili). These ores include also massive, galena ores, occurring in nests with barite and calcite (T_H 180-140°C).

6. (...). (Authors' abst.)

RAVICH, M.I. and BOROVAYA, F.E., 1949, Phase equilibria in ternary water-salt systems at elevated temperatures: Akad. Nauk SSSR, Izvest. Sektora Fiz.-Khim. Anal., v. 19, p. 69-81 (in Russian; see Translations).

RAYMOND, C.F. and HARRISON, W.D., 1975, Some observations on the behavior of the liquid and gas phases in temperate glacier ice: J. Glaciology, v. 14 (71), p. 213-233.

REBROVA, K.P. and BAZURIN, A.Z., 1976, Pecularities of decrepitation of gas-liquid inclusions in quartz up to 1550°C (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 162-163 (in Russian); translation by A. Kozlowski).

The intensity of decrepitation of G/L inclusions in vein quartz during heating to 700°C was studied by use of the stage "Pyrite" and microscope MBS-1, and at higher T, by observations of samples heated to 900-1550°C.

Decrepitation of G/L incluisons in vein quartz occurs over a long T interval and is in two stages. From 200 to 1000°C inclusions over 10-15 μm in size are opened, but most minute inclusions remain unopened. At 1200-1550°C nucleation, growth, and complete inversion of quartz to cristobalite, opens all minute inclusions. During this inversion of quartz to cristobalite a part of the volatiles is trapped as G bubbles, 1-40 μm in size, strongly depending on the conditions of the experiments.

Some of these G inclusions formed by preservation of vacuoles of the former G/L inclusions or as the result of incomplete crystallization of layers of cristobalite in the cracked zones in quartz . Especially large bubbles (20-40 μm) develop at the periphery of the quartz grains during formation of a thin film of glass on their surface, which makes the escape of G components difficult. This phenomenon is especially common in the range 1500-1550°C, when viscosity of glass is high. Crystallization of cristobalite from glass does not cause the elimination of bubbles from the former glass. These facts should be remembered in attempting to remove inclusions from quartz. (Authors' abstract).

RED'KIN, S.F. and RED'KINVA, S.I., 1977, On some factors showing the direction of changes in the ore-forming process (abst.), in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Sib. Branch, v. II, p. 95-96 (in Russian; translation by A. Kozlowski). Authors at Central Sci.-Res. Geol.-Prop. Inst. of Geol. Ministry, U.S.S.R.

In the abstract the ratios of main ore elements and their importance for ore origin are discussed, as exemplified by unnamed Pb-Zn and Au deposits. T_D and T_H for sphalerite range from 140 to 260°C; this T change is accompanied by change of Fe content in sphalerite from 0.5 to 6% and sharp decrease of Cd content; T_D of galena vary from 120 to 220°C and the higher T the lower Ag content. (Abst. by A.K.)

REID, R.C., 1976, Superheated liquids: Amer. Scientist, v. 64, no. 2, p. 146-156.

Pertinent to problems of metastability in fluid inclusions. (ER)

REKHARSKII, V.I., PASHKOV, Yu.N. and NOSIK, L.P., 1976, Conditions of formation of the rare metal deposit Tyrnyauz (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 78-79 (in Russian; translation by A. Kozlowski).

At the W-Mo deposit Tyrnyauz the following hydrothermal-metasomatic formations are developed: lime skarns, feldspar-quartz, quartz-sericite and berezite. P inclusions in quartz, scheelite and Mo-bearing scheelite, garnet, calcite and sphalerite of the same formation, although developed in various rocks, are characterized by the same composition, phase contents, T_H, and isotopic composition of the gases. P inclusions in minerals of the feldspar-quartz formation are essentially gaseous and polyphase (T_H 420-250°C) for the plagioclase-scheelite subformation and water - CO_2 (T_H 360-250°C) for the quartz-molybdenite subformation. In minerals of the quartz-sericite formation P polyphase inclusions homogenize at 230-220°C; in those of the berezite formation two phase inclusions homogenize at 250-160°C. (Authors' abst.)

REKHARSKII, V.I., PASHKOV, Yu.N., and NOSIK, L.P., 1977, Temperatures and composition of the ore-forming solutions at the Tyrny-Auz deposit: Geol. Rudnyk Mestor., v. 19, no. 5, p. 93-98 (in Russian).

See preceding item. (ER)

REUTIN, Yu.V., 1976, Pulsating geothermal regime of ore mineralization (Kuinskii granite massif of the Central Kazakhstan) (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of

Geol., p. 81-82 (in Russian; translation by A. Kozlowski).

The earliest post-magmatic assemblages are quartz-feldspar-muscovite and essentially quartz (with muscovite) greisen veins in granites with scattered wolframite crystals, and in some places--with drusy quartz; T_H = 485°C, both of G/L and L/G inclusions. Drusy quartz has T_H from 210 to 180°C.

Wall rocks are silicified serpentinites and sericitic rocks. T_H of inclusions in quartz of metasomatites range from 380 to 300°C. Ore-bearing veinlet quartz of the second generation with rare metal minerals, fluorite and magnetite yields T_H 400-365°C. Post-ore quartz-fluorite veinlets have T_H in liquid at 190-180°C.

Hydrothermal veins with sulfide, rare metal and fluorite mineralization in quartz-sericite zones have T_H (of inclusions in quartz and fluorite) of 185 and 200°C. Very tiny post-ore quartz-fluorite veinlets have T_H 120°C. (Author's abst.)

REYF, F.G., 1976, Causes of various schemes of homogenization of melt inclusions (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 113-114 (in Russian; translation by A. Kozlowski).

Quartz-muscovite crystallized P inclusions homogenize by a different process than glass and crystallized quartz-feldspar P inclusions. In quartz-feldspar inclusions (I) dms melt first, and next G disappears, whereas quartz-muscovite inclusions (II) finish their homogenization with melting dms:

I) dms + G → dms + G + melt → G + melt → melt;

II) dms + G → dms + G + melt → dms + melt → melt.

Type I of homogenization is caused by the fact, that specific volume of dms < specific volume of melt, and during isochoric crystallization (or supercooling of melt into glass), shrinkage bubble forms; thus it is shrinkage scheme of homogenization. During crystallization of muscovite-quartz inclusions, bubble appears when, due to crystallization of part of dms, saturation of melt with water is achieved (retrograde boiling). G phase is thus under high pressure, hence it is scheme of retrograde boiling. During cooling of melt to crystallize quartz plus muscovite, dms appear earlier than G phase and there is no shrinkage. The reason is as follows: P-V-X relations in water-silicate-acid systems cause increase of specific volume of H_2O-bearing melts on P decrease. At P < 4 to 6 kb this increase of volume is comparable with its decrease caused by crystallization of part of melt and G bubble appears only when caused by retrograde boiling. (Author's abst.)

REYF, F.G. and BAZHEEV, Ye.D., 1976, Ore-forming role of magmatogenic chloride fluids (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 71-72 (in Russian; translation by A. Kozlowski).

Mariktikanskoe tungsten deposit occurs in the marginal part of a granite massif and consists of quartz-wolframite veins. Quartz, crystallizing together with wolframite, bears inclusions of salt solutions (G+L+xls). External zones of crystal bear inclusions with smaller crystals of halite (or halite + sylvite), about 10 vol. % (T_H 380-395°C), than internal ones (50-60 vol. %, T_H 480-510°C). Latest quartz zones and quartz crystals overgrowing wolframite, bear G/L two-phase inclusions (T_H 325-335°C). Quartz from wall granites of ore veins bears fluid inclusions with crystals (G 20-30 vol. %, L 5-15 vol. %, xl 60-70 vol. %, and ore mineral (∿ 3 vol. %) which dissolves as the last phase at T_H 760-790°C. Quartz in the walls of cavities near ore bodies sometimes bears crystallized melt inclusions (T_H 1000-1080°C) and inclusions of salt melt ($T_H > 100°C$; sic - probably a misprint for 1000°C ? AK.). During heating some crystallized inclusions form two melts: silicate and salt. Tungsten ores formed from highly saline fluids, separating from crystallizing intrusion. (Author's abst.)

REYF, R.G. and BASHEEV, Ye.D., 1977, Magmatogenic chloride solutions and tungsten mineralization: Geokhimiya, 1977, no. 1, p. 63-70, (in Russian; translated in Geochem. Internat., v. 14, p. 45-51). Authors at Geol. Inst., Buryat Branch, Sib. Div., Buryat Geol. Survey, Ulan Ude, USSR.

Thermobarometric methods have been applied to deduce the formation conditions for a granite intrusion and the quartz-wolframite veins in it. The minerals were deposited by chloride solutions containing over 30% NaCl at 520-335°. These solutions originated from a granite magma locally enriched in alkali chlorides to such an extent that it separated into silicate and salt melts at about 1000°. (Authors' abstract)

REZNITSKIY, L.Z., 1976, Petrological significance of microinclusions bearing gypsum (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 63-64 (in Russian; translation by A. Kozlowski).

Polyphase, oriented microinclusions with gypsum in calcite from phlogopite veins of Sliudianka formed during crystallization of calcite with anhydrite. Two genetic groups of inclusions bear gypsum:

1. Crystal - gaseous inclusions (autopseudomorphic) - formed during hydration of anhydrite, in vacuoles of three-phase inclusions. They bear gypsum crystals, gas (vapor) and solution (the latter 5-10 vol.%). After complete inversion of gypsum (into anhydrite? A.K.) during heating these inclusions give same T_H as normal P inclusions in calcite. Thus, anhydrite-bearing inclusions are P, i.e., syngenetic with calcite. This is especially important, since anhydrite is an indicator of redox potential for sulfur and it is often absent in macroparagenetic association.

2. S inclusions. The simplest type consists of pseudomorphs of gypsum after anhydrite inclusions - it could be formed only by partial dissolution and removal of anhydrite, contemporaneous with anhydrite hydration. Sometimes one may observe a series of inclusions: gypsum + liquid ± relic anhydrite, with various phase ratios. There occur also two-phase G/L inclusions formed in the vacuoles after dissolved gypsum inclusions by neutral or alkaline hydrotherms. (From the author's abst.)

RHODES, J.M. and DUNGAN, M.A., 1977, The nature of primary ocean-floor basalts (abst.): Papers presented 20-23 Sept. 1977, Basaltic Volcanism Study Project, Lunar Sci. Inst., Houston. First author at Lockheed Electronics Co., Inc., Houston, TX 77058.

Glass inclusions in phenocrysts of olivine, plagioclase and spinel vary widely in composition, reflecting both a liquid-line of descent and phenocryst-melt interactions. Allowing for those uncertainties, and back-calculating to remove the effects of crystal fractionation, certain well-defined characteristics emerge. The more mafic glass inclusions have Mg/Mg+Fe values that approach 0.70, they are low in TiO_2 and Na_2O (less than 1.0 and 2.0% respectively) and are high in CaO (>12%). (From the authors' abstract)

RICH, R.A. and BARABAS, A.H., 1977, Mineralogy, paragenesis, fluid inclusions, and origin of the Schwartzwalder uranium mine, Jefferson County, Colorado (abst.): Econ. Geol., v. 72, no. 4, p. 737-738.

See Fluid Inclusion Research -- Proceedings of COFFI, v. 9, p. 114 (ER)

RICH, R.A., HOLLAND, H.D., and PETERSEN, Ulrich, 1977, Hydrothermal uranium deposits: Developments in Economic Geology, no. 6, Amsterdam, Elsevier Sci. Pub. Co.

A thorough review (27 refs) of fluid-inclusion data is given in Chapt. 3 (pp. 23-34). (ER)

RICHARDSON, C.K. and HOLLAND H.D., 1976, Fluoride complexing and fluorite deposits, (abst.): Geol. Soc. Amer., Abstracts with Programs, v. 8, no. 6, p. 1068-1069. Authors at Dept. of Geol. Sci., Harvard Univ., Cambridge, MA 02138.

The sol. of fluorite has been det. by a weight-loss tech. at 260°, and 100°C in sol. containing KCl, NaCl, NaCl + $CaCl_2$, and NaCl + $CaCl_2$ + $MgCl_2$. In KCl sol. the increase in sol. with increasing ionic strength can be described by the extended Debye-Hückel equation at 100° and 200°C and by the Debye-Hückel equation at 260°C. In NaCl sol., however, the increase in sol. with increasing ionic strength requires the presence of NaF° and possibly of NaF_2^- complexes. The sol. of fluorite at 200° and 260°C in NaCl + $CaCl_2$ sol. containing large amounts of $CaCl_2$ is many times the sol. expected from common ion effect calc. The sol. of fluorite in these sol. can only be explained by the presence of CaF^+ complexes in addition to the NaF° complexes. The sol. of fluorite is considerably greater in sol. containing both $CaCl_2$ and $MgCl_2$ (in a molar ratio of 9/1) than in NaCl-$CaCl_2$ sol. The sol. increase can be explained by the presence of MgF^+. The stability constants for NaF°, CaF^+, and MgF^+ increase with increasing T. Fluorite will therefore tend to ppt. from NaCl-$CaCl_2$-$MgCl_2$ sol. during cooling. Approx. 30 mg of CaF_2 would ppt. during cooling from 200° to 100°C from 1 kg. of solutions such as those found in fluid inclusions in fluorite from the Cave-in-Rock, Illinois fluorite deposit. Unreasonably large volumes of fluids are therefore not required to form such deposits. (Authors' abstract)

RICHTER, Dorothy and SIMMONS, Gene, 1977a, Microcracks in crustal igneous rocks: microscopy: Am. Geophys. Union Monograph 20, p. 1-23.

RICHTER, Dorothy AND SIMMONS, Gene, 1977b, Microscopic tubes in igneous rocks: Earth and Planetary Science Letters, v. 34, p. 1-12. Authors at Dept. Earth and Plan. Sci., Mass. Inst. Tech., Cambridge, Mass. 02139 (USA).

Microscopic tubes have been observed in several igneous rocks and may be quite common. They occur in single crystals and have either elliptical or circular cross-sections 1-5 μm in diameter and are ten to hundreds of microns long. Microtubes may be hollow, or partially or completely filled with another phase, but are distinct from acicular crystals of accessory minerals such as rutile. Microtubes can form by at least three processes: (1) the partial annealing of microcracks, (2) the natural etching of dislocations, or (3) the primary inclusion of fluid material during crystal growth. (Authors' abstract)

RICKARD, D.T. (ed.), 1977, Annual Report of the Ore Research Group, Stockholm Univ., 28 pp. (in English).

A review of work in progress by various workers, including fluid inclusion studies on Laisvall by S. Lindblom. (ER)

RICKWOOD, P.C., 1977, A technique for extracting small crystals from thin sections: Amer. Miner., v. 62, p. 382-384.

Micromanipulators used by life scientists have been evaluated for extracting minute grains (< 20μm) from petrological thin sections. A pantograph design with a single control for all motion was found to be the most convenient, and sharpened hypodermic needles made ideal probes. (Pertinent to many fluid inclusion manipulations. ER)

RIKHVANOV, L.P., CHEREPNIN, V.K., and DOMARENKO, V.A., 1977, Physicochemical conditions of formation of products of hydrothermal activity in the zone of the deep fault in the northern part of Kuznetskiy Alatau (thermobarogeochemical data) (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Sib. Branch, v. II, p. 135-136 (in Russian; translation by A. Kozlowski). First author at the Tomsk Polytechnical Inst., USSR.

T of formation of Au, Hg, rare metal-sulfide etc. deposits were determined by means of decrepitation. The maximum decrepitation was observed at T, °C: propylites 350-400, quartz-feldspar-hydromica metasomatites-same, plus peak at 100-200, berezites-same plus 100-150; probably T 100-250°C is typical of ore-forming process. T_D of monomineralic specimens were obtained (°C): chlorite 320-360, clay minerals 200-280, quartz 250-350 and 100-150, ankerite 280-310 and 220-250, calcite 250-280, barite 150-200, fluorite 130-160. Water leachates yielded following composition of inclusion fluids: Cl, HCO_3, SO_4, NO_2, CO_3, NH_4, K, Na, Ca, Mg, Fe^{3+} (error of determination ≤10%); total salts 2-462 mg/l. (From the authors' abst.)

RIPLEY, E.M., 1977, Oxygen and hydrogen isotopic composition of ore-forming fluids and metamorphic fluids at the Raul mine, Peru (abst.): Econ. Geol., v. 72, no. 4, p. 738.

See Fluid Inclusion Research -- Proceedings of COFFI, v. 9, p. 114 (ER)

RIPLEY, E.M. and OHMOTO, Hiroshi, 1977, Mineralogic, sulfur isotope, and fluid inclusion studies of the stratabound copper deposits at the Raul Mine, Peru: Economic Geology, v. 72, p. 1017-1041.

The Raul mine, situated within the Coastal Mesozoic Belt of Central Peru, consists of stratabound pyrite-chalcopyrite ores in Upper Cretaceous andesitic volcanics, graywackes, and siltstones. The host rocks and ores are metamorphosed to the upper greenschist-lower amphibolite facies.

The 800+ m stratigraphic sequence of the area can be divided into five units, each characterized by a predominant lithology and type of mineralization. Unit I, the oldest exposed rocks in the mine, consists of tuffs and agglomerates of andesitic composition. Unit II is composed of graywacke, with minor tuffaceous zones. Andesite lavas and pyroclastics compose Units III and IV. Unit V consists of siltstone with lesser amounts of tuffs and limestones. Layered sulfide-amphibolite ore horizons (mantos) occur intercalated in Units II, III, and V, whereas stringer and disseminated ore occurs in the lavas and pyroclastics of Units III and IV.

Analyses of Co, Ni, Zn, Mn, Ag, and Sn content of pyrite and chalcopyrite indicate that significant differences in the minor element content of these minerals exist between units. $\delta^{34}S$ values of sulfide minerals also show distinctly different distributions between units: Unit I, -10 to +3‰; Unit II, 0 to +9‰; Unit III, +9 to +23‰; Unit IV, +8 to +12‰; and Unit V, 0 to +14‰.

Temperature of ore deposition in the manto of Unit II, based on fluid inclusion filling temperatures, was about 320° to 360°C. Thermochemical considerations of coexisting sulfides in Unit V (pyrite + pyrrhotite + chalcopyrite) place a possible temperature range of 70° to 350°C for Unit V mineralization. Silicate mineral assemblages in the host rocks suggest that metamorphic temperatures were between 300° and 500°C. Peak metamorphic temperatures were probably caused by igneous activity related to intrusion of the Coastal Batholith.

The data on mineralogy, temperature, and sulfur isotopic composition of sulfide minerals, together with information on the stability of Fe- and Cu-chloride complexes, suggest that manto ores in Units II and III formed at pH conditions of 4 to 7, from a fluid with a $\delta^{34}S_{\Sigma S}$ value of +23 ± 3‰, A ΣS content from 10^{-1} to 10^{-2} *m*, and a log ($\Sigma SO_4/\Sigma H_2S$) ratio from 0 to +2. Manto mineralization in Unit V occurred from fluids with variable $\delta^{34}S_{\Sigma S}$ values (+3 to +15‰). The stringer and disseminated ores in Units III and IV were formed from fluids with $\delta^{34}S_{\Sigma S}$ values greater than +12‰ for Unit IV and +23‰ for Unit III.

The $\delta^{34}S_{\Sigma S}$ values of the fluids involved in pyrite-chalcopyrite deposition suggest a sea-water origin for the sulfur. A model is presented involving circulation of sea water caused by heat associated with submarine volcanic activity. Sea water sulfate was partially or totally reduced to sulfide at elevated temperatures by reaction with Fe^{2+}-bearing minerals. Precipitation of ore minerals occurred on or near the sea floor, primarily as a result of a decease in temperature, accompanied by increases in oxidation state and pH of the fluid. (Authors' abst.)

RIPP, G.S., 1977, Contribution to evaluation of conditions of formation of pyrite lead-zinc deposits of Buryatia (abst.), in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Sib. Branch, v. II, p. 97-98 (in Russian; translation by A. Kozlowski). Author at Buryat Division

of Siberian Branch of Acad. Sci. U.S.S.R.

Water leachates from ores and monomineralic samples yielded variations of pH from 8 (early stage) to 4 (late stage). Two- and three-phase fluid inclusions in sphalerite, barite and quartz from the deposit Ozernoe have T_H in L 130-210°C; the third phase is LCO_2 of relatively high density 0.5-0.6 g/cm^3, proving high P. (Abst. by A.K.)

RISON, William and KYSER, Kurt, 1977, Rare gases, oxygen and hydrogen in Hawaiian xenoliths and basalts (abst.): Amer. Geophys. Union, Trans., EOS, v. 58, no. 6, p. 537.

We have measured the isotopic abundances for all the rare gases, oxygen and hydrogen in volcanic xenoliths and dredged volcanic basalts from Hawaii. Isotopic rare gas patterns in the xenoliths differ from atmospheric by a suggestion of an enrichment in ^{129}Xe, large excesses of radiogenic ^{40}Ar, $^{3}He/^{4}He$ ratios one to two orders of magnitude greater than atmospheric, $^{20}Ne/^{22}Ne$ and $^{21}Ne/^{22}Ne$ ratios 3 to 10 times atmospheric. The high $^{3}He/^{4}He$ and the apparent ^{129}Xe enrichments may indicate a primitive rare gas component, and the neon anomalies, a mixing of a primitive component with ^{21}Ne and ^{22}Ne produced by nuclear reactions. Oxygen in the xenoliths is isotopically heavier ($\delta^{18}O$ = +6 to +7 per mil) than is accepted for average unaltered mid-oceanic ridge basalts ($\delta^{18}O$ = +5.5 per mil).

Our analyses on the glassy rims of dredged pillow basalts suggest a substantial degree of interaction between the molten lava and seawater. Values of δD range from -80 to -40 per mil, and vary with the H_2O content (δD and $\delta^{18}O$ = 0 for seawater), while unaltered mid-oceanic ridge basalts show an average δD = -77 per mil. The values of $\delta^{18}O$ range from +6 to +4.5 per mil. However, the basalts have $^{3}He/^{4}He$ up to 10 times, and $^{40}Ar/^{36}Ar$ up to 3 times atmospheric.

The rare gas fractionation pattern in both the basalts and xenoliths show a slight depletion of Ne and enrichment of Xe compared to the atmospheric pattern. This is a different pattern than normally seen in mid-oceanic ridge basalts, where Ne is enriched. We ascribe this pattern, and the isotopically heavy oxygen in the xenoliths, to heterogeneity in the mantle, either of a primitive nature or from recycling of crustal material depleted in Ne and heavy in oxygen. (Authors' abstract).

ROBERTS, S.A., 1975, Early hydrothermal alteration and mineralization in the Butte district, Montana: PhD dissertation, Harvard Univ., 173 pp.

Fluid inclusions have been identified which represent the fluid which caused the Early veining and pervasive alteration. This fluid has a density of about 0.65, a salinity of about six weight percent, and (during some of the earliest events) had a copper concentration of at least two thousand parts per million. No evidence has been found for boiling of this fluid during ore formation. (From the author's abstract).

Four types of inclusions were recognized:

I L + 30-40% G + 3 transparent birefringent dms + chalcopyrite? (∿2000 ppm Cu equivalent). None of the dms dissolve on heating. Density 0.65; salinity <26%. Believed to be responsible for the "Early" events. T_h 350-390°C, in liquid.

II L + 5% G and no dms. T_h mainly 200-275°C.

III L + 5% G + large halite, small hematite(?), an opaque, and one or two small birefringent crystals; salinity ∿35%. T_h 220-301°C; T_s NaCl 200-245°C.

IV L + 60-90% G. T_h (in vapor) 380-462°C.

Type I inclusions were ground to within 1-2 μm of chalcopyrite(?) dms on upper walls of inclusions and a beam of 0.3 μamps at 25 kb used in the electron microprobe, with traverses, to recognize the Cu, Fe, and S. Pressures and temperatures of formation were estimated to be 1.7 kb and 600°C, based on independent geothermometers and fluid inclusion T_h. This pressure is considerably higher than other estimates. (ER)

ROBINSON, A.L., 1977, Critical phenomena: experiments show theory on right track: Science, v. 196, p. 861-863.

A "research news" report on recent studies of critical phenomena, showing that Curie points and order-disorder transitions in solids, as well as liquid-liquid consolute points in unary systems can all be considered by a new unified theory, the "renormalization group theory". Laser interferometry on liquids at the critical point under exceptionally stable thermostated conditions shows that several hours are required for a sample to come to thermal equilibrium when the temperature is raised from Tc + 0.002°K to Tc + 0.004°K, when Tc is the critical temperature. Pertinent to the interpretation of critical phenomena seen in fluid inclusions (ER)

ROCK, N.M.S., 1976, The role of CO_2 in alkali rock genesis: Geological Magazine, v. 113, no. 2, p. 97-192.

The extreme rarity of alkaline rock suites bearing both calcic plagioclase and magmatic carbonatites is believed to reflect a fundamental bifold division between Gabbroic and Carbonatitic types, plagioclase being present only in the former and carbonatite only in the latter. Alkali basalt magma may be parental to both lineages, the gabbroic lineage deriving from normal differentiation under low CO_2-pressure, and the carbonatitic by suppression of plagioclase crystallization under high pressures of CO_2, leading through pyroxene fractionation to a "secondary parental" olivine-poor nephelinite magma. Support for this hypothesis is found in evidence for the suppression of plagioclase in CO_2-rich alkali basaltic magmas and for the secondary origin of olivine-poor nephelinites, in the nature of xenoliths and cumulates at carbonatite complexes, in Sr isotopic data, and in major and trace element compositions of the magmas. The possible origin of melilitic rocks at carbonatite complexes is also briefly discussed. (Author's abstract)

RODIONOVA, L.N. and RODINOV, S.M., 1977, On the conditions of ore formation at one of the tin deposits in the Badzhal'skiy region (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. I, p. 132-133 (in Russian; translation by A. Kozlowski). Authors at the Far East Inst. of the Mineral Raw Materials of the Geology Ministry.

The deposit consists of a series of mineralized zones in acid volcanites. The zones are quartz-feldspathic metasomatites with quartz-cassiterite veins and veinlets. Greisens with cassiterite and late sulfide associations are subordinate. Inclusions in quartz and cassiterite are of three types: I - T_H 420-500°C in G phase II - 280-410°C in L phase, with cassiterite and tourmaline as trapped minerals, III - inclusions in late quartz, T_H 320-177°C in L phase, halite is dm, total salt concentration 35-40 wt.%. (Abst. by A.K.)

RODZIANKO, N.G., RYLOV, V.G., POLISHCHUK, I.B. and VASILENKO, V.N., 1976, Conditions of formation of the copper-pyrrhotite and polymetallic ore mineralization in the S. Dagestan (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 88 (in Russian; translation by A. Kozlowski).

Pre-ore stage at the deposit Kizil-Dere appeared as silicification, chloritization and sericitization at 420-280°C. (...) Ore bodies formed at T 330-120°C. Sulfide ores (quartz-pyrite association of the early stage) formed at low T; T_D of opal-like quartzite was 200-140°C. Main stage was at 330-280°C (forming essentially pyrrhotite ores with the hexagonal $Fe_{10}S_{11}$ - $Fe_{12}S_{13}$). Following commercial ores developed in the pyrite-pyrrhotite host from 280 to 160°C; quartz-chlorite-chalcopyrite association formed at 280-205°C and quartz-pyrite-sphalerite with galena at 220-160°C. Post-ore drusy quartz and aragonite formed at 140-40°C. (Author's abst.)

ROEDDER, E., 1977a Fluid inclusion evidence on the environments of sedimentary diagenesis (abst.): Geological Research 1977, U.S. Geol. Survey Prof. Paper 1050, p. 174-175.

See <u>Fluid Inclusion Research</u> - <u>Proceedings of COFFI</u>, v. 9, p. 116 (1976).

ROEDDER, Edwin, 1977b Fluid inclusion studies of ore deposits in the Viburnum Trend, southeast Missouri: Econ. Geol., v. 72, p. 474-479.

Although good material is scarce, 109 small fluid inclusions in sphalerite were studied, at least some of which are probably primary in origin. Most samples came from mines or drill cores in the Viburnum Trend in southeast Missouri.

Metastability was observed frequently during freezing point determinations. Freezing temperatures are mainly in the range -20 to -28°C, corresponding to very saline brines; homogenization temperatures are mainly in the range 94° to 120°C. These sphalerite fluid inclusion data fit into the ranges observed for the ore-depositing fluids in most Mississippi Valley-type deposits, even though the district is different in some respects.

In addition, primary inclusions were studied from the associated, but presumably later, gangue calcite. Fourteen inclusions in Viburnum calcite all contain brines which are much less saline. Most inclusions out of 16 in calcite from three areas in the nearby Old Lead Belt yielded similar low salinities. Twelve inclusions in sphalerite from pyrite-sphalerite-calcite veins in the Precambrian basement beneath the Fletcher mine have trapped hotter, more dilute fluids and hence represent a different mineralization. (Author's abstract)

ROEDDER, Edwin, 1977c Fluid inclusions as tools in mineral exploration: Econ. Geol., v. 72, p. 503-525.

This is the text of an address given in 1975 as the Soc. Econ. Geologists Distinguished Lecture in Scientific Research. It is a review of various ways in which inclusion study may be helpful in mineral exploration, with 152 references (ER).

ROEDDER, E., 1977d Stable and metastable fluid inclusion data, Browns Canyon fluorspar district, Chaffee Country, Colorado, and similar epithermal and hot-spring (?) deposits, in Problems of Ore Deposition, Fourth IAGOD Symposium, Varna, 1974, vol. 2: Sofia, Pub. House Bulgarian Acad. Sciences, p. 186-195. Author at U.S. Geol. Survey, 959 National Center, Reston, Virginia 22092, U.S.A.

T_H ranges from 120°C-165°C; the true T_{Frz} is about -0.08°C, but superheated ice at high negative pressure and temperatures as high as +7°C was encountered commonly. Other types of metastability were also encountered. Similar data were reported for the Northgate fluorite district and Wagon Wheel Gap, Colorado, and Cougar Spar Mine, Utah, but several other localities, including one in Mexico, contained much more saline fluids. Several conclusions are drawn concerning the hotspring environment. (ER)

ROEDDER, E., 1977e Changes in ore fluid with time, from fluid inclusion studies at Creede, Colorado, in Problems of Ore Deposition, Fourth IAGOD Symposium, Varna, 1974, vol. 2: Sofia, Pub. House Bulgarian Acad. Sciences, p. 179-185.

See Roedder, 1974a, Fluid Inclusion Research--Proceedings of COFFI, v. 7, p. 187-188 (1974).

ROEDDER, E. and ROSASCO, G.J., 1977, Sulfur compounds in fluid associated with porphyry copper deposits (abst.): Geological Research 1977, U.S. Geol. Survey Prof. Paper 1050, p. 162.

A review of use of laser-activated Raman technique to analyze for $SO_4^=$ in solution and to identify anhydrite as a "daughter mineral" in porphyry copper deposits as at Bingham, Utah. See Fluid Inclusion Research - Proceedings of COFFI, v. 8, p. 156-157 (1975).

ROEDDER, Edwin and WEIBLEN, P.W., 1975, Anomalous low-K silicate melt inclusions in ilmenite from Apollo 17 basalts: Proc. Lunar Sci. Conf. 6th, p. 147-164.

This is the full paper corresponding to an abstract in Fluid Inclusion Research--Proceedings of COFFI, v. 8, p. 154, 1975. (ER)

ROGERS, P.J., 1977, Fluid inclusion studies in fluorite from the Derbyshire orefield: Inst. Min. & Met., Trans., Sect. B., v. 86, p. B128-132. Author at Inst. Geol. Sci., Keyworth, Nottingham.

Fluorite samples from 29 localities yielded mean primary fluid inclusion homogenization temperatures in the range 92-154°C. A pressure correction of 11°C applied to the data gives mean formation temperatures in the range 103-165°C. Freezing studies indicate that the ore-forming fluid had salinities in the range 18-25 equivalent wt% of sodium chloride. Semi-quantitative analysis of leachates from crushed fluorite revealed enrichment of potassium by comparison with modern formation waters, but potassium deficiency when compared with samples from the Askrigg and Alston blocks. (Author's abstract)

ROKACHEV, S.A., KOVAL'CHUK, A.I., SUNGUROVA, Z.N. and MAURER, V.I., 1976, Gas composition and halogens in ores and rocks of the sulfide deposits (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 91-92 (in Russian; translation by A. Kozlowski).

The highest average gas content (8 cm^3/kg) characterizes weakly metamorphosed S. Urals deposits. In greenschist and low T amphibolite facies (Middle Urals, N. Caucasus, Altai, Central Kazakhstan and Karelia) gas content is about 5 cm^3/kg; the lowest content is in the deeply metamorphosed deposits of Karelia: 2 cm^3/kg. By gas chromatography, H_2O, N_2, CO_2, H_2, locally CH_4 and very rarely CO were determined. In some deposits of the S. Urals and N. Caucasus, water occupies up to 90 vol.% of gas phase, but usually it makes up 1 to 10 vol.%; especially low water content characterizes ancient deposits of Karelia. Most (96%) of the samples from weakly metamorphosed deposits contain mainly N_2 (90-100 vol.%); CO_2 occupies up to 80 vol.% and it appears in almost all samples, H_2 occurs in all samples as 1-10 vol.% of total gases and only in Karelia, commonly together with CH_4, does $CH_4 + H_2$ approach 100%. Ores and sedimentary rocks of the weakly metamorphosed deposits, on the basis of their gas composition and 1000 Br/Cl, 1000 g/Cl and Br/I ratios in water leachates, are comparable with marine sediments. (Authors' abst.)

ROMANCHEV, B.P., 1977, On the reliability of homogenization temperatures of primary inclusions: Geokhimiya, 1977, no. 5, p. 726-735 (in Russian; translated in Geochem. Internat., v. 14, p. 65-73). Author at Vernadskiy Inst. Geochem. and Anal. Chem., Acad. Sci. USSR, Moscow.

Homogenization of microinclusions in minerals is discussed from the point of view of the phase rule. It is shown that the temperature of crystallization of a mineral can be reliably determined from the temperature of solution of a mineral entrapped in the inclusion different in composition from the host mineral, provided the initial volume of the inclusion is known. (Author's abstract)

ROMANCHEV, B.P. and KRIGMAN, L.D., 1976, Interpretation of thermometry of magmatogenic inclusions (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 106 (in Russian; translation by A. Kozlowski).

Natural melts are heterogeneous and for this reason results of inclusion thermometry are not limited only to the equality of T_H and T of growth of crystals. Thus, T of melt trapping should be evaluated at the moment the inclusion achieves its original volume in the process of homogenization. In minerals which crystallized contemporaneously, the original volume of inclusion is achieved when melting of the last dm finishes. Inclusions may consist of: glass + G, glass + G + dms, G + dms. If mineral bears inclusions of glass + G, the inclusions have their original volume and homogenization should be fixed in them. If inclusions are of type: glass + G + dms, or G + dms, their original volumes are achieved when last dm melts. If homogenization scheme is:

glass + G + dms → melt + dms → melt, the original melt was undersaturated with volatiles; if the scheme is: glass + G + dms → melt + G → melt, original melt was saturated with volatiles and trapping of G phase in inclusions is possible. Then homogenization of the inclusion filling will be followed by an increase of vacuole volume even after achieving of the equilibrium melt-G inside inclusion, and possibly T_H > T of crystallization of host mineral. T of disappearance of the last dm is the best value and closest to the T of crystallization of the host mineral. (Authors' abst.)

RONA, P.A., 1977, Tag hydrothermal field: Mid-Atlantic ridge crest (lat 26°N)(abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 1146-1147.

ROSASCO, G.J. and ETZ, E.S., 1977, The Raman microprobe: a new analytical tool: Research and Development, June 1977, p. 20-35. Authors at Inst. for Materials Res., Nat. Bur. Stand., Washington, D.C. 20234.

A new Raman microprobe has been developed. This instrument allows routine measurement of the Raman spectra of individual, micrometer-size particles. This new probe is important in that both the chemical species present in the microparticle and its crystalline state can be inferred from the Raman spectrum. The essentials of the design of the instrument are briefly highlighted. Sample preparation and measurement techniques are outlined. The performance and practical utility of this new instrument are illustrated by results obtained on samples relevant to the characterization of airborne particulates. Preliminary results obtained in the study of urban air particulate dusts, selected organic materials, and microscopic fluid inclusions in minerals are also highlighted. (Authors' abstract) (Includes brief mention of $SO_4^=$ in solution in inclusions in quartz from Bingham, Utah (p. 32). (ER)

ROSASCO, G.J. and ROEDDER, E., 1977, New technique for analysis of fluid inclusions (abst.): Geological Research 1977, U.S. Geol. Survey Prof. Paper 1050, p. 161-162.

A review of the application of a newly designed laser-activated Raman spectrometer to fluid inclusions. See Fluid Inclusion Research - Proceedings of COFFI, v. 8, p. 156-157 (1975).

ROSIKHINA, A.I., SIVORONOV, A.A. and YATSENKO, G.M., 1976, Temperatures of granite formation at the Ukranian shield (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR Inst. of Geol., p. 118 (in Russian; translation by A. Kozlowski).

Quartz and feldspar from granitoids (pegmatite veins and fillings of interstices between boudins) were studied from Tikich and Ingul-Ingulets complexes, central part of the Ukranian shield. There were distinguished: 1) one-phase inclusions of L CO_2, 2) two-phase of L H_2O + L CO_2, 3) three-phase L H_2O + L CO_2 + G, and 4) two-phase L H_2O + G; the last were studied. Maximum T_H for P inclusions was 580°C; PS inclusions homogenized at 450-350°C, S ones at 227-217 in L phase. Metamorphism of rocks under conditions of amphibolite facies was at 525°C and 2200 atm. At 525-370°C formerly homogeneous CO_2-salt-aqueous solution divides into L (CO_2 + H_2O) and L water-salt solution, forming two-phase fluid. Higher T of granite formation, in comparison with metamorphic rocks, presents T interval of stability of amphibolite facies. (...) (From the authors' abst.)

ROSLYAKOVA, N.V., TSIMBALIST, V.G, and SHUGUROVA, N.A., 1976, Composition of ore-forming solutions of the Berikul'skoe gold ore deposit: Genetic types and regularities of distribution of deposits of gold in the Far East (Materials of Conference on Gold Potential of the Amur area and adjacent regions, Blayoveshchensk, May 1971), editor V.G. Moiseenko, Novosibirsk, Siberian Branch of "Nauka" Publishing House, p. 64-71 (in Russian). Authors at Inst. Geol. Geophys. Siberian Branch of Acad. Sci. USSR, Novosibirsk-90.

Ores, consisting of pyrite, chalcopyrite, galena, sphalerite, native gold, arsenopyrite, stannite, tetrahedrite, bismuthinite, magnetite (Askol'd) and pyrite, gold, chalcopyrite, arsenopyrite, galena (Fashidon), occur in quartz veins and cataclastic zones. Compositions of parent solutions are given in the table (in g/l, water leachate method, leachate made from quartz).

Component	Askol'd	Fashidon
Na	26.45	13.94
K	12.75	4.80
Ca	41.00	3.20
NH_4	3.50	3.60
Total cations	83.70	24.54
Cl	8.00	5.60
HCO_3	213.50	43.92
Total anions	221.5	49.52
Total salts	305.2	75.06
100(Na/Na+K)	77.93	83.13
100(Cl/Cl+HCO_3)	6.06	18.00
H_2O, wt.%	0.06	0.15

(Abst. by A.K.)

ROSSOVSKIY, L.N., 1977, First finding of pollucite and its crystals (sic.) in Afghanistan: Akad. Nauk SSSR Doklady, v. 236 no. 1, p. 216-219 (in Russian). Author at the Krasnoyarskoe Div. of the Siberian Branch of Sci.-Research Inst. of Geol., Geophys. and Mineral Raw Materials.

Pollucite from localities: Parun, Nilau-Kulam, Shamakat, Alingar, Surkhrud, Daray-Pich, Kurgal occurs in pegmatitic veins. The size of crystals varies from 1 to 20 cm. P G/L inclusions in pollucite yielded T_H 405-100°C. (Abst. by A.K.)

ROSSOVSKIY, L.N. and KONOVALENKO, S.I., 1977, Corundum plagioclasites from the SW Pamirs: Akad. Nauk SSSR Doklady, v. 235 no. 3, p. 663-666 (in Russian). Authors at the Krasnoyarskoe Div. of the Siberian Sci.-Research Inst. of Geol., Geophys. and Mineral Raw Materials.

Corundum plagioclasites (i.e., desilicified pegmatites) occur in valleys of rivers: Daray-Stazh, Avdzh, Sumdzhin, Gondarv at the W slope of the Shakhdarinskiy Mt. crest. Pegmatites formed under action of hydrothermal solutions at >500-600°C (T derived from association anorthite + corundum and absence of margarite). Overlapping late hydrotherms altered pegmatite minerals into association: corundophyllite + diaspore + pink mica + rutile, T_H + pressure corrections for inclusions in diaspore equals 310-290°C. (Abst. by A.K.)

ROZEN, O.M., SIDORENKO, S.A., KUZNETSOVA, N.N., 1977, Scapolite and apatite as indices of composition of volatile components at metamorphization of granulitic complex of the Kola Peninsula: Akad. Nauk, USSR, Doklady, v. 237, p. 441-444 (in Russian).

RUCKLIDGE, J.C. and PATTERSON, G.C., 1977, Role of chlorine in serpentinization: Contrib. Min. and Pet., v. 65, p. 39-44.

RUDENKO, N.I. and SHAMANINA, N.L., 1977, On the possibility of application of decrepitation analysis for revealing zonation of the magnetite deposits in the Turgay area (abst.) <u>in</u> Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. I, p. 103-104 (in Russian; translation by A. Kozlowski). Authors at the Leningrad Mining Inst., Leningrad.

The authors tried to find characteristic features of magnetite decrepitation analysis for different types of ore parageneses. T_D (beginning of decrepitation) was 358-392°C, and that of the beginning of mass decrepitation was 440-446°C in the following deposits: Kachkarskoe, Kurzhunkul'skoe, Sokolovskoe, Aleshinskoe. (Abst. by A.K.)

RUMYANTSEV, V.N., 1976, On information obtainable from thermobarometric studies of gas-liquid inclusions in minerals (abst.): Problems of genetic information in mineralogy (Proceedings of the All-Union Mineralogical Seminar), Syktyvkar, June 1-4, 1976: Syktyvkar, Acad. Sci. USSR, Komi Div., p. 73-75 (in Russian; translation by A. Kozlowski). Author at Ministry of Geology USSR, Moscow.

A review of the value of the data that are obtainable from various techniques of fluid inclusion studies and their relationship to the parameters of natural processes. (A.K.)

RUMYANTSEV, V.N., 1977, The problem of information derived from thermobarogeochemical studies of gas-liquid inclusions in minerals (connected with reconstruction of conditions of vein mineral-formation). Vses. Mineral. Obshch. Zapiski, v. 106, no. 3, p. 265-273 (in Russian). Author at the All-Union Sci.-Research Inst. of Mineral Raw Materials, Moscow.

Paper contains discussion of the following aspects of fluid inclusion studies: leakage of inclusions, pH of solution in inclusions vs pH of parent solution, relation between chemical composition of mineral-forming fluid and composition of fluid inclusions, precipitation of dm of the same composition as host mineral on the walls of inclusion vacuole, crystallization of other dms, change of vacuole volume due to precipitation of host mineral from the liquid trapped in inclusion and its influence on estimated T_H and P, concentration of ore elements in hydrothermal fluid, activity of volatile components, salt concentrations.

The paper essentially reviews several articles, published before and in 1976. (Abst. by A.K.)

RYE, R.O., BETHKE, P.M., BARTON, P.B., Jr., and WETLAUFER, P.H., 1977, Complex hydrologic history of Creede ore deposits in Colorado (abst.): Geological Research 1977, U.S. Geol. Survey Prof. Paper 1050, p. 5-6.

Studies of light stable isotopes showed that the epithermal silver-lead-zinc-copper ore deposits at Creede, Colo., were deposited from a complex hydrologic system dominated at most times by meteoric waters.

The δD and $\delta^{18}O$ of the hydrothermal fluids responsible for the deposition of various generations of sphalerite, quartz, and carbonate and of sericite and chlorite were determined directly from analysis of fluid inclusions and estimated indirectly from isotopic analysis of the minerals. The $\delta^{13}C$ of the hydrothermal fluids was estimated from data on carbonated rocks. The $\delta^{18}O$ data indicate that the fluids contained a substantial meteoric component during the deposition of sphalerite, quartz, sericite, and chlorite. The carbonate rocks, on the other hand, were deposited from either magmatic waters or waters that equilibrated with country rock at near-magmatic temperatures. The δD data also indicate that two distinct meteoric waters with different recharge areas contributed to the hydrothermal fluids. The $\delta^{13}D$ data indicate that the carbon in the fluids that deposited the carbonate minerals in the veins came from a deep-seated source and not from the sedimentary source from which the large volume of preore travertine deposited in the periphery of the Creede caldera was derived.

Differences in the isotopic compositions of the fluids correlate with differences in mineralogy but not with depositional sequences, an indication that fluids from different sources occupied the ore zone recurrently.

The existence of meteoric waters of δD -55 to -95 $^{\circ}/_{\circ\circ}$ in the same ore deposit has several climatic implications. The difference between these values and those of present-day surface waters (δD -112$^{\circ}/_{\circ\circ}$) suggests that the climate was milder at the time of ore deposition. The difference between the δD values of the two waters suggests that one had a relatively low elevation recharge area, receiving waters dominantly from the Gulf of Mexico, and that the other had a relatively high elevation recharge area, receiving precipitation from the Pacific Ocean. These interpretations are consistent with geologic evidence indicating that, at the time of ore deposition (24.6 m.y. B.P.), (1) the Creede area was approximately 1,000 m lower than it is at present; (2) there were no major mountain barriers between the Gulf of Mexico and the Creede district; and (3) there was considerable relief to the north of the district during mineralization. (Authors' abstract)

RYERSON, F.J. and HESS, P.C., 1977, The partitioning of elements between immiscible silicate liquids (abst.), in Abstracts of Papers, Internat. Conf. on Experimental Trace Elem. Geochemistry, Sedonia, Ariz., Sept. 12-16, 1977: Univ. Ariz., p. 103.

RYKART, Rudolf, 1977, Fenster und Libellen: Lapis, v. 2, no. 12, p. 40-41 (in German).

"Fenster" quartz crystals (with strongly reentrant faces) are described and illustrated as are some of the resulting large primary fluid inclusions. (ER)

RYTUBA, J.J. and DICKSON, F.W., 1977, Reaction of pyrite + pyrrhotite + quartz + gold with NaCl-H_2O solutions, 300-500°C, 500-1,500 bars, and genetic implications: Problems of Ore Deposition, Fourth IAGOD Symposium, Varna, 1974, v. II, p. 320-326.

RYZHENKO, B.N., 1976, Thermodynamics of the dissolution of inorganic substances in hot aqueous solutions: Geokhimiya, 1976, no. 2, p. 229-246 (in Russian; translated in Geochem. Internat., v. 13, 1976, p. 139-153 (pub. in 1977)).

SABOURAUD, C., PARNAUD, F., DUVAL, F. and HUMBERT, L., 1977, Fluid inclusion studies of calcites from limestone joints (abst.): Inst. Mining and Met., Trans., Sect. B, v. 86, p. B159.

Preliminary study of cavities and their solid and liquid contents inside calcites that fill fissures shows that this approach can yield valuable information with regard to the diagenesis of carbonates. The calcite grains record all the periods and variations of underground water movement during their growth and after the filling of the fissures. (Authors' abstract)

SAFAROV, Yu. A., 1976, Temperatures of formation of the tungsten deposits of Caucasus (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 81 (in Russian; translation by A. Kozlowski).

Following types of deposits were distinguished: a) skarn, b) hydrothermal-metasomatic, c) hydrothermal. Skarn deposits formed during several stages with the main minerals - scheelite, Mo-bearing scheelite and molybdenite, with T_H for this association 650-90°C. Scheelite crystallized at 575-320°C. W ores of the hydrothermal-metasomatic deposits occur in quartz and quartz-feldspathic veins and metasomatically altered amphibolites; they were formed by Cl-alkaline solutions at 400-100°C (scheelite at 300-260°C). Hydrothermal deposits are quartz veins and silicification zones with the scheelite-sulfide mineralization. Minerals of the commercial ores formed at 340-220°C, and post-ore quartz at 240-170°C. (Author's abst.)

SAHU, K.C., PANCHAPAKESAN, V., and PATIL, R.R., 1977, Fluid inclusion studies on samples from Kolihan mines of Khetri copper belt: Jour. Geol. Soc. India, v. 18, no. 12, p. 671-674.

Fluid inclusion studies were carried out on the milky white vein quartz intimately associated with Kolihan sulphide assemblage. The studies reveal that the deposition should have taken place at a temperature higher than 350°C and the ore-bearing solutions could have had a very high degree of salinity approaching the condition of a "hydrosaline melt" with 33% NaCl and 17% KCl by weight. (Authors' abstract)

SAITO, K., BASU, A., ALEXANDER, E.C., Jr., and DRAGON, J.C., 1977, Rare gases in mantle derived samples (abst.): Amer. Geophys. Union Trans., EOS, v. 58, p. 1249.

SAKAI, H., 1977, Sulfate-water isotope thermometry applied to geothermal systems: Geothermics, v. 5, p. 67-74. Author at Inst. for Thermal Spring Research, Okayama Univ., Misasa, Tottori-Ken, Japan.

The oxygen isotopic fractionation between sulfate ion and water is a useful measure of the temperature of geothermal reservoirs. The rate of the oxygen isotopic exchange reaction between sulfate and water in acid to neutral thermal waters of a temperature of 100°C or higher is sufficiently fast to justify that the sulfates are in isotopic equilibrium with the reservoir waters. The isotopic thermometer has been successfully applied to several Japanese geothermal fields. The temperatures measured by this method are in good agreement with silica and alkali-temperatures. Some factors affecting the results as well as the analytical techniques of the oxygen isotopic analyses of sulfates are discussed. (Author's abstract)

SAKAI, H. and MATSUBAYA, O., 1977, Stable isotopic studies of Japanese geothermal systems: Geothermics, v. 5, p. 97-124. Authors at Inst. Thermal Spring Research, Okayama Univ., Misasa, Tottori-Ken, Japan.

Stable isotopic studies on Arima type brines, Green Tuff type thermal waters and three volcanic systems, Hakone, Ibusuki and Satsuma-Iwojima, were reviewed with emphasis on the origins of the water and sulfur species in these systems. Of the three volcanic systems, Hakone is a subaerial volcano consisting of calderas, central cones and a caldera lake, whereas Ibusuki belongs to a caldera half-drowned in the ocean. Satsuma-Iwojima is a volcanic island erupted within a drowned caldera ca. 40 km off the southern coast of Kyushu. Comparisons of the isotopic data of the waters and sulfur species from the three different volcanoes indicated that the waters of meteoric, oceanic and magmatic origins are involved in various ways and proportions in the volcanic activities. A considerable fraction of the volcanic sulfur species is shown to be recyclic in origin. It was demonstrated that a combined use of chemical and isotopic data on thermal waters and dissolved sulfates would yield useful information on the hydrological aspects of many geothermal systems. (Authors' abstract)

SAKHIBGAREEV, R.S. and LASHKOVA, L.N., 1977, On corrosion of minerals by oils and bitumens: Akad. Nauk SSSR Doklady v. 234 no. 6, p. 1452-1455 (in Russian). First author at the All-Union Oil Sci.-Research Geol.-Prospect. Inst., Leningrad.

Pertinent to element transport by oil-bearing mineral forming fluids. (A.K.)

SAMOYLOV, V.S., 1977a, Carbonatites (facies and conditions of formation), 292 pp., "Nauka" Publishing House, Moscow (in Russian).

The book bears data on T of formation of carbonatites, determined by various geothermometers, and data on physico-chemical carbonatite systems, that are pertinent to studies of fluid inclusions in minerals of carbonatites. (A.K.)

SANIN, B.P., 1977, Some physico-chemical peculiarities of formation of deposits of gold-galena-sphalerite formation in E. Transbaikalia (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Sib. Branch, v. II, p. 48-49 (in Russian; translation by A. Kozlowski). Author at Inst. Geochem. of Siberian Branch of Acad. Sci. USSR.

Deposit of Au-galena-sphalerite formation occurs in Upper Jurassic volcanic rocks, cut by numerous porphyrite, porphyry and lamprophyre dikes. Ore bodies are kataclastic zones with network of thin veinlets. Water leachates from early pyrite bear Cl, SO_4, K, Na, Ca, Mo, Fe; pH of leachate 4.4. Pyrite of later quartz-carbonate-sphalerite-galena stage yielded in leachate ions: Cl, SO_4, HCO_3, F, K, Na, Ca, Mo, Fe; pH of leachate 5.7, whereas sphalerite of the same stage, although gave leachate of similar ionic composition, its pH was 6.2. Leachate from sphalerite of subsequent quartz-carbonate-sulfosalt stage was 7.2. Hence, deeper solutions were more acid, bearing mainly K and SO_4, but at subsurficial levels pH increased and Ca, Cl and SO_4 became more important. (From the author's abst.)

SATO, Toshio, NAMBU, Masateru, OMORI, Yasuo, and HAYAKAWA, Norihisa, 1977, On the analysis of fluid inclusions in quartz with ion microanalyzer: Bulletin of the Research Institute of Mineral Dressing and Metallurgy, Tohoku University, v. 33, no. 2, Rept. 745, p. 92-102 (in Japanese, with English abstract; see translations, under Nambu).

SAVEL'EVA, N.I. and NAUMOV, G.B., 1976, Analysis of methods of study of the salinity of fluid inclusions in minerals (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 168 (in Russian; translation by A. Kozlowski).

The water leach method has neither a good basis nor (established ?) limits. Values given in published papers often are larger than the solubility of compounds although microscopic studies do not find the appropriate daughter minerals.

The nature of many errors is connected essentially with the manipulations during leaching. High results are possible from extraction of components of solid microinclusions; low results may be caused by absorption on the surface of the finely ground sample (this was checked especially). The method of triple leaching does not exclude these errors. Ten or twelve multiple leaches reveal a gradual but nonlinear change of concentration of the individual elements, possibly connected with a change in the active surface of the ground sample.

Such errors decrease with increase in size of the particles. Hence decrepitation of quartz grains (0.24-1mm), leaching and analysis of the dried salt was used. Possibilities were examined of opening inclusions with temperature shock, pressure up to 1000 atm and vacuum of 0.01 mm Hg. The results were compared with data on cryometry of inclusions, NaCl solutions and artificial mixtures close to the composition of solutions of G/L inclusions. This showed that decrepitation empties the inclusion filling and the method of opening of inclusions by decrepitation is most suitable. (Author's abst.).

SAWKINS, F.J., 1977, Fluid inclusion studies of the Messina copper deposits, Transvaal, South Africa: Econ. Geol., v. 72, p. 619-631.

The Messina copper deposits comprise an important group of breccia pipes, disseminated replacement, and vein deposits emplaced in granulite facies metamorphic rocks of the Limpopo mobile belt. This east-northeast-trending belt was the locus of normal faulting, magmatism, and ore deposition during the period of Karroo igneous activity (210-170 m.y. B.P.).

The ore minerals consist primarily of chalcopyrite and bornite with lesser amounts of chalcocite and minor native copper. Pyrite is present only at the outermost margins of the orebodies and forms part of the unusual zonal distribution of ore minerals, which in broad terms comprises concentric zones of chalcopyrite, bornite, and chalcocite occurring succesively from the edges toward the centers of the replacement orebodies. Within the breccia-pipe orebodies ore minerals with increasing copper content occur sequentially with increasing depth in the pipes.

Heating and freezing studies on inclusions in quartz and some calcite samples, representing a considerable vertical range within the orebodies, confirm the hydrothermal nature of ore deposition. Fluid inclusion filling temperatures lie in the range 210°C to 120°C for quartz and, coupled with paragenetic studies, indicate that at least the latter stages of copper sulfide deposition occurred at temperatures down to 160°C. Detailed temperature studies on zoned quartz crystals indicate an overall decrease in temperature with time. The deposition of calcite took place in the temperature range 160°C to 60°C.

Freezing studies indicate a salinity range for the hydrothermal fluids from ∿25 to 2 equivalent weight percent sodium chloride, but no halite was seen in any inclusions except one that lost some of its fluid due to leakage during a heating run. Patterns of salinity variation with respect to time appear to be complex but exhibit an overall trend toward decreasing salinity with decreasing filling temperature.

Birefringent acicular or tabular daughter minerals are present in many of the inclusions in Messina quartz, and in some occupy up to 20 volume percent or more of the inclusion cavity. However, no clear relations between filling temperature, salinity, and the presence or absence of these minerals are apparent. X-ray studies of a crystal removed from a large inclusion shows it to be layered alumino-silicate mineral, probably sodium montmorillonite.

On the basis of the fluid inclusion data and previous alteration and chemical studies, a genetic model involving initial dissolution of host-rock quartz followed by albitization and quartz deposition in open cavities is proposed. Metallization appears to have occurred primarily during the stages of albitization and that of the early quartz deposition. The source of the hydrothermal fluids must remain conjectural at this stage, but the geologic setting and available geochemical data suggest a link between ore deposition, peralkaline magmatism, and active circulation of meteoric water. (Author's abstract).

SAWKINS, F.J., O'NEIL, J.R. and THOMPSON, J.M., 1977, Geochemical evidence relating ore deposition to current geothermal convective activity, Baguio Gold District, Luzon, Philippines (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 1157-1158. First author at Department of Geology and Geophysics, University of Minnesota, Minneapolis, MN 55455.

The Acupan and Antamok gold deposits of the Baguio district have produced ∿3x10^5 kg of gold. The quartz-rich veins in the area still contain geothermal waters in their deeper portions and at one locality underground a high pressure steam vent has been active for five years.

Fluid inclusion studies on quartz indicate deposition in the range 250-300°C by low salinity fluids (0-6 equiv. wt. %). Fluid inclusion gas analyses indicate that CO_2, CO, H_2, NO, H_2S, SO_2, and CH_4 were present at times in the ore fluids (>99% H_2O). δD values for fluid inclusion waters range from -72.2 to -81.5. Chemical studies of various waters in the area indicate reservoir temperatures up to 250°C. Isotopically these waters range from -58 to -75 (δD) and -2.17 to -11.48 ($\delta^{18}O$). $\delta^{18}O$ values (3.19 to 6.06) for vein quartz are light, given the temperature regime, as are $\delta^{18}O$ values from various host rocks (1.63 to 4.55). Minimum isotopic temperatures of 180-205°C are calculated from the $\delta^{18}O$ fractionations between quartz and unaltered groundwater ($\delta^{18}O = -11.0$). Prior ^{18}O shift of such waters would increase the calculated quartz deposition temperatures.

The data indicate ore deposition by a hydrothermal convective system dominated by meteoric water under conditions of high water to rock ratios, and at temperatures close to those currently present in the subsurface. Whether the current geothermal activity represents the waning stages of the ore-deposition event, or a later resurgence of geothermal activity is not clear at present. (Authors' abstract)

SAWKINS, F.J. and RYE, R.O., 1977a, Fluid-inclusion and stable isotope studies indicating mixing of magmatic and meteoric waters, Caudalosa silver deposit, central Andes, Peru, in Problems of Ore Deposition, Fourth IAGOD Symposium, Varna, 1974, vol. 2: Sofia, Pub. House Bulgarian Acad. Sciences, p. 110- . First author at Dept. of Geology and Geophysics, Univ. Minn., Minneapolis, MN, USA.

Inclusions from various stages of quartz and sphalerite (T_H 325-175°C, 4-18% NaCl equiv.) show a marked drop with successive stages. Deuterium ranges from -62 to -125‰, generally decreasing in later stages. Higher deuterium correlates with higher salinity, suggesting mixing of high salinity magmatic water and low salinity meteoric waters. (ER)

SAWKINS, F.J. and RYE, R.O., 1977b The Messina copper deposits, Republic of South Africa: ore genesis associated with an intracontinental rift zone (abst.): Econ. Geol., v. 72, no. 4, p. 738-739.

See Fluid Inclusion Research -- Proceedings of COFFI, v. 9, p. 122 (ER)

SAZONOV, V.N., TALANTSEV, A.S., ILYASOVA, L.K., BAKHTINA, A.P. and DEMINA, N.Ye., 1977, P-T-X conditions of formation of deposits of gold-sulfide-quartz formation (exemplified by the Urals) (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. USSR, Sci. Council on Ore Formation, Sib. Branch, v. II, p. 46-47 (in Russian; translation by A. Kozlowski). Authors at the Inst. Geol. Geochem. of the Ural Sci. Center of Acad. Sci. USSR, Sverdlovsk.

Outer zones of aposerpentinite metasomatites formed from solutions: Na>>K>>Mg plus CO_2, H_2, N_2. In intermediate zone, in fluid inclusions K and Mg contents sharply increase (K/Na=1.36); commonly solutions are SO_4, Cl>>F. In the inner zone adjacent to ore vein Mg and K increase further (K/Na=2.64). Stronger listvenitization is caused by increasing CO_2 content and decreasing H_2 and N_2. Vein quartz in inclusions bears Na/K$\geq$2, Ca is present, but Mg occurs only occassionally. Cl is the main anion, F has concentrations tens to hundreds of times lower than Cl. At deeper levels Na, K and HCO_3 contents decrease but Ca, Mg, Cl and SO_4 increase. Differences in solutions forming veins and wall-rock metasomatites cause doubts concerning widely accepted hypothesis on simultaneous forming of veins and metasomatites. (From the authors' abst.)

SCHERP, A. and STRÜBEL, G., 1977, Hydrothermal investigation of the system $BaSO_4$-$SrSO_4$-NaCl-H_2O and its bearing on Ba-Sr mineralizations, in Problems of Ore Deposition, Fourth Symposium of the International Assoc. on the Genesis of Ore Deposits, Varna, 1974: Sofia, Bulgaria, Bulgarian Acad. of Sci., v. III, p. 23-28 (in English).

Full paper corresponding to abstract in Fluid Inclusion Research -- Proceedings of COFFI, v. 7, p. 198-199, 1974. (ER)

SCHREYER, W., MEDENBACH, O., ABRAHAM, K. and NICOLAYSEN, L.O., 1977, CO_2-rich fluid inclusions in the polymetamorphic basement rocks of the Vredefort Structure, South Africa, and their possible bearing on its origin, in Second International Kimberlite Conference 1977, Extended Abstracts (unpaginated).

The ring-like Vredefort Structure consists of a collar of steeply dipping overturned Witwatersrand metasediments and a 50 km diameter core of Archean basement in a similar tectonic position. The border between the Archean and the collar is marked by a sedimentary unconformity. Thus the whole structure represents a section through most the continental crust (Slawson 1976).

Within the collar metamorphism increases inward changing the nearly unaffected peripheral slates into hornfelses with andalusite, cordierite etc. On the basis of the mineral assemblages reported by Bisschoff (1969) maximum temperatures of about 500°-600°C may be estimated for this static metamorphism. Petrologic studies of the Archean basement rocks reveal, however, that this type of metamorphism continues and increases further towards the center of the structure, where it is superimposed on the previous dynamic metamorphism of the Archean and where it may affect possibly unmetamorphosed granites and other intrusives. Metamorphic conditions could be deduced for two polymetamorphic sediments:

1. A former regional metamorphic granulite located about midway between collar and center exhibits breakdown of its former garnet in the presence of quartz into a symplectite of cordierite, hypersthene, and a different garnet. Microprobe analyses yield the following M-values (Mg/(Mg+Fe)) of the new minerals: cordierite: 0.60; hypersthene: 0.41; garnet: 0.19. Based on the experimental results of Hensen and Green (1973) who studied this multivariant breakdown reaction some 750° and 5 kb can be estimated.
2. In an iron formation occurring at the center of the ring ferropigeonite ($En_{70}Fs_{17}Wo_{13}$) had formed which requires minimum temperatures of some 800°-850°C (Simmons et al. 1974). Upon cooling this pyroxene did not invert but exsolved into clinoeulite and ferroaugite (Schreyer et al. 1977).

Many quartz crystals occurring in polymetamorphic basement rocks from various localities within the ring contain two-phase fluid inclusions which, on the basis of their freezing temperature near -56°C, consist of virtually pure CO_2. In some rocks near the unconformity three-phase inclusions with some additional H_2O were found. Although CO_2-rich inclusions are well known from deep-seated granulites elsewhere (Touret, 1971), the ones observed here are of particular genetic significance: In rocks of the outer portion of the core they form decorations of quartz lamellae which are regarded by some investigators as indications for meteorite impact (e.g. Carter 1968).

Kink bands in biotites and the appearance of pseudotachylites and shatter cones both in the outer core as well as in the collar are further testimonies of a high-strain-rate deformation which has been attributed to shock metamorphism. Since this deformation is clearly younger than the static metamorphism, the impact hypothesis meets with the difficulty in explaining why a meteorite should have hit the very spot in Southern Africa where this localized static metamorphism had occurred.

Comparison of quartz lamellae and other deformational features of Vredefort with the shock features observed in basement rocks of the Ries crater indicate that similarities only exist with the very lowest grades of shock metamorphism of the Ries. Contrary to te Ries the quartz lamellae of Vredefort exhibit all stages of a recrystallization which increases in intensity from the outer core to the center of the structure. Thus, whereas in rocks close to the unconformity SEM investigations show parallel open fractures, these are healed by finely recrystallized quartz closer to the center. In the central portion of the structure the quartz grains form excellent polygonal annealing textures with 120° triple points. Nevertheless, in many cases the CO_2 inclusions can be found to follow parallel planes that are continuous beyond the grain boundaries of the annealing fabric. Since the arrangement of these planes is directly comparable to that of the decorated quartz lamellae of the outer core, this observation must be considered as evidence that high-strain-rate deformation has also produced quartz lamellae in the center of the structure prior to annealing. In the course of the complete recrystallization of quartz the CO_2 inclusions have partly coalesced into larger but fewer inclusions which are notably rarer in zones close to the new grain boundaries of quartz.

Heating-stage measurements of CO_2 inclusions in six rocks of various portions of the core revealed a remarkably consistent behavior: In all cases the inclusions homogenized to form liquid at temperatures ranging from 22°-28C which indicates specific densities of 0.7-0.8 gr/cm^3. Using the extrapolated PVT data for CO_2 of Kennedy (1954) in conjunction with the metamorphic temperatures derived mineralogically the following ranges of partial pressures of CO_2 can be estimated: At 750°C 2.9-3.9 kb, at 850° 3.3-4.4 kb.

The spatial arrangement of CO_2-rich inclusions along the lamellae in quartz suggests that the gas was incorporated either concomitantly with or subsequently to a rock deformation characterized by very high strain rates. Similar fluid inclusions decorating quartz lamellae in rocks of the Charlevoix structure, Quebec, were found by Pagel and Poty (1975) to consist of H_2O. The lack of CO_2 is used by those authors as a strong argument for meteorite origin of that structure. Following their reasoning and keeping in mind that no higher-grade features of shock metamorphism were found at Vredefort, a meteorite imapct is unlikely to have caused the Vredefort structure but an endogeneous origin must be sought: The time of CO_2 incorporation is, like that of the high-strain-rate deformation, precedes a second period of static metamorphism (annealing) which is confined to the central area of the core. Thus all these events must be seen as episodes in a long history of thermal and structural development of the Vredefort dome. As already suspected by Nicolaysen (1972) for other cryptoexplosion structures high fluid pressures and their explosive release seem to be the dominant reason for the high-strain-rate deformation at Vredefort. The source of both the CO_2 and the enormous heat flow causing static metamorphism with a vertical extent of more than 25 km over a limited area can best be seen in a mantle-derived magma diapir that cooled near the base of the continental crust. (Authors' abstract)

SCOFIELD, N. and NOBLE, D. C., 1977, Two-phase glass inclusions in phenocrysts in rhyodacite represent metastable liquid immiscibility in undercooled silicic melt (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 1165-1166. First author at Institute of Mineral Research and Department of Geology and Geological Engineering, Michigan Technological University, Houghton, Michigan 49931.

Inclusions of silicic magmatic liquid now consisting of two distinct glass phases plus one or more vapor bubbles are present in phenocrysts of plagioclase and quartz in calc-alkalic rhyodacites of the Julcani volcanic center, Peru. The rocks, with SiO_2 contents of 65 to 69 weight percent, contain abundant phenocrysts of plagioclase, quartz, biotite, and hornblende, have low FeO*/MgO ratios, and underwent intratelluric crystallization under conditions of very high fO_2.

The inclusions consist of colorless glass that contains one or more globules of green glass less than 10 to about 75 microns in diameter. The green glass globules have an appreciably higher refractive index than the surrounding clear glass, approximately equal to that of the enclosing andesine and quartz. Some of the green glass globules show evidence of incipient devitrification. Electron microprobe analysis of the two glass phases is in progress.

The two-phase inclusions reflect the separation of subordinate amounds of more mafic liquid from highly silicic (about 70 percent SiO_2) melt. The demonstration of immiscibility in natural silicic liquids does not, however, necessarily provide support for the hypothesis that some very silicic melts are produced by liquid-liquid separation, since the glasses apparently were trapped as a single phase and unmixed only at submagmatic temperatures above the liquid-glass transition range. Similar two-phase glass inclusions, which have been observed in other rocks from Peru and Central America, are probably a common feature of appropriately quenched silicic and intermediate volcanic rocks. (Authors' abstract)

SEDOVA, I.S., 1976, P-T regime of formation of ultrametamorphic granitoids (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 121 (in Russian; translation by A. Kozlowski).

Ultrametamorphogenic granitoids form at the final stages of tectonic-metamorphic cycle during P decrease over a range of 1-3 kb. Estimated from inclusions of CO_2, the maximum P of fluid in the zone of amphibolite facies of the Muzkol complex is 7-8 kb, whereas in zone of ultrametamorphism - 4.5-5.5 kb. Kyanite-sillimanite facies series of the amphibolite facies at SW Pamirs formed at P 8-9 kb, but main mass of ultrametamorphic granitoids (vein migmatites) appeared after P decrease to 5-6 kb; ultrametmorphism began at P 8-6 kb.

Autochthonous, allochtonous, metasomatic and anatectic types of ultrametamorphic granitoids were distinguished. Inclusions of mineral-forming media are distributed unequally. Especially numerous are S inclusions in allochthonous granitoids, with alterations appearing in zones of low-degree metamorphism, metasomatism or tectonic activity.

Melt inclusions were not found in metasomatic granites. Maximum T_H of early salt (brine) inclusions for granitoids of amphibolite facies - 700-650°C. Anatectic granites of the vein migmatites, in addition to salt and G/L inclusions, also contain melt inclusions (T_H 830-780°C); this T is over a range of 100°C lower than T of anatectic substrate on the basis of other methods. T_H of melt inclusions in granitoids of kyanite-sillimanite facies series from E. Transbaikalia and Tyan'-Shan' are higher, but P is 1.5-3 kb lower. (Author's abst.)

SEREZHNIKOV, A.I., 1977a Sulfate thermal waters from Kamchatka: Akad. Nauk SSSR Doklady, v. 235 no, 6, p. 1419-1422 (in Russian). Author at the All-Union Sci.-Research Inst. of Hydrogeol. and Eng. Geol., Staraya Kupavna, Moskovskaya obl.

Analyses presented for Mn, Fe, Li, Na, K, Rb, Cs, NH_4, Ca, Mg, HCO_3, Cl, SO_4, F, H_4SiO_4, B, W, As, and CO_2; pertinent to fluid inclusion chemistry. (A.K.)

SEREZHNIKOV, A.I., 1977b Recent sulfate hydrotherms in the region of the Koshelevsky volcano (S. Kamchatka), their relations to volcanism and low-temperature dissolving of minerals, in: Hydrothermal process in the areas of tectonic-magmatic activity, p. 184 193, "Nauka" Publ. House, Moscow (in Russian).

SEYFRIED, William and BISCHOFF, J.L., 1977, Hydrothermal transport of heavy metals by seawater: the role of seawater/basalt ratio: Earth and Plan. Sci. Lett., v. 34, p. 71-77. First author at Dept. Geol., Stanford Univ., Stanford, CA.

Seawater reacted with basaltic glass at 260°C and 500 bars under water-dominated conditions (50:1 water/rock ratio) efficiently leached and maintained heavy metals in solution. Cu, Zn, and Ba are transferred in significant proportions to the aqueous phase, while Fe and Mn attain concentrations of 45 and 20 ppm respectively as the basalt is completely made over to magnesian smectite. High metal solubility is a function of acidity maintained by large excess of dissolved Mg and equilibria with the alteration phase.

Metal concentrations and relative proportions are consistent within limits required for metal-rich fluid which produced East Pacific Rise metalliferous sediments.

Experiments mixing metal-bearing altered seawater and normal seawater were carried out as a qualitative indicator of sea-floor precipitation processes. Bulk composition of the precipitates are strongly influenced by mixing ratio. Precipitates range from silica-magnesium rich under low dilution by seawater to essentially pure ferric hydroxide under conditions of high dilution. (Authors' abstract)

SHAFFER, N.R., 1977, Possibility of Mississippi Valley-type ore deposits in Indiana (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, p. 650.

Preliminary information from fluid inclusions in sphalerite samples indicates that some specimens formed at temperatures within the range of those reported from Mississippi Valley-type deposits.

Because of favorable geology, occurrence of minor amounts of ore minerals, and tentative evidence that ore-type fluids passed through suitable host rocks, a real possibility exists that undiscovered Mississippi Valley-type ore deposits may occur in Indiana. (From the author's abstract)

SHAPENKO, V.V., 1976, Thermobarogeochemistry of tungsten deposit Kholtoson (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 69-70 (in Russian; translation by A. Kozlowski).

The deposit consists of the quartz-huebnerite-sulfide veins in Paleozoic diorites. It is connected with a stock of Mezozoic granite porphyry, cut by pre-ore lamprophyre dikes. Inclusions in the commercial parageneses reflect the instability of crystallization conditions and processes of heterogenization of hydrotherms. CO_2 is the prevailing gas; for huebnerite moreover the presence of H_2S is typical. (Author's abstract)

Mineral	Types of inclusions and T_H, °C			Pressure, bar
	$G+LH_2O$	$G+LCO_2+LH_2O$	$G+LH_2O$+crystals	
Quartz	340-150	340^*		1550-400
Huebnerite	290-250	320^*	250^{**}	1500-500
Microcline	310-290			
Fluorite	280-110	$200\text{-}300^*$	210^{**}	1000-300
Sphalerite	250-240			
Rhodochrosite	285	350^*		1550-600
Triplite	234			
Calcite	240-230			
Sericite /sic./	200			

$^*T_D$ before homogenization; **T of dissolution of G phase.

SHAPENKO, V.V., 1977a, Thermobaric parameters of the ore formation at Kholtoson tungsten deposit (SW Transbaikalia) (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. I., p. 142 (in Russian; translation by A. Kozlowski). Author at GEOKHI AN USSR.

The deposit consists of quartz-huebnerite veins in quartz diorite. Pre-ore quartz-microcline vein association formed at 380-350°C; ore minerals at 320-250°C and 1500-300 bars, and precipitated from H_2O-CO_2 solutions (LCO_2 appears in inclusions in quartz, huebnerite, scheelite, rhodochrosite and fluorite; boiling was very frequent. Post-ore minerals crystallized at T as follows: sphalerite 280°C, triplite 260°C, calcite 240°C, and fluorite 190°C, from low CO_2 or CO_2-free solutions. Huebnerite (∿100 specimens from six commercial veins) yielded a very narrow interval of T_H (290-250°C); no vertical T gradient observed. (Abs. by A.K.)

SHAPENKO, V.V., 1977b, Role of carbon dioxide in the formation of molybdenum-tungsten mineralization in the southwestern Transbaikal Region: Izv. Vyssh. Uchebn. Zaved., Geol. Razved., 1977, v. 20 (8), p. 31-33 (in Russian). Author at Mosk. Gos. Univ. im. Lomonosova, Moscow, USSR.

CO_2 is the most important component of mineralizing solns. in formation of rare metal mineralization of the deposits examd. Data on the presence of H_2CO_3 in pyrogenetic and hydrothermal quartz suggests a juvenile source of aq. H_2CO_3 in the hydrothermal mineralization process is induced by the complex course of the development of the veined structure. Ore fields of complex structure are characterized by the appearance of H_2CO_3 in minerals originating in various stages of the mineralizing process. The stages in the development of veined structures do not agree with stages in the evolution of mineralizing solns. Development of H_2CO_3 inclusions in fluorides, assocd. mainly with W mineralization is found in the Dzhindinsk ore field. Fluid pressure was estd. to be 300-1200 kg/cm^2. (Chem Abst., 1978, no. 6, 88:76611n)

SHATKOV, G.A., 1975, Fluorine and chlorine in basalts as possible indicators of metallogenic zonation: Sovets. Geol., 1975, no. 6, p. 121-127 (in Russian; translated in Internat. Geol. Review, v. 18, no. 10, 1976, p. 1182-1188).

SHCHEPETKIN, Yu.V., NESTEROV, I.I., KULAKHMETOV, N.Kh. and RYL'KOV, A.V., 1976, Decrepitation in the recognition and correlation of sedimentary beds (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 155 (in Russian; translation by A. Kozlowski).

T_D (visual method) of Mesozoic rocks of W. Siberian Platform ranges from 790 to 360°C. T_D was used for correlation of beds in boreholes. (From the authors' abst.)

SHCHEPOT'YEV, Yu.M. and ANDRUSENKO, N.I., 1975, Genetic features of near-surface gold and mercury deposits of Kamchatka: Sovets. Geol., 1975, no. 6, p. 62-71 (in Russian; translated in Internat. Geol. Review, v. 18, no. 9, 1976, p. 1059-1066).

Distinctive genetic features of near-surface gold-silver and mercury ore mineralization of Kamchatka are examined on the basis of a detailed study of the geologic-structural factors controlling them, material composition of the ores, their gas-liquid inclusions, and calculated depth of formation of the ore in the best prospected bodies of Kamchatka. The ore deposits were formed at depths of 100-600 m. Their minerals were formed from sulfate-chloride-bicarbonate solutions at pressures from 640 to 70 atmospheres or below. An important factor of ore deposition was the carbon-dioxide regime in the solutions, which was determined by the volcanotectonic activity within the gold-ore fields. (Authors' abstract)

Includes a table of homogenization temperatures for various assemblages, ranging from 480°C (in vapor phase) down. (ER)

SHCHERBAKOV, Yu.G. and ROSLYAKOVA, N.V., 1977, Temperatures of ore formation as a criterion of prognosis of the depth of gold ore mineralization (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Sib. Branch, v. II, p. 57 (in Russian; translation by A. Kozlowski). Authors at Inst. Geol. Geophys. of Siberian Branch of Acad. Sci. USSR, Novosibirsk.

T_H were measured for inclusions in quartz from Au and Au-Ag vein deposits in Kuznetskiy Alatau and in garnet, wollastonite, plagioclase, quartz and calcite from skarn Au deposits in NE Altai. They are: 500-60°C for veins and 880-50°C for skarns; gold ores formed at 350-170°C. At Au-Ag deposit T increased over interval $\sim$50°C from surface to depth 390°C; in upper part commercial stage yielded T 250-170°C, in lower part 300-225°C. From T_H conclusions for prospecting may be obtained. (Abst. by A.K.)

SHCHERBAKOVA, Z.V., 1976, Soda-potash feldspars: Tr. Inst. Geol. Geofiz., Akad. Nauk SSSR, Sib. Otd., 1976, no. 253, 67-81, 169-174 (in Russian).

The alk. syenites of the Kunolei complex (Transbaikal region) contain 75-90% K-Na feldspars. The feldspars contain high Na concns., have crytoperthite structure and are essentially of anorthoclase compn. The feldspar grains have characteristic zonal structure; the more ordered outer zones contain ≤36% orthoclase and the less ordered central zones ≤20% orthoclase. The crystn. temps. and pressures of the feldspars and quartz are estd. from the homogenization temps. of fluid inclusion and the compn. and degree of order of the feldspar. There are differences between the mineral compn. of the K-Na feldspars in different portions of the complex which correspond to its formation stages. (Chem. Abst., 1978, no. 3, 88:39807k)

SHCHERBAN', I.P., 1977, Main parameters of processes of formation of low-temperature metasomatites and accompanying ores, as indicated by thermodynamic, experimental and thermobarogeochemical data (Altae-Sayan area) (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Sib. Branch, v. II, p. 141-142 (in Russian; translation by A. Kozlowski). Author at Inst. of Geochem. and Physics of Minerals of Acad. Sci. of Ukrainian SSR, Kiev.

In the Altae-Sayan area at least five formations of low-T near-ore metasomatites were found: 1) listvenites-berezites, 2) argillites, 3) sericite-chlorite metasomatites, 4) gumbeites* and 5) albite-carbonate metasomatites, associated with Au, pyrite-polymetallic, Hg, W, etc. ores. Listvenites-berezites form when three main conditions exist: increase of pH from <6, $\Sigma CO_2 > 10^{-3.8}$, T<350°C, T_H had values 280-370°C, P 600-800 atm. Argillites formed during action of CO_2-rich solutions on alumosilicates, but at pH<4-5, T<250-300°C; fluid inclusions yielded values T_H 75-140°C, P⩽900 atm (Hg ores). Sericite-chlorite metasomatites developed under action of solutions with pH$\sim$6, of K-Mg type at T⩽400 C; fluid inclusion data: 150-350°C, 500-700 atm. Albite-carbonate or K-spar metasomatites need high CO_2 activity ($<10^{-3.5}$), Na or K in solution, increase of pH of acid solutions, T⩽300-350°C; fluid inclusions showed T_H 120-200°C (carbonates), or 280-360°C and 600-840 atm (W ores). (From the author's abst.)

*See next page

*Gumbeite - from the name of Gumbeika River in the Urals, a rock connected with propylitization process. Name applicable (after Korzhinskiy) for a rock of alumosilicate composition, altered during low-T near-vein metasomatism, and bearing orthoclase, ankerite and other minerals typical of this type of alteration. Minor components: quartz, rutile, pyrite. (Transl. by A.K. from Geologicheskiy slovar', v. 1, p. 202, "Nedra", Moscow, 1978).

SHCHERBAN', I.P., DOLGOV, Yu. A., BOROVIKOVA, G.A., and GIBSHER, N.A., 1976, Physicochemical conditions of formation of the Tishinskoe pyrite-polymetallic ore deposit according to the thermodynamic and thermobarometric data: Geologiya i Geofizika, v. 17, no. 12, p. 46-56; (in Russian; trans. in Soviet Geol. and Geophys., v. 17, no. 12, 1976, p. 34-41 (Allerton Press)). Abstracted in <u>Fluid Inclusion Research--Proceedings of COFFI</u>, v. 9, 1976, p. 124.

SHCHERBAN', I.P. and SHIROKIKH, I.N., 1977, On new type of metasomatites at sulfide-polymetal deposits. Akad. Nauk SSSR Doklady, v. 235 no. 2, p. 458-461 (in Russian). Authors at the Inst. Geol. Geophys. Siberian Branch of the Acad. Sci. USSR, Novosibirsk.

At the Rubtsovskoe deposit (Rudnyi Altai) quartz-albite or albite/oligoclase porphyry (rhyolite-dacite after Daly) is metasomatized into rocks: Mg-chlorite + hydromica + quartz + calcite + pyrite → same, with increasing hydromica and pyrite, decreasing chlorite and absent calcite → quartz + hydromica + decreasing pyrite → quartz + strongly decreasing pyrite and hydromica. The metasomatites formed under 300°C and 55 atm, i.e., at lower P and T than other wall metasomatites of ore deposits (e.g., quartz-sericite rock at Zyryanovskoe deposit 420°C, 1000-1500 atm, listvenite-berezite at Tishinskoe 330°, 600-800 atm.) (Abst. by A.K.)

SHEARMAN, D.J., and ORTI CABO F., 1976, Upper Miocene Gypsum: San Miguel de Salinas, SE Spain: Mem. Soc. Geol. It., v. 16, p. 327-339.

Note: the presence of "brine" inclusions in gypsum crystals is reported, but no description is given, as authors' interest is focused on solid inclusions. (Piero Lattanzi)

SHENGELINA, D.M., AKHVLEDIANI, R.A. and KETSHOVELI, D.N., 1977, Graphite thermometer: Akad. Nauk SSSR Doklady, v. 235 no. 6, p. 1407-1409 (in Russian). Authors at Geol. Inst. of the Georgian Acad. Sci., Tbilisi.

Applicable for T interval 300-850°C under P from 1 to 6000 bar; C_o is the measured parameter. Comparisons with the other mineral geothermometers is presented. (Abst. by A.K.)

SHEPHERD, T.J., 1977, Fluid inclusion study of the Witwatersrand gold-uranium ores: Phil. Trans. R. Soc. Lond., v. 286-A, p. 549-565 (also paginated 315-331). Author at Inst. Geol. Sci., Geochem. Div., 64-78 Gray's Inn Road, London WC1X 8NG.

Fluid inclusions, preserved in quartz pebbles of the uraniferous and auriferous Precambrian oligomictic conglomerates of the Witwatersrand Basin, provide a unique insight into the genesis of the ores. Using differences in inclusion characteristics in conjunction with intra- and inter-deformational textures for adjacent pebbles, a distinction is made between pre- and post-depositional inclusions. Excluding those related to subsequent brittle fracture, the former comprise five principal types; two of which are distinguished by the development of liquid carbon dioxide. Collectively they indicate a moderate to high pressure-temperature environment of vein quartz formation. Systematic variation in the relative abundance of these inclusion assemblages for different sections of the orefield demonstrates the importance of well-defined provenance areas or multiple entry points into the basins. A marked sympathetic relationship between uraniferous banket ores and the presence of vein quartz rich in liquid carbon dioxide inclusions, together with a corresponding antipathetic relationship for gold, strongly suggests separate sources for the metals. The temporal and spatial aspects of the association "U-CO_2" also imply a uranium influx into the basin from discrete areas of the hinterland contemporaneous with the sediments. Post-depositional inclusions are subordinate and offer no support for the alternative epigenetic model and show only a later interaction of relatively cool circulating groundwaters. A discussion is given of the probable nature and origin of uranium in the source rocks and its mode of transportation. In conclusion, a proposal is made for the use of applied fluid inclusion research in the evaluation of and exploration for similar deposits. (Author's abstract)

SHEPPARD, S.M.F., BROWN, P.E., and CHAMBERS, A.D., 1977, The Lillois intrusion, East Greenland: hydrogen isotope evidence for the efflux of magmatic water into the contact metamorphic aureole: Contrib. Mineral. Petrol., v. 63, p. 129-147. First author at Scottish Universities Research and Reactor Centre, East Kilbride, Glasgow G75 OQU, U.K.

The epizonal, Tertiary Lillois layered intrusion (5-9 km diameter) has a well developed amphibolitised basalt aureole, several hundred metres wide. Meteoric water did not interact with either the magma or the hot plutonic rocks. Meteoric waters, however, did enter locally, at a very late stage, during low temperature serpentinisation of periodotite. (From the authors' abstract)

SHILO, N.A., SIDOROV, A.A., and GONCHAROV, V.I., 1976, Use of thermobarogeochemical data for systematics of gold deposits from NE part of the USSR, in Thermobarogeochemistry of mineral formation, N.P. Ermakov, ed.: Rostov, Rostov Univ. Press, p. 65-77 (in Russian).

Full paper corresponding to abstract in Fluid Inclusion Research volume 6, p. 144-145, 1973.

(V.I. Naiborodin added as fourth author in 1976 version.)

SHIMADA, Nobutaka, 1977, Lead-zinc ore deposits of the Tsushima Islands, Nagasaki Prefecture, with special reference to Shigekuma-type mineralization: Mem. Fac. Sci., Kyushu Univ., Ser. D. Geol., v. 23, no. 3, p. 417-480, (in English).

Liquid plus vapor fluid inclusions in quartz from stage IV of the Shigekuma deposit had T_H 208-222°C. No liquid CO_2 was observed, although others had reported it. (ER)

SHIROKIKH, I.N., BORISENKO, A.S. and SHUGUROVA, N.A., 1977, Physicochemical parameters of formation of wall-rock metasomatites at Ilinskoe and Dybyk gold ore deposits (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Sib. Branch, v. II, p. 55-56 (in Russian; translation by A. Kozlowski). Authors at Inst. Geol. Geophys. of Siberian Branch of Acad. Sci. USSR, Novosibirsk.

The deposits occurring in Onon-Turinskaya zone in E. Transbaikalia consist of following metasomatites: 1) quartz-albite, 2) quartz-amphibole, 3) stilpnomelane-apatite, 4) quartz-tourmaline, 5) quartz-carbonate-sericite (berezites); metasomatites 3, 4(?) and 5 are gold-bearing. Results of studies of G/L inclusions are summarized in the table.

Metasomatite	Mineral	T_H, °C	P, atm	Solutions	Composition and concentration, wt.%
Quartz-albite	quartz, albite	>450-500		G	H_2O, CO_2, "acid gases", N_2
Quartz-amphibole	amphibole	>450		G	
Stilpnomelane-apatite	apatite	500-230		G,L	Do. + NaCl
Quartz-tourmaline	quartz	415-320	450-500	G,L	NaCl 10-40
Berezite	quartz	350-190	700-800	L	CO_2 5-20, NaCl 25-30

(Abst. by A.K.)

SHLICHTA, P.J., 1977, Effects of convection on crystal morphology and perfection (abst.): in Program and Abstracts, Third M.S.A.-F.M. Syposium, Crystal Growth and Habit, Tucson, Arizona, Feb. 13-14, 1977 (unpaginated).

SHLYAPNIKOV, D.S. and SHTERN, E.K., 1977, Experimental studies of composition of solid phases and solubility in systems $MgO-H_2O-CO_2$ and $MgO-NaHCO_3-H_2O$ at temperatures 25 and 150°C: Akad. Nauk SSSR, Doklady, v. 234 no. 2, p. 448-451 (in Russian). Authors at the Inst. Geol. Geochem. of the Ural Sci. Center Acad. Sci. USSR, Sverdlovsk.

SHMURAEVA, L.Ya., 1976, Chemical composition of hydrotherms during formation of quartz-huebnerite veins at the Bom-GorKhon deposit (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 194 (in Russian; translation by A. Kozlowski).

The deposit occurs as a series of quartz veins at the SW side of a granitoid massif. Ore bodies formed during greisen and vein quartz stages; the latter consists of huebnerite and sulfide substages. In G/L inclusions Na>K; in huebnerite substage Na/K is 2.6-3.2; in inclusions in sulfides Na/K 1.6-2.0; dark gray vein quartz contains a smaller amount of inclusions with Na/K 3.0-3.2. Ca/Mg in minerals of the huebnerite substage was in interval 5-12 (quartz, huebnerite), reaching 15 in triplite. In inclusions in minerals of sulfide substage Ca/Mg was 45-50. Huebnerite and sulfide substages are thus sharply divided, on the basis of studies of the main cations in fluid inclusions. (Author's abst.)

SHMURAEVA, L.Ya., 1977, On the evolutionary trends in the chemical composition of solutions in the Bom-Gorkhon deposit (W. Transbaikalia) (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. I, p. 173 (in Russian; translation by

A. Kozlowski). Author at VSEGEI, Leningrad.

The deposit of Mo-W ores formed from solutions bearing K, Na, Li, Ca, Mg, SO_4, HCO_3, Cl, and F, being of Cl-HCO_3-Na type. Early W ores (quartz + huebnerite + triplite) yielded Na/K ratio in fluid inclusions 2.6-3.2, Ca/Mg -- 5-15. Later sulfide ores (pyrite, sphalerite) the values are respectively 1.6-2.0 and 45-50; increasing Ca activity is confirmed by intensive scheelitization of huebnerite. (From the author's abst.)

SHNAYDER, A.A. and SHNAYDER, M.S., 1976, Decrepitation activity of hydrothermal deposits during prospecting of tin ore bodies, (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 143 (in Russian; translation by A. Kozlowski).

At the Malo-Kenskoe deposit the quartz-chlorite-sulfide cassiterite ore and at Novo-Dzhagynskoe deposit the quartz-chlorite-tourmaline cassiterite ore have the highest decrepitation activity in the richest varieties. Decrepitation data were successfully used for prospecting. (From the authors' abst.)

SHNAYDER, M.S. and SHNAYDER, A.A., 1976, Methods of thermometry during studies of stages of mineral formation of vein bodies (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 152-153 (in Russian; translation by A. Kozlowski).

Quartz, cassiterite, carbonate, chalcopyrite, arsenopyrite, pyrrhotite, and tourmaline, as well as mineral-paragenetic associations were studied by the decrepitation and homogenization methods. Studies were made at tin ore deposits of the N. Sikhote-Alin (deposits: Mopau, Pionerskoe, Nadezhda) and Omsukchan region (Malo-Kenskoe, Novo-Kzhagyn, Industrial'noe). At all deposits, formed in a number of stages, distinct mineral zoning is present, as well as regular variations of T_H and T_D, decreasing from the center to the marginal zones of veins. Decrepitation activity and sample weight loss characterize the amount of inclusions of parent solution in the minerals and the degree of metasomatic impregnation. These parameters have a reverse connection with T_D. The above studies are useful for prospecting. (Authors' abst.)

SHOJI, Tetsuya, IMAI, Hideki, and TAKENOUCHI, Sukune, 1977, Ion microprobe microanalysis of the ore minerals from the Mamut Mine, Sabah, Malaysia: Mining Geology, v. 27, p. 323-330.* Authors at Dept. of Min. Devel. Eng., Univ. Tokyo, Hongo, Tokyo, Japan.

Minor elements in the ore minerals from the Mamut porphyry copper deposit, East Malaysia, have been analyzed by ion microprobe. The fact that the sulfides from the hornblende zone of adamellite porphyry where gaseous inclusions are dominant are generally poor in minor elements, indicates that minor elements were more concentrated in highly saline solutions than in sulfide minerals. The fluid inclusion data (Nagano et al., 1977) and the distribution of minor elements between chalcopyrite and pyrite indicate that no remarkable temperature gradient existed in mineralization of the core and ore-shell. (From the authors' abstract) *(In English)

SHUGUROVA, N.A. and DOLGOV, Yu. A., 1976a. Compositions of gases in the deep oceanic water on the basis of studies in authigenic minerals, in Genetic studies in mineralogy, Yu. A. Dolgov et al., eds.: Novosibirsk, Inst. Geol. and Geophy. Sib. Branch Acad. Sci. USSR, p. 26-29 (in Russian).

Specimens were collected during the 48th cruise of the ship "Vityaz". Authigenic minerals bear inclusions of the bottom oceanic water; G dissolved in this water was analysed by the method of analysis of individual inclusions. Results are given in the Figs. 1 and 2.

Conclusions:

1. CO_2 content increases from 30% (by vol., of total G, A.K.) at the depth 1000 m to 84% at 9000 m.

2. N_2/O_2 ratio for oceanic water is higher than for air (3.76), being equal 4.1 at 1400 m, since N_2 concentration decreases slower than O_2.

3. Concentration of CO_2 in G composition of oceanic water is more than one thousand times higher than in air. VG/V inclusion, i.e., VG/V water ratio exceeds one hundred.

4. High solubility of G in oceanic water reveals relation not with partial P in atmosphere, but with P general in oceanic water.

5. Henry's law is not applicable for evaluation of G concentration in oceanic water deeper than 500-700 m. Many oceanic waters in the areas of activity of submarine volcanoes may contain high amounts of dissolved G. For abyssal zone (2-7 thousand m) concentration of dissolved CO_2 may reach 5 and more wt. %, and at 10 thousand m - 10-12 wt. %.

6. Three zones of oceanic water may be distinguished: I-zone of gaseous CO_2, down to depth 500-700 m. CO_2 falls into oceanic water as G, saturates it and next separates as G bubbles, floating up to the surface. II - zone of light liquid CO_2, from 500-700 to 2500 m. CO_2 from submarine volcanoes emanates as liquid with density lower than density of oceanic water. First portions saturate water and following ones as droplets go up and in the zone of G CO_2 change into G CO_2 bubbles. III - zone of heavy liquid CO_2. Emanations of submarine volcanoes at depth > 2500 m appear as flows of L CO_2 with density of oceanic water. L CO_2 partly dissolves in water and the remainder with small amount of dissolved water occupies the neighboring depressions of oceanic bottom. (Authors' text shortened and translated by A.K.)

Figure 1. Content of CO_2 dissolved in the deep bottom waters of ocean.

Figure 2. N_2/O_2 ratio of gases dissolved in the oceanic waters.

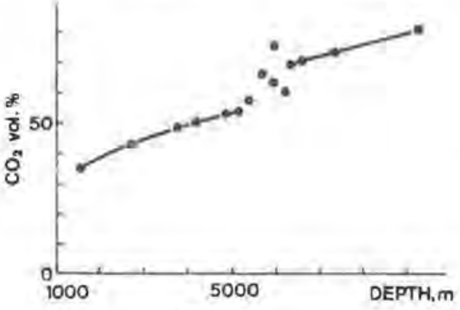


Fig.1

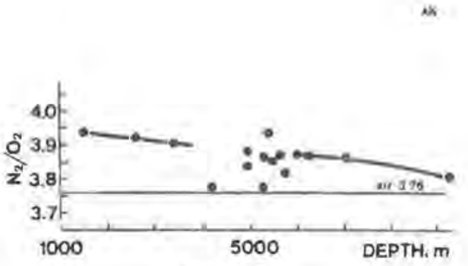


Fig.2

SHUGUROVA, N.A. and DOLGOV, Yu. A., 1976b, Inclusions in minerals of rocks of oceanic crust, in Genetic studies in mineralogy, Yu. A. Dolgov et al., eds.: Novosibirsk, Inst. Geol. and Geophy. Sib. Branch Acad. Sci. USSR, p. 29-31 (in Russian).

Several samples collected from the oceanic bottom were investigated for fluid inclusions: high quartz from Pacific; pyroxenes from Atlantic; plagioclases from basalts, Atlantic (sample received from USA); and plagioclase from the active volcano at Curtis Island near Kermadec deep, Pacific. Results are given in table 9.

Table 9. Results of quantitative analysis of composition of G phase of individual inclusions from minerals of oceanic crust

					Concentration, vol. %	
No.	Sample	T_H, °C	Dia. of bubble after crushing, mm	$\frac{V_G}{V_{incl.}}$	H_2S, SO_2 HCl, HF, NH_3	CO_2
1	High quartz from effusives, Pacific Ocean		0.016		37.4	33.1
2			0.013		88	12.0
			0.020		81	16.4
3			0.023	1	100	
4			0.010		22	78
1	Augite from picritic lava, Atlantic Ocean		0.0044		65.2	34.8
2			0.0034		66.8	33.2
3			0.004		67.0	33.0
4			0.0035		66.5	33.5
1	Plagioclase from oceanic basalt, Atlantic Ocean	1250	0.0038	11.3	68.0	32.0
2		1267	0.0087	12.8	72.4	27.6
3		1260	0.0093	21.43	48.0	52.0
4		1258	0.0013	2.7	73.0	27.0
5		1260	0.0082	25.11	62.3	37.7
1	Plagioclase from active volcano Curtis, Kermadec deep, Pacific	950	0.008	7.4	32.2	67.8
2		920	0.016	7.06	45.2	54.8
3		950	0.015	20.8	42.0	58.0

Notes: Analysis 1 has 20.8 % CO, and 8.7% H_2; all other analyses have neither. No hydrocarbons, O_2, or (N_2 + rare gases) reported from any sample.

Preliminary conclusions:

Submarine volcanoes yield to oceanic water various G mixtures, mostly dissolving in the water. G are most probably sulfur-bearing ones (H_2S, SO_2) since NH_3, HCl and HF are less probable. CO_2 is also important component. (Authors' text shortened and translated by A.K.)

SHUGUROVA, N.A., DOLGOV, Yu.A. and IVANOVA, G.M., 1976, Composition of gaseous inclusions in silicate spherules of various origin, in Genetic studies in mineralogy, Yu.A. Dolgov et al., eds.: Novosibirsk, Inst. Geol. and Geophy. Sib. Branch Acad. Sci. USSR, p. 3-8 (in Russian; see translations).

SHUGUROVA, N.A., DOLGOV, Yu.A., MADANYAN, O.P., and IGUMNOV, V.A., 1976, Ore-forming hydrotherms of the Kadzharan Cu-Mo deposit (abst.), Abstracts

of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 193-194 (in Russian; translation by A. Kozlowski).

1. Triple water leachates from quartz of molybdenite, chalcopyrite and pyrite low- and moderate-T (250-450°C) stages revealed that the ore-forming hydrotherms had total salinites up to 850 g/l, and may be divided into two groups:

a) M_{553}* ($HCO_3$74$SO_4$23Mg80Ca15);
b) M_{458} ($HCO_3$54Cl38Na45Mg39Ca10);
M_{855} ($HCO_3$66Cl21Na33Mg33Ca29);
M_{437} ($Cl_{52}HCO_3$42Ca41Na29Mg24).

(Presumably in percent of
anions and of cations
respectively (E.R.))

These brines differ from the recent mineral waters of the Kadzharan ore field and surrounding granitoid intrusions in relatively higher content of K and Mg, different K/Na ratio, and general chemical composition, and they seem to be close to modern hydrothermal ore solutions. (Cheleken, Salton Sea, etc.) where the role of juvenile waters is slight.

2. By analysis of G in individual inclusions the hydrotherms were divided into groups: CO_2+HCl+HF, with up to 4 vol. % each of H_2+CO; N_2+CO_2+HCl+HF, with up to 60 vol. % N_2+noble gases, and probably with He present. G composition is close to acid gases from crater lakes of the areas of recent volcanic activity. (Authors' abst.)

* Probably total salts in g/l; A.K.

SHUGUROVA, N.A., SHOKHONOVA, L.A, and GRISHINA, S.N., 1976, Further data on method of analysis of gases in individual inclusions (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 170 (in Russian; translation by A. Kozlowski).

The method of analysis of several G components in inclusions down to 5-1 µm was improved.

1. Specific reagents for H_2S, SO_2, HF, SO_3, COS, S_2O_3, HCl and distinguishing them from CO_2 were worked out. HF forms complex salt with iron rhodanide, NH_3 with the Nessler reagent, HCl with silver nitrate, H_2S with molybdenum reagent, SO_2, SO_3, COS, S_2O_3 - forming of the Turnbull blue.

2. Inert liquids as media for carrying of the G bubble were looked for, like as PMS-4000, PMS-1000, PFGOS-4, NPS-D-1, distilled glycerol, concentrated H_2O_4 (sic), MS-20, VM-2, clock oil "INRENOL", vegetable oils.

3. Practical separation of G mixture was studied.

4. Experiments were carried with quantitative separation of CO_2 and H_2S in G phase by use of solutions of diethanoammine. (Authors abst).

SHVADUS, M.I., 1975, Microinclusions of melt in the quartz of the ore-bearing granitoids of Central Buryatia and the first results of their study: Geologiya i Geofizika, v. 16, no. 12, p. 97-101, (in Russian; translated in Soviet Geol. & Geophysics, v. 16, no. 2, p. 79-82).

A preliminary report on the melting of daughter crystals and T_H of microscopic inclusions of magmatic melts in the quartz from the ore-bearing granitoids of Central Buryatia. The central part of the granitoid plutons crystallized at ∿780°C, the marginal parts at ∿890°C (ER).

SHVADUS, M.I., 1976a Composition of crystallized inclusions and conditions of crystallization of granite melt, (abst.), Abstracts of Fifth

All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 109-110 (in Russian; translation by A. Kozlowski).

In quartz from ore-bearing (F-rare metal) granitoids of W. Transbaikalia three types of inclusions were found:

1. Filled with quartz and feldspars, T_H 855-865°C, P total 0.5-0.7 kb, H_2O content <1 wt.%.
2. Filled with quartz, feldspars and muscovite.
3. Filled with quartz and muscovite, T_H 910°C, H_2O content ∿3 wt.%, $P_{H_2O} < P_{total} > 3.2$ kb. (From the authors' abst.)

SHVADUS, M.I., 1976, Inclusions in fluorite from granitoids of Transbaikalia (abst.), Abstracts of Fifth All-Union Conference on Thermobargeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 153-154 (in Russian; translation by A. Kozlowski).

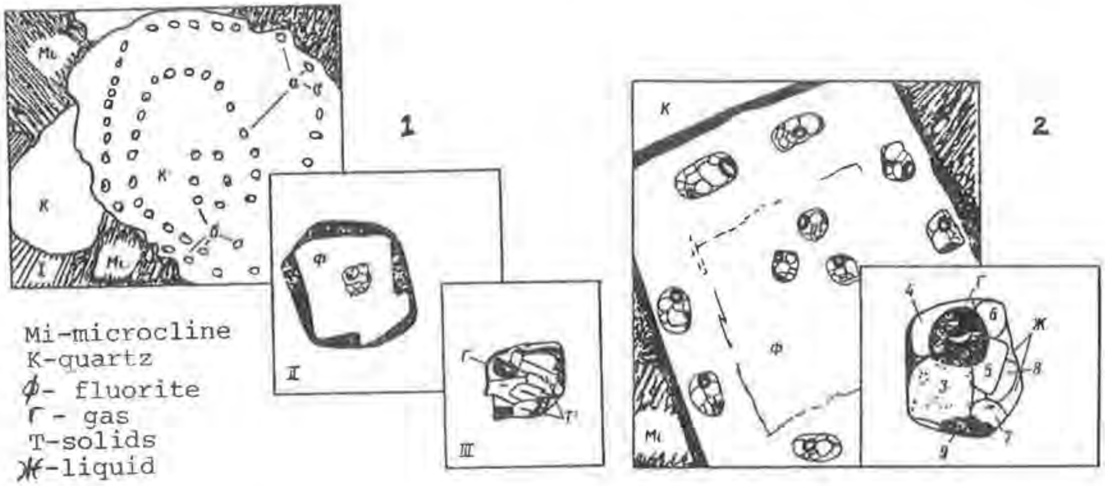
(See next abstract - ER)

SHVADUS, M.I., 1977, Inclusions in fluorites from granites from Transbaikali: Akad. Nauk. SSSR Doklady, v. 237 no. 3, p. 706-708 (in Russian). Author at Geol. Inst. of Buryatian Division of Siberian Branch Acad. Sci. USSR, Ulan-Ude.

Granites, granosyenites and quartz-syenites etc. bear F-rare metal mineralization. Quartz contains droplet-shape crystal inclusions of fluorite 5-50 μm in size, sometimes occurring, together with P silicate melt inclusions, in zones of growth (Fig. 1). Solid fluorite inclusions bear melt inclusions of oval shape, 5-8 μm long, consisting of 3-5 anisotropic inclusions + G phase, phase ratios (85-90)/(15-10), respectively. At 640°C after 1 hour, inclusions in fluorite begin to melt, 2 hours later, at 720°C, solid phases in inclusions melt, ratio melt/G=90/10. Following increase of T causes slight melting of walls of host mineral and T_H is 840-855°C; heterogenization of inclusions appears at 800°C after 0.5-hour run at this T. Following cooling causes quenching of melt to form glass. Interstitial fluorite from these granites (up to 3%) bears azonally distributed crystal-liquid inclusions (Fig. 2) 5-12 μm long, filled with (G (15-25), L (10-15) and dms (75-60, all vol.%). Dms consist of 6-7 minerals: four are isotropic and transparent (by optical properties two are close to Na and K chlorides, occupying 60 vol.%, 3 and 4 in Fig. 2, and two other-to fluorite, 5 and 6 in Fig. 2), two are anisotropic (7 and 8 in Fig. 2), and highly birefringent, and an opaque ore mineral. At 105-110°C dm 7 dissolves, at 190-210°C-KCl does, and on further heating, all dms except the ore mineral dissolve in visible degree. At 290°C G phase homogenizes, at 300-315°C-dm 5, at 350-360°C-dm 6, at 450°C-dm 8, and at 490-510°C-NaCl. Complete homogenization appears at 680-720°C after dissolution of the ore mineral, which crystallizes on cooling to 640-680°C. Time necessary for homogenization is 3-4 hours. Veinlets of late fluorite bearing inclusions filled with G+L+dm have T_H 350-490°C. Hence, three varieties of fluorite occur in those granitoids: magmatic, late magmatic and hydrothermal.

Fig. 1 I-Zonal distribution of inclusions in quartz: (a-melt, b-solid inclusions of fluorite); II-detail of I, enlarged 20x, inclusion of fluorite-bearing melt inclusion; III-melt inclusion in fluorite from quartz grain, enlarged 30x.

Fig. 2 Crystal-liquid inclusions in interstitial fluorite, other explanation in the abstract. (Abst. by A.K.)



SHVEDENKOV, G. Iu., SHVEDENKOVA, S.V., and KALININ, D.V., 1977, Influence of water and carbon dioxide on fusing temperature in the system albite-potash feldspar-quartz: Akad. Nauk SSSR, Doklady, v. 237, p. 1157-1190 (in Russian).

SIDOROV, A.A. and GONCHAROV, V.I., 1977, Volcanogenic paleohydrotherms and ore formation (exemplified by the Okhotsk-Chukotka volcanogenic belt) (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Sib. Branch, v. II, p. 137-138 (in Russian; translation by A. Kozlowski). First author at the North-East Complex Sci.-Research Inst. of Far-East Sci. Center of Acad. Sci. USSR.

Relatively deep-seated deposits of volcanogenic character formed from chloride-rich (up to 40-50%) brines at T 200-500°C and P up to 1000 atm and more. Deposits of Cu-Mo, Sn-Ag and Au may be included. The second group of deposits, connected with hydrotherms diluted with vadose waters (total salts up to 15%), formed at T up to 300°C and $P \leq 200$ atm (Pb-Zn, certain Au-Ag, Sb-Hg and Sb deposits). The third group is connected with abrupt decreases of P and T; P usually <300 atm, T 80-400°C, total salts 8-12%. Late mineral associations of those deposits often are of higher temperature regime than early ones. (From the authors' abst.)

SIDOROV, A.A., GONCHAROV, V.I., NAYBORODIN, V.I., YEREMIN, R.A., and SAVVA, N.Ye., 1976, Ore-formation in volcanogenic deposits (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 181 (in Russian; translation by A. Kozlowski).

Deposits are divided into two groups: I. with decreasing T during formation and II. with increasing T of formation. In the final stages of type II deposits P also increases, up to 250-300 atm.

Hydrotherms of Au-Ag deposits of type II in the early stages are characterized by high concentrations of Cl, K and Na, whereas in the late

ones - of HCO_3, Ca and Mg; concentration of SO_4 is high during all stages of formation of the Ag deposits. Alkali contents and total salt concentrations are higher than for type I, as well as concentrations of H_2S, SO_2, HF and, in late stages, CO_2. (Authors' abst.)

Type of deposits	T of mineral formation, °C		
	pre-commercial	commercial	post-commercial
Gold-pyrite	420-135	205-135	405-160
Gold-sulfoantimonite	170-120	240-90	290-130
Gold-argentite	400-335	340-300	410-220
Essentially silver	350-240	395-260	410-200

SIGURDSON, D.R., and LAWRENCE, E.F., 1975, Paragenesis and fluid inclusion thermometry of a ferberite-bearing contact metastomatic deposit: Tungsten Jim Mine, Custer County, Idaho (abstr.): Geol. Soc. Am. Abstr. Programs, v. 7, no. 3, p. 374-375, 1975.

See Fluid Inclusion Research -- Proceedings of COFFI, v. 8, p. 169-170. (ER)

SILICHEV, M.K., 1977, Thermobarometric conditions of formation of certain beryl-wolframite and antimonite deposits of Yakutia (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. I, p. 134-135 (in Russian; translation by A. Kozlowski). Author at Allakh-Yun'skaya Geol.-Prosp. Expedition of the Yakutian Territorial Geol. Bureau, Khandyga, Yakutian Automomic SSR.

Beryl-wolframite ore occurs in quartz-vein-greisen formation in connection with antimonite low-gold ores. Temperatures are as in the table:

Associations and minerals	T_H, °C	T_D, °C	
		thermoacoustic	vacuum
	Beryl-wolframite stockwork		
Rare-metal association			
Quartz	410-225 (8)*	500-250 (6)	658-250 (14)
Beryl	310-195 (1)	530-330 (1)	523-484 (1)
Wolframite	-	-	573-559 and 464-218 (14)
Scheelite	-	-	373-323 (1)
Polysulfide association			
Arsenopyrite	-	-	464-144 (5)
Pyrrhotite	-	-	318-150 (5)
Quartz-carbonate association			
Quartz	190-142 (1)	-	-
Calcite	125- 60 (1)	-	-
	Antimonite deposit		
Quartz	170- 50 (1)	-	-
Antimonite	-	-	210-140 (1)

*in parentheses number of samples.

P during formation of the rare metal association was 840 atm, by the Naumov-Malinin method. (From the author's abst.)

SILLITOE, R.H. and KHAN, S.N., 1977, Geology of Saindak porphyry copper deposit, Pakistan: Inst. Mining and Metal., Trans.., Sect. B, v. 86, p. B27-B42. First author at Dept. Mining Geol., Royal School of Mines, London.

Coexisting high-salinity and gas-rich fluids (indicative of boiling conditions), typical of those assumed to be largely magmatic in origin from potassium silicate alteration in porphyry copper deposits, were observed in fluid inclusions in quartz from potassic alteration at Saindak. (ER)

SIMKIV, Zh.A. and DOROSHENKO, Yu.P., 1976, Chemical composition of the mineral-forming solutions of rare-metal molybdenum-tungsten deposits of Kazakhstan (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 193 (in Russian; translation by A. Kozlowski).

Complex deposits of the quartz-vein-greisen type (E. and N. Kounrad, Akchatau, Karaoba etc.) are characterized by a similar sequence of mineral associations (...). Ores formed at T 440-245°C and P 1200-600 atm. Triple water leachates from quartz of the molybdenite-quartz stage yielded a Cl-Na solution, with K>Ca>Li, HCO_3>F; the complex rare-metal and wolframite-quartz stage yielded F-Na with K>Li, HCO_3>Cl; sulfide-quartz stage yielded a high content of CO_2 and HCO_3, HCO_3-K-Na type plus Ca>Li and Cl>F. (Authors' abst.)

SIMKIV, Zh.A., and MYAZ', N.I., 1976, Chemical methods in analysis of water leachates (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept. 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 179-180 (in Russian; translation by A. Kozlowski).

Water leachates may be divided into the following groups: a) silica type (Si > Na,K,Ca,Mg etc.); b) calcium type (Ca > Na,K,Mg,Si etc.); c) sulfide type (S $\gtrsim$ Si $\gtrsim$ Na $\gtrsim$ Ca etc.); d) sulfate type (S* > Si,Na,K,Ca etc.); e) others. Each group should have a specific scheme of analysis. (...) (Authors' abst.) * as SO_4? (A.K.)

SINKEVICH, T.P., VIKULOVA, L.P. and NOVIKOVA, A.N., 1977, Contribution to the problem of formation of various generations of quartz at one of gold ore deposits of East Siberia (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Sib. Branch, v. II, p. 50-52 (in Russian: translation by A. Kozlowski). Authors at East-Siberian Sci.-Research Inst. of Geol. Geophys. and Mineral Raw Materials of Ministry of Geology.

Veinlet and dispersed quartz-sulfide mineralization bears four varieties of quartz: I) heterogranoblastic quartz forming rounded aggregates, II) heterogranoblastic mosaic quartz in veinlets or lenticular bodies, III) heterogranoblastic quartz of gold-sulfide veinlets, IV) fibrous or prismatic quartz. Quartz I, II and III bear G+L H_2O and G+L H_2O+L CO_2 inclusions. Most inclusions homogenize in L at 340-390°C (several inclusions at 400-410°C), those with L CO_2- 210-330°C, and only 3% of inclusions homogenize in G at 310-395°C (quartz I and II). In quartz III inclusions with L CO_2 have T_H 230-275°C, and without L CO_2 - 188-200°C. Up to 20% of inclusions bear only L H_2O phase. Quartz IV bears rare G/L inclusions with T_H 100-150°C and mostly one-phase L H_2O inclusions. (Abst. by A.K.)

SINYAKOV, V.I., 1977a, On temperature of formation of magnetite ores of the skarn deposits in the Kuznetsk-Sayan province (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. I, p. 105 (in Russian; translation by A. Kozlowski). Author at Inst. Geol. Geophys. of Siberian Branch Acad. Sci. USSR, Novosibirsk.

T_D of main mass of magnetite ores was 400-560 (±20)°C. Some deposits yielded lower T_D: Lespronkhoznoe in Mg-skarns-500-560°C; Teyskoe in similar rocks-460-560°C; Irbin-400-540°C and Kazskoe-400-520°C, both in Ca-skarns; Abakan in hydrous silicates-440-540°C. Correction to T_D that should be subtracted (negative value), obtained by comparison with T_H of inclusions in gangue minerals, equals -100 ± 20°C. (Abst. by A.K.)

SINYAKOV, V.I., 1977b, Temperature zoning of ore system during formation of the magnetite ores of one of the structural-morphological types of the magnesia-skarn deposits (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. I, p. 106-107 (in Russian; translation by A. Kozlowski). Author at Inst. Geol. Geophys. of Siberian Branch Acad. Sci. USSR, Novosibirsk.

Magnetite from the central part of the Teyskoe deposit (Kuznetskiy Alatau) has high T_D (660-700°C); marginal associations magnetite-serpentine and magnetite carbonate yielded lower T_D (560-600 and 520-540°C, respectively). (A.K.)

SIVORONOV, A.A., ROSIKHINA, A.I. and ZHIKHAREV, A.P., 1976, On fluid regime of metamorphism of granulite facies, on the basis of data of mineral thermobarogeochemical studies (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 119 (in Russian; translation by A. Kozlowski).

Archean metamorphism was in the range of the granulite facies, where $P\ H_2O < P\ CO_2$. During studies of fluid inclusions in garnet, hypersthene, diopside and quartz from Archean supracrustal rocks, a special group of syngenetic crystal-fluid inclusions was found, consisting of inclusions: a) one-phase, b) two-phase crystal (10-60 vol. %) + fluid, c) polyphase (G + solids + one or more liquids; G + solids + L CO_2), d) one- or e) two-phases of CO_2. During heating of inclusions up to T_H (1200-800°C) and P 2.5 kb, primary fluid of granulite metamorphism is a highly concentrated CO_2-salt system (solution-melt with low concentration of water); it bears carbonates or silicates of alkalies and alkaline earths, confirming the important role of CO_2 in processes of Archean metamorphism. (Authors' abst.)

SKRYABIN, V.B., 1976, Melt inclusions in granites of the Voronezh massif (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 110-111 (in Russian; translation by A. Kozlowski).

Muscovite-bearing melt inclusions in quartz from the Liskino granite are usually alone, only rarely to they form groups or lines.

In addition to muscovite they bear very tiny nondistinguishable dms; G volume equals muscovite volume. At 590°C at the boundary of inclusion a rim of melt from melting vacuole walls appears. After homogenization of G phase at 825°C, volume of melt and dimensions of inclusion increase due to melting of walls; during further heating muscovite melts at 1025°C (T_H) after 6-11 hours run. Quartz (that should form dm, A.K.) is visible on the walls of vacuole, hence true muscovite-bearing inclusion may be observed only after its complete homogenization. In the studied inclusions volumes (%): muscovite 61-69, quartz 29-37, G 2-2.5, are typical. Muscovite carries $\sim$5 wt.% H_2O, thus trapped melt should bear 3.2-3.6 wt.% H_2O, i.e., at 1025°C P_{H_2O} $\sim$500b. From trapping to appearance of G phase P_{H_2O} decreases to 250b to muscovite crystallization and melt enriches in SiO_2; subsequent crystallization of the main mass of quartz on the walls of vacuole causes decrease of P_{total} in inclusion, and, presumably, $P_{fluid} > P_{total}$, causing retrograde boiling of melt and appearance of G phase. (Author's abst.)

SLACK, J.F., 1977, Multistage vein ores of Lake City caldera, Western San Juan Mountains, Colorado (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 1179. Author at U.S. Geol. Survey, Reston, VA.

Polymetallic (Ag,Pb,Zn,Au,Cu) fissure veins occur in an arcuate belt around the N, NE, and E margins of the 22.5 m.y. Lake City caldera in the western San Juan Mountains, Colo. Production since 1875 totals $12 million. Veins are open-space fillings of steeply dipping fractures and minor fault zones typically 0.5 to 1.5 m wide and up to 2000 m long within intermediate to silicic volcanic rocks. Concentric mineral zones about the caldera comprise an inner qtz-chalcopyrite zone, an intermediate hybrid zone, and an outer rhodochrosite-tetrahedrite zone. Stages of mineralization identified include (from oldest to youngest): (I) preore qtz-pyrite, (II) banded qtz-sulfide ores, (III) massive rhodochrosite, (IV) postore qtz-carbonate-fluorite, (V) barite-sulfosalt ores, (VI) Au-Ag telluride ores, and (VII) postore barite-chalcedony. All seven stages are related to the caldera cycle.

Fluid inclusion and geochemical studies at the Ute-Ulay mine indicate that Stages II-IV there formed with T=265-190°C, salinity=4 to 0 equiv. wt.% NaCl, log $f_{O_2}=10^{-38}$ to 10^{-36}, log $f_{S_2}=10^{-10}$ to 10^{-9}, and pH= 5 to 6. Stage V fluids underwent local boiling (T$\sim$250°C; sal.=1 to 12 wt.% NaCl) and throttling, with accompanying time-space increases in both pH and f_{O_2}. Complex lateral and vertical variations in ore and gangue mineralogy result from a combination of simple zoning along one stratigraphic interval and juxtaposition of younger upon older stages at sites of repeated vein opening and brecciation. The younger base + previous-metal assemblages (Stages V-VII) appear to be genetically unrelated to the older base-metal assemblages (Stages I-IV), and formed from a hydrothermal solution having a separate source, probably ring fracture volcanism following resurgent doming and caldera collapse. (Author's abstract)

SMIRNOV, V.I., ed., 1977, Ore deposits of the USSR, vols. 1-3: London, Pitman Pub. Ltd.

This is a translation by D.A. Brown from the Russian original published by Nedra Press, Moscow, in 1974. It is an excellent source for descriptions and literature on Soviet ore deposits, and includes, in the front of each volume, the latitudes and longitudes of each of of the deposits described. (ER)

SMIRNOV, V.I., and others, eds., 1976, The metallogeny of mercury: Moscow, Nedra Press, 256 pp. (in Russian; translated by Canadian Secty. of State Multilingual Services Division, 480 pp., 1976).

Consists of a series of articles by various authors containing many references to published literature dealing with fluid inclusion studies on mercury deposits. No new data recognized. (ER)

SMITH, C.B., McCALLUM, M.E., COOPERSMITH, H.G., and EGGLER, D.H., 1977, Petrography, petrology and chemistry of kimberlite from the Colorado-Wyoming state line and Iron Mountain, Wyoming districts, in Second International Kimberlite Conference 1977, Extended Abstracts (unpaginated).

Petrographic and field evidence in the Colorado-Wyoming districts indicates that kimberlite magma containing immiscible silicate and carbonate fluid phases in various degrees of segregation was emplaced into hyabyssal dike systems. Diatreme formation by fluidization and explosive boring, and attendant carbonatization, apparently was initiated in portions of the dike systems where the carbonate-rich fluid phase was most concentrated, and where fluid pressures exceeded load pressures. (From the authors' abstract)

SMITH, S.P., 1977, Noble gases in igneous rocks and minerals (abst.): Amer. Geophys. Union, Trans., EOS, v. 58, no. 6, p. 536.

Ne, Ar, Kr, and Xe measurements are reported for gabbro, peridotite, carbonatite, kimberlite, MOR basalt glass, MOR rhyolite glass, biotite, beryl, olivine and pyroxene. Sources of noble gases in terrestrial samples include: (1) primordial gas from undegassed parts of the earth, (2) undegassed radiogenic ^{129}Xe and $^{131-136}$Xe from extinct ^{129}I and ^{244}Pu, (3) radiogenic gases from continuing decay of U, Th, and K, (4) products of nuclear reactions such as (n,α) or (α,n) and (5) gases from the present or past atmosphere or hydrosphere. Important questions are whether noble gases are present in magmas at emplacement, at what stage in magmatic evolution are gases introduced and from what sources. Direct evidence of magmatic noble gases may be obtained from igneous glasses representing quenched melts, e.g. MOR basalt glass containing excess radiogenic Ar. Gas with ^{20}Ne/^{22}Ne 2.5% higher than the atmospheric ratio 9.8 and with ^{20}Ne/^{36}Ar = 500 is found in a MOR rhyolite glass. This gas may represent a primordial magmatic component, but the ^{20}Ne/^{36}Ar ratio is at least 10 times any known primordial ratio, suggesting that the gas may instead be fractionated atmospheric gas. Non-radiogenic and excess radiogenic gases in crystalline rocks may represent magmatic gases from melted source rocks. The nature of magmatic gases should vary depending on the source rock, whether sedimentary rock with absorbed atmospheric gas, ancient undegassed mantle, etc. Gases may also be carried into magma by deep hydrothermal circulation of meteoric water. Alternatively, gases may have been introduced during metamorphism at elevated temperature and gas pressure. Beryls studied contain ^{21,22}Ne from (α,n) reactions as well as radiogenic ^{40}Ar and ^{238}U spontaneous-fission Xe. Skaergaard gabbros contain atmospheric Xe and elementally-fractionated gases similar to gases in sedimentary rocks. Correlation of gases with original igneous or metamorphic features may be used to distinguish among alternative sources. (Author's abstract)

SOKOLOV, S.V., 1976, Temperatures of formation of ultramafic rocks (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 101-102 (in Russian; translation by A. Kozlowski).

T of formation were evaluated for meymechites, peridotites, and pyroxenites, forming massifs of the Maymecha-Kotuy province (Guli) and Karelo-Kola region (Afrikanda, Kovdor). The methods used were homogenization of inclusions, melting of rocks and distribution of Fe and Ni between coexisting olivine and clinopyroxene.

Olivine crystallizes from meymechite melt at T 1480-1350°C, changing composition from Fo 96-94 to Fo 91-87. Main mass of meymechite crystallized at lower T, typical for peridotite magma.

Good coincidence of T values was obtained by application of various methods to peridotites of the Guli complex (1250-1150°C), and by Fe content in olivines and pyroxenes for all massifs: 1225-1170°C (Guli), 1230-1180°C (Afrikanda), 1220°C (Kovdor).

Decreased Ts were obtained by Ni geothermometer, in comparison with T_H. Pyroxenites and peridotites yielded the same T_{Ni}. In the Kovdor intrusion T_{Ni} of pyroxenites decreases from normal to alkaline varieties, and increases the amount of aegirine minal in clinopyroxenes. Zones of fracturing are marked by G inclusions in plagioclase. (Author's abst.)

SOKOLOV, S.V. and ROMANCHEV, B.P., 1976, Thermometry of the ultrabasic-alkaline complexes (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 106-107 (in Russian; translation by A. Kozlowski).

1. T_H of melt inclusions in minerals from Kovdor massif were estimated.

2. T_H decrease from early to late rocks: olivinite → pyroxenite → melitic and nepheline-pyroxene rocks → carbonatite; simultaneously composition of clinopyroxene changes from augite-diopside (pyroxenite) to aegirine-diopside (carbonatite).

3. Melt inclusions in forsterite from olivinites (T_H 1280-1200°C) and augite-diopside from pyroxenite (T_H 1210-1100) bear silicate phases, ore mineral and rarely G. In melilitic rocks melt inclusions are either silicate (T_H 1080-950°C) or carbonate, as well as of transitional type. The first ones homogenize in silicate melt, the second ones-in salt melt, the third ones gave immiscible phases of silicate and salt melts. (sic.) Inclusions with carbonate phases are less characteristic for nepheline-pyroxene rocks, and have T_H 1090-950°C in dark glass (after quenching? A.K.). In wollastonite and forsterite from carbonatites, crystalline-fluid inclusions were found with T_H 780-750 in highly-concentrated solution-melt, saturated with volatiles.

4. All mineral associations of silicate rocks and possible crystallization paths of the primitive melt are characterized by systems: diopside-acmite-nepheline, akermanite-diopside-nepheline, akermanite-melilite. Compositions of melilites on the plot: akermanite-gehlenite-Na-melilite are high-temperature magmatic.

5. Liquation of filling of melt inclusions confirms liquation as the method of separation of carbonatite during crystallization differentiation of the ultrabasic-alkaline melt. (Authors' abst.)

SOKOLOV, Ya.N., 1976, Temperatures of formation of hydrothermal quartz veins used for evaluation of rock-crystal-bearing regions (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 144 (in Russian; translation by A. Kozlowski).

1) Early veins occurring in accordance with lamination of wall rock, consisting of metamorphosed, grainy, rock-crystal-free quartz have T_H and T_D of G/L inclusions in ranges 570-100°C. 2) Later cross cutting veins of coarse- and very coarse-crystalline quartz (T_H and T_D 440-190°C) contain cavities bearing rock crystal of low quality (T_H and T_D 340-80°C). 3) Late veins of drusy and parallel-growth quartz (T_H and T_D 500-100°C) bear most of the high-quality rock crystal (T_H and T_D 420-65°C). Vertical extent of rock-crystal-bearing zone is 400-600 m, formed over 2000 m below the former Earth's surface. If this zone coincides with the level of development of albite-sericite-quartz metasomatites, commercial veins are more frequent and suitable; T_H and T_D of these veins equal 300-130°C. (From the author's abst.)

SOKONBAEV, K.Dzh., GROSHEV, A.K., and ABAKIROV, Sh. A., 1976, On the time and temperature conditions of formation of quartz and accessory topaz from granites of the Sukhodol'skiy massif (SE Kirgiziya): Kirgiz Otdel. Vses. Mineralog. Obshch., Zapiski, v. 9, p. 91-95 (in Russian).

In rocks of the Sukhodol'skiy massif there were found these stages of metasomatosis: 1) perthitization and sericitization, 2) albitization and formation of Li micas (protolithiomite & zinnwaldite) from biotite, 3) greisenization (formation of greisen quartz, gilbertite, muscovite, fluorite, etc.), and accessory minerals: topaz, cassiterite, Ta-Nb minerals, tourmaline . T_H of G/L inclusions in L were 276-310°C, and of those bearing LCO_2 - 285-290°C; this topaz formed before greisenization. Greisen topaz contains G/L inclusions with T_H 240-270°C, and paragenetic greisen quartz - 240-265°C, all inclusions homogenizing in L. In greisen topaz LCO_2 was not found. (Abst. by A.K.)

SOMMER, M.A., 1977, Volatiles H_2O, CO_2, and CO in silicate melt inclusions in quartz phenocrysts from the rhyolitic Bandelier air-fall and ash-flow tuff, New Mexico: Jour. Geol., v. 85, p. 423-432. Author at Dept. Geol. Sic., Brown Univ., Providence, RI 02912.

Silicate melt inclusions in quartz phenocrysts from air-fall and ash-flow tuff were studied from a section of Bandelier Tuff in Sandia Canyon, Jemez Mountains, New Mexico. My aim was to estimate the concentration of some major volatile species (H_2O, CO_2, and CO) in the magma before explosive eruption. On a microscope heating stage, I determined the melting points of the inclusions and, with an electron microprobe, determined the bulk chemical composition. I estimated total H_2O, CO_2, and CO by difference on the basis of the microprobe analyses and measured H_2O, CO_2, and CO separately by quantitative mass spectrometry. I found several textural varieties of modified inclusions that correlate with field occurrence and cooling rate: devitrification, zoning, and resorption of the host mineral are evidence of slow cooling. The modified inclusions are unsuitable for chemical analysis using the microprobe. Unmodified inclusions in the quartz phenocrysts from air-fall pumice are clear and glassy, and presumably contain the intratelluric assemblage of volatiles. Bulk chemical analysis of these clear glassy inclusions by electron microprobe revealed a rhyolitic composition of the glass consistent with petrography. Electron microprobe analysis by difference techniques were used to determine volatile contents in the glass. Oxide totals range from 2.4 to 7.0 ± 2.5% weight percent volatiles (average 5.4 wt.%). Using the melting point determinations of the inclusions (average 935°C ± 10°C), quantitative monitoring mass spectrometry revealed an average volatile content of the inclusions to be 3.6 ± 0.9 wt.%. The principal volatile species were found to be H_2O 91.9%, CO_2 2.7%, and CO 4.8% (in percent of total volatiles). Utilizing the temperature-compositional data, I used the melt inclusions as geobarometers, which revealed a depth to chamber of about 5 km that is consistent with geologic estimates. (Author's abstract)

SONDERGELD, C.H., and TURCOTTE, D.L., 1977, An experimental study of mineral deposition in a boiling fluid environment (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 1187-1185.

An attempt to model porphyry copper mineralization using boiling of a copper sulfate solution in a porous medium (ER).

SOPKO, P.F., 1977, Contribution to the problem of physico-chemical conditions of formation of the pyrite deposits of the Southern Urals (abst.), in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Sib. Branch, v. II, p. 99-100 (in Russian; translation by A. Kozlowski). Author at Geol. Inst. of Bashkir Division of Acad. Sci. U.S.S.R., Ufa.

Sulfides precipitated in all deposits at T from 430-400 to 80-70°C, but associations bearing minerals of Cu and Zn formed at 300-150°C (T_H). P was evaluated to be some hundreds of atm. (From the author's abst.)

SOTNIKOV, V.I., BERZINA, A.P., SHUGUROVA, N.A., and MOTORINA, I.V., 1977, Physico-chemical prarmeters of processes of formation of copper-molybdenum ore deposits (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. I, p. 167-168 (in Russian; translation by A. Kozlowski). Authors at Inst. Geol. Geophys., Siberian Branch Acad. Sci. USSR, Novosibirsk.

Crystallization of subvolcanic intrusions developed at T 1110-800°C. Main components of G dissolved in silicate melt were "N_2 + rare gases", later CO_2 and subsequently halogens. Explosive breccias, formed at 700-600°C down to 300-250°C, were associated with intrusion, P were ∿2000 atm, solutions were mainly of G type, rich in HCl and later in CO_2. Early metasomatites formed at 800-600°C, main ores--at 450-200°C, P varied from 1500 to 100-80 atm. Both metasomatites and ores originated from G solutions rich in halogens (later in CO_2) and/or from highly concentrated L solutions. Boiling was noted at 400-500°C. Ore-forming process developed with a great role of chlorine. (Abst. by A.K.)

SPARKS, R.S.J., 1977, Bubble growth in magmas during explosive volcanic eruptions: numerical solutions (abst.): Amer. Geophys. Union, Trans., EOS, v. 58, no. 6, p. 526.

SPARKS, S.R.J. and SIGURDSSON, Haraldur, 1977, Magma mixing: a mechanism for triggering acid explosive eruptions: Nature, v. 267, p. 315-318.

SPOONER, E.T.C. and BRAY, C.J., 1977, Hydrothermal fluids of seawater salinity in ophiolitic sulphide ore deposits in Cyprus: Nature, v. 266, p. 808-812. Authors at Dept. Geol. and Min., Parks Road, Oxford, UK.

Freezing points of fluid inclusions in vein quartz intergrown with sulphides from ophiolitic cupriferous pyrite ore deposits in Cyprus indicate a hydrothermal fluid of seawater salinity, and confirm the hypothesis of metal transport in hot seawater. It is therefore suggested that the economic potential of oceanic crust layer 2 is probably negligible. (Authors' abstract)

Freezing of Ts of -1.6 to -2.4°C, and T_H of 301-351° were found. Some feathery dms similar in appearance to dawsonite were frequently present; their high birefringence suggested carbonate or sulfate (ER)

STAVROV, O.D. and ZOZULYA, T.A., 1975, The K/Rb ratio in quartz from tin deposits as an indicator of their magmatic source: Geokhimiya, no. 7, p. 1043-1048, 1975 (in Russian; translated in Geochem. Internat., v. 12, no. 5, 1975, p. 62-67).

Variation of K/Rb ratio in (fluid inclusions in, Ed.) quartz of silicate-quartz and silicate-sulfide groups of tin deposits has been investigated. In quartz from the silicate-quartz tin deposits the K/Rb ratio varies along the line representing differentiation of granitic magma, forming differentiated intrusive complexes, and in the silicate-sulfide tin deposits, along the line of differentiation of andesite-dacite magma. It is concluded that there are two magmatic sources of tin-bearing solutions. The data obtained may be used to determine the source of tin in a given deposit. (Authors' abstract)

STEEN-MCINTYRE, V.C., 1977, Approximate dating of Quaternary tephra deposits using tephra glass hydration and etching of heavy mineral phenocrysts (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 1190-1191.

Application of the method of Roedder and Smith (1964) using the liquid water in pumice vesicles, and other data, to date tephra (ER)

STEPANOV, G.N., 1977, Physico-chemical conditions of formation of the skarn-scheelite-sulfide deposits in the Far East of the USSR (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. I, p. 136-137 (in Russian; translation by A. Kozlowski). Author at the Far East Geol. Inst. of the Far East Sci. Center of Acad. Sci. USSR, Vladivostok.

T of ore formation decreased from 340 to 180°C, concentrations of ions and gases in inclusion fluids in quartz (mol per kg H_2O): Na 0.69, K 0.24, HCO_3 2.30, Cl 0.65, CO_2 3.60, CO 0.08, CH_4 0.47, H_2 0.04, N_2 1.27 (skarn-scheelite-gold-sulfide ores). For skarn-scheelite-cassiterite-polymetallic ores T were 400-320°C (magnetite-fluorite stage) and 310-210°C (polymetallic stage), fluid composition: Na 2.12, K 0.78, Cl 1.74, HCO_3 2.47, CO_2 1.12, CH_4 0.11, N_2 0.15 mol per kg H_2O. (Abst. by A.K.)

STEPANOV, G.N., LAVRIK, N.I., STEPANOVA, M.V., IVANOV, V.S., MALAKHOV, V.V., and ROMANENKO, I.M., 1976, Thermobarogeochemistry in the evaluation of ore deposits at Primor'ye (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 142-143 (in Russian; translation by A. Kozlowski).

In G/L inclusions in quartz from Sn, W, and Au deposits, by gas chromatography, H_2O, CO_2, CO, CH_4, H_2 and N_2 were determined. Probably C determines pH and Eh of hydrothermal solutions. CH_4 and H_2 in inclusions in quartz from cassiterite-sulfide and skarn-scheelite-sulfide deposits indicate reducing conditions of ore formation. Cassiterite-silicate and Au-quartz deposits formed under conditions of increased Eh (CO_2 prevails in inclusions). Intermediate conditions are typical for quartz-cassiterite and quartz-wolframite formations (presence of CO). Composition of gases is also applicable for evaluation of the depth of formation and degree of erosion of deposits. (From the authors' abst.)

STEPANOV, G.N., STEPANOVA, M.V., GVOZDEV, V.I., and KURYAKOVA, O.P., 1976, Evolution of hydrothermal solutions at skarn-scheelite-sulfide deposits of the (Soviet) Far East (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 77 (in Russian; translation by A. Kozlowski).

1. Formation of the deposits was connected with cooling of hydrotherms from 550-500°C to 70°C. In minerals of skarns and quartz-sericite metasomatites the inclusion filling is essentially gaseous. In inclusions in quartz-sericite metasomatites, quartz-scheelite and sulfide ores, concentrations of HCO_3 and Cl increase, likewise Na in quartz-scheelite ores (sic.). Concentrations of CO_2 and CH_4 in the quartz-scheelite stage are 7.37 and 0.77, respectively; in minerals of the sulfide stage - 2.41 and 0.94; in quartz-sericite metasomatites the CO_2 content - 1.65, H_2-0.40, CO-0.39 (all in gram-mol per kg).

2. Lermontovskoe deposit represents the deepest facies, Vostok 2 - shallower, and Agylki deposit, the shallow facies. From deep to shallow deposits the concentrations of K, Na, HCO_3, Cl, CO_2 and N_2 increase, whereas CH_4 concentration decreases. In individual ore bodies the concentrations of H_2 and CH_4 are higher in the deep levels and in the shallow levels, CO_2, N_2 and CO are higher. (Author's abst.)

STĘPISIEWICZ, Marek, 1977, Physico-chemical conditions of post-magmatic mineral formation in Strzelin granitoids: Archiwum Mineralogiczne, v. 33, p. 61-74 (in Polish with English abstract and summary). Author at Inst. Geochem., Mineral. and Petro. of the Warsaw University.

The mineralogical assemblage of post-magmatic minerals in Strzelin granitoids was investigated. The chemical compositions of fluid inclusions in quartzes homogenizing or decrepitating from 500°C to about 100°C suggest crystallization of mineral parageneses from relatively strongly diluted chloride-carbonate solutions bearing Al^{3+}, Na^+, K^+, Ca^{2+}, Li^+ and CO_2 under a pressure of 650-800 atms. (Author's abstract)

STOGNIY, A.G., 1976, Temperature of formation of minerals from corundum metasomatites at the Karatass deposit (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 117 (in Russian; translation by A. Kozlowski).

Inclusions in sapphirine, spinel, corundum, amphibole, garnet and quartz, were studied. T_H of polyphase inclusions in corundum >600-700°C, G phase consist mainly of CO_2. T_H of G/L inclusions in fine-crystalline amphibole from metasomatite 355-340°C, recrystallized inclusions bearing solid phase decrepitate at >180°C. Quartz from pegmatites bears G/L inclusions with T_H 340-320, 220-180 (dm calcite) and 220-140°C. Garnet from pegmatite bears G, and G/L inclusions with T_H ∿400°C. Garnets from gneiss wall-rock differ by containing numerous solid inclusions of apatite, often with trapped primary G bubbles. (...) (Author's abst.)

STRAUS, J.M. and SCHUBERT, G., 1977, Hydrothermal convection in a rectangular box of porous material: two- or three-dimensional?(abst.): Amer. Geophys. Union Trans., EOS, v. 58, p. 1248.

STRÜBEL, G. and SCHAEFER, B., 1977, Experimental investigation of barite-fluorite mineralization (abst.): Fortsh. Min., v. 55, pt. 1, p. 138-139 (in German).

SUSHCHEVSKAYA, T.M., 1977, New data on composition of tin-bearing hydrothermal solutions (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. I, p. 138-139 (in Russian; translation by A. Kozlowski). Author at GEOKHI AN USSR, Moscow.

The data were obtained during studies of the Komsomol'skoe tin ore region in the Khabarovsk area and Kavalenovskiy tin ore region in Primor'ye, USSR, both of the cassiterite-silicate type. Tin-bearing solutions are high T, moderately concentrated, weakly alkaline H_2O-CO_2 systems with main components: Na, K, Ca, Cl, HCO_3, and secondary ones: B, Mg, F, HS, Li; rare and ore elements have concentration 10^{-3} to 10^{-5} per liter. Main gases are CO_2, CH_4, commonly CO and N_2 are also present, and rarely H_2. Eh does not influence the cassiterite precipitation, but the pH value is the main factor. (Abst. by A.K.)

SUSHCHEVSKAYA, T.M., BARANOVA, N.N., KOZERENKO, S.N., and BARSUKOV, V.L., 1976, The composition of hydrothermal solutions forming cassiterite-sulfide and gold-silver ores from fluid inclusion data (abst.): 25th Internat. Geol. Congress Abstracts, v. 1, p. 195-196. Authors at Vernadsky Inst. Geochem. Anal. Chem., Acad. Sci. USSR, Moscow.

Chemical features of the solutions forming cassiterite-sulfide and gold-silver ores from several Soviet Far East deposits were studied using data obtained from the chemical composition of inclusions and calculations of the stability of complex compounds.

Formation of the cassiterite-sulfide ores is a long and complex process with the economically important stage lying within interval 300-450°C. Study of the liquid and gaseous phase composition leads to the conclusion that the main components of the tin-bearing hydrothermal solutions are Na, K, Ca, Cl, HCO_3, CO_2, CH_4. Their concentrations are

0.1-1.0 M/l. A peculiar feature of the tin-bearing solutions is the constant presence of fluorine, its average concentration being about 0.1 M/l. Lithium and boron both have an average concentration of about 0.01 M/l and increase up to 0.1 M/l when mineral associations, containing compounds of these elements are deposited, such as tourmaline, Li-containing muscovite, etc. Tin-bearing solutions contain magnesium and sulphur in the amount 0.1-0.001 M/l, and some ore metals accompanying tin in sulfide-cassiterite deposits such as Pb, Cu, W, whose concentration is 10^{-3}-10^{-5} M/l. Elevated concentrations of these metals were found in solutions extracted from samples taken from zones containing corresponding minerals, pH-values of the tin-bearing solutions, calculated from the data on carbonate equilibrium, indicate the neutral or slightly alkaline character of these solutions. Tendency to increasing pH values during precipitation of the main quantity of cassiterite was also revealed.

From the data on CO_2-CH_4 equilibrium at 300°C, Eh values could be calculated; average Eh was about 700 mv, so the main mineral associations of the cassiterite-sulfide deposits were formed in a reductive environment.

Hydrothermal solutions, forming gold-silver ores, are characterized by domination of sodium and hydrocarbonate ions, and, hence, by slightly alkaline reaction. Redox potential of these solutions is close to that of tin-bearing ones, 700-800 mv. Carbon dioxide is the main component of the gaseous phase of the inclusions. Its highest content was found in the quartz precipitated at the quartz-rhodonite stage, nearly simultaneously with gold and silver mineral precipitation.

It is calculated that in the solution of the studied composition, several ion pairs and complexes sufficiently stable at elevated temperatures, can be formed. So the most part of Ca, Mg, F, SO_4, and notable part of HCO_3, were present in the form of complex particles.

Data on inclusion compositions and on SnO_2 and Au solubility in water and electrolyte solutions at high temperatures indicate that, though the chemical composition of the two groups of hydrothermal solutions are similar, difference in the chemical properties of tin and gold leads to different forms in which the two elements are present in the solution. Tin, most probably, is transported in the form of fluorine-hydroxyl complexes, whereas gold, evidently, in the form of chlorine-hydroxyl complexes. (Authors' abstract)

SUSHCHEVSKAYA, T.M., BARANOVA, N.N., KOZERENKO, S.N., and BARSUKOV, V.L., 1976, The composition of hydrothermal solutions forming cassiterite-sulfide and gold-silver ores from fluid inclusion data (abst.): in Internat. Geol. Congress, 25th Session, Reports of Soviet Geologists (Tugarinov, A.I., et al., eds.), p. 285-292: Moscow, Izd. Nauka (in Russian with English summary).

See preceding abstract. (ER)

SUSHCHEVSKAYA, T.M., BARSUKOV, V.L., VOLOSOV, A.G., and MALAKHOV, V.V., 1976, Values of pH during precipitation of hydrothermal cassiterite (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 194-195 (in Russian; translation by A. Kozlowski).

1. Solubility of cassiterite in water and water solutions of electrolytes of elevated T and analogy with solubility of similar compounds suggest that change of pH is one of the main causes of crystallization of cassiterite.

2. Values of pH of parent solutions of cassiterite were calculated from data on composition of L and G phases of fluid inclusions in quartz and cassiterite of the cassiterite-silicate deposits from Soviet Far East. (...)

3. Minerals of the main associations precipitate at pH 5.6-8.8 for T_H 350-250°C (when pH of neutral medium 5.80-5.65). (...) (From the authors' abst.)

SUSHCHEVSKAYA, T.M., DOROFEEVA, V.A., and KNYAZEVA, S.N., 1977, Comparison of two methods of determining pH from fluid inclusion data: Geokhimiya, 1977, no. 6, p. 939-942 (in Russian).

Fifteen analyses of fluid inclusions (from Sn deposits) for Li, K, Na, Ca, Mg, Cl, F, HCO_3, and CO_2 are presented, along with calculated pH values using two methods. The critical datum is the analysis for HCO_3. (ER)

SUSHCHEVSKAYA, T.M. and RYZHENKO, B.N., 1977, Calculation of the composition of tin-bearing hydrothermal solutions: Geokhimiya, 1977, no. 7, p. 1091-1095 (in Russian; translated in Geochem. Internat., v. 14, no. 4, p. 88-91). First author at Vernadskiy Inst. Geochem. and Anal. Chem., Academy of Sciences of the USSR, Moscow.

Presents calculated equilibrium concentrations of many ionic species over a temperature range of 25-300°C. (ER)

SUSTAVOV, O.A., 1976, Water index of vein quartz (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976; Ufa, Bashkir Section. Acad, Sci. USSR, Inst. of Geol., p. 148 (in Russian; translation by A. Kozlowski).

1. Adycha-Taryn Au-Sb ore zone and Abycha-El'gin megabrachyanticlinorium in the Verkhoyan'ye-Kolyma folded area are regions of extensive development of quartz veins with T_D 230-270°C.

2. "Water index of vein quartz" (W.I.) characterizes ratio of water and gas in inclusions. Gangue milky quartz from the Adycha-Taryn zone has W.I. 2-4 (202 samples). For Au ore deposits higher values of W.I. are typical, equal 4-10, in comparison with Au-Sb ore deposit (sic.). (Author's abst.)

SUTTON, F.M. and McNABB, A., 1977, Boiling curves at Broadlands geothermal field, New Zealand: New Zealand Journal of Science, v. 20, p. 333-7. Authors at Applied Mathematics Division, DSIR, Wellington, New Zealand.

When measurements are made in bores at the Wairakei geothermal field, the temperature and pressure at any point in a bore are generally related by the boiling curve for water. At the Broadlands field, in contrast, the pressures tend to be higher than those that are found in a boiling water system.

It is well known that there is considerably more carbon dioxide in the geothermal waters at Broadlands than at Wairakei.

This paper seeks to show that the excess pressures encountered at Broadlands can be accounted for by the partial pressure due to about 4% by mass of carbon dioxide in the geothermal fluid before exploitation.

SVIRIDENKO, A.F. and SMIRNOV, A.A., 1976, T-P conditions of formation of jadeites from Pribalkhash'ie (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept. 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 62-63 (in Russian; translation by A. Kozlowski).

Jadeites from Kenterlau and Arkharsu bear G/L inclusions with T_H 330-300°C in the early varieties and 215-210°C in the late ones. Solutions in G/L inclusions in early jadeite have T_{Frz} -2 to +1.5°C, i.e., concentration of HCO_3^- solution ranges from 7 to 10 wt.%. Later jadeite bears inclusions with halite and LCO_2. P is about 700 atm. for early jadeite and 350 atm. for the later. Jadeite crystallized probably at 380-360°C (early) and 330-320°C (late).

SVOREN', I.M. and PISOTSKIY, B.I., 1976, Trapping of inclusions by hydrothermal colloids (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 161-162 (in Russian; translation by A. Kozlowski).

Growth of crystals in gels of H_4SiO_4 was studied. Hydrogel with density 1.02-1.05 g/cm^3 was obtained from $Na_2SiO_3 \cdot 9H_2O$ and distilled water plus 1N solution of acid. (...) Crystals of gypsum, calcite, aragonite and calcium tartrate were obtained. The latter contained inclusions almost completely filled by liquid. In gels, prepared for growth of aragonite, the formation of CO_2 bubbles was observed. (From the authors' abst.)

SWANSON, S.E., 1977, Relation of nucleation and crystal-growth rate to the development of granitic textures: Am. Min., v. 62, p. 966-978. Author at Tuttle-Jahns Lab. for Exp. Pet. and Geol. Dept., Stanford Univ., Stanford, CA 94305

SWANSON, S.E. and FENN, P.M., 1977, The effect of F and Cl on the nucleation and growth of albite from the melt (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 1194-1195.

In spite of their dramatic effect on melting of silicates, the effect of halogens on the crystallization process is minimal save for the increase in the ease of nucleation. (From the authors' abstract).

TAKENOUCHI, S., 1977, Study on ore-forming fluids and its application to mineral exploration: Mining Geol. (Japan) v. 27, no. 142, p. 63-68 (in Japanese).

A review, in particular, of fluid inclusion studies (ER).

TAKENOUCHI, S. and IMAI, H., 1977, Fluid inclusion study at the Fujigatani and Kiwada area of southwestern Japan, in Problems of Ore Deposition, Fourth IAGOD Symposium, Varna, 1974, vol. 2: Sofia, Pub. House Bulgarian Acad. Sciences, p. 203-207.

See same authors, 1974, Fluid Inclusion Research--Proceedings of COFFI, v. 7, p. 221 (1974).

TANELLI, G., 1977, Skarn deposits of Tuscany: Rendiconti Soc. It. Miner. Petrol., v. 33, p. 875-903 (in Italian). Author at Ist. Min., Petrog. e Geoch. dell Univ., via Lamarmora 4, 50121 Firenze, Italy.

A comprehensive review of the geological, attitudinal, mineralogical and petrological data, with evaluation of some physico-chemical parameters. The environment of formation can be characterized by a decreasing temperature from 450°C to 200°C, a pressure of a few hundred bars and an f_{S_2}-f_{O_2} field where the magnetite and pyrite are the stable phases. (Abst. by Piero Lattanzi)

TAUSON, L.S. and KUZMINA, T.M., 1977, Peculiarities of composition of aqueous extracts from quartz of pegmatite veins with different mineralizations: p. 67-71 in Geochemical methods of prospecting and analysis: Irkutsk, Sib. Inst. Geochemistry (in Russian with English abstract).

Pecularities of the aggregate state of fluid inclusions in quartz from different pegmatites and the composition of aqueous extracts from this mineral are shown. Muscovite pegmatites differ by a high content of K^+ in the cations, HCO_3^- is the main anion of solutions. Rare-metal pegmatites are characterized by prevalence of Na^+ (more rarely - Ca^{++}, Mg^{++}, Li^+) among cations, HCO^- (sic) or Cl^- in the anion part. (Authors' abstract)

TAYLOR, B.E., and O'NEIL, J.R., 1977, Stable isotope studies of metasomatic Ca-Fe-Al-Si skarns and associated metamorphic and igneous rocks, Osgood Mountains, Nevada: Contrib. Mineral. Petrol., v. 63, p. 1-49. First author at Dept. of Geol., Stanford Univ., Stanford, CA 94305.

Garnet-pyroxene skarns were formed 90 m.y. B.P. in the Osgood Mountains at or near contacts of granodiorite with calcareous rocks of the Cambrian Preble Formation. The metasomatic replacement followed contact metamorphic recrystallization of the Preble. The sources, temperature, and variation in H_2O/CO_2 ratios of the metasomatic fluid are interpreted from 269 analyses of oxygen, carbon, hydrogen, and sulfur isotopes in whole rocks, minerals, and inclusion fluids.

Skarns formed in three mineralogical stages. Oxygen isotope data indicate that temperatures during the crystallization of garnet, pyroxene and wollastonite (Stage I) were least 550°C, and that the metasomatic fluid had an $X_{CO_2} \leq 0.035$ in the massive skarns, and ≤ 0.12 in vein skarns up to 3 cm thick. Pore fluids in isotopic equilibrium with garnet in calc-silicate metamorphic rocks, on the other hand, had $X_{CO_2} \leq 0.15$.

The metasomatic fluids of Stage I were derived primarily from the crystallizing magma. The isotopic composition of magmatic water was $\delta^{18}O=+9.0$, $\delta D=-30$ to -45. Oxygen isotope temperatures of greater than 620°C were determined for the granodiorite. Isotopic and chemical equilibria between mineral surfaces and the metasomatic fluid were approached simultaneously in parts of the skarn several meters or more apart, while isotopic and chemical disequilibria (i.e., zoning) have been preserved between 20 to 40 μm-thick zones in grandite garnet. More Fe-, or andradite-rich garnet crystallized in more H_2O-rich C-O-H fluids ($X_{CO_2} \leq 0.01$) than present with grossularite-rich garnet ($X_{CO_2} \leq 0.035$).

Stage II was marked by the replacement of garnet and pyroxene by quartz, amphibole, plagioclase, epidote, magnetite, and calcite. Many of the replacement reactions took place over a relatively narrow range in temperature (480-550°C), as indicated by ^{18}O fractionations between quartz and amphibole. Meteoric water comprised 20 to 50% of the metasomatic fluid during Stage II.

Calcite was formed along with pyrite, minor pyrrhotite, and chalcopyrite during Stage III, although the crystallization of pyrite and calcite had begun earlier, during Stages I and II, respectively. Carbon and sulfur isotope compositions of calcite and pyrite indicate a magmatic source for most of the C and S in the metasomatic fluids of Stage III. By the end of Stage III, meteoric water constituted as much as 100% of the metasomatic fluid. Minerals from grandiorite and skarn do not show large depletions in ^{18}O because the oxygen isotope composition of the metasomatic fluid was buffered by the calcareous wall rocks and the grandiorite.

Meteoric water in the vicinity of the Osgood Mountains during the Late Crectaceous ($\delta^{18}O_{calc.} \simeq -14.0$, $\delta D = 0107$) was slightly enriched in ^{18}O and D relative to present-day meteoric water ($\delta^{18}O = 15.9$, $\delta D = -117$). (Authors' abstract)

TAYLOR, H.P., Jr., 1977, Water/rock interactions and the origin of H_2O in granitic batholiths: J. Geol. Soc. London, v. 133, p. 509-558.

D/H and $^{18}O/^{16}O$ data have now been obtained on a wide variety of granitic batholiths of various ages. The primary δD values of the biotites and hornblendes are remarkably constant at about -50 to -85, identical to the values in regional metamorphic rocks, marine sediments and greenstones, and most weathering products in temperature climates. Therefore the primary H_2O in these igneous rocks is probably not "juvenile," but is ultimately derived by dehydration and/or partial melting of the lower crust or subducted lithosphere. Most granitic rocks have $\delta^{18}O = +7.0$ to $+10.0$, probably indicating significant involvement of high-^{18}O metasedimentary or altered volcanic rocks in the melting process; such an origin is required for many other granodiorites and tonalites that have $\delta^{18}O = +10$ to $+13$. Gigantic meteoric-hydrothermal convective circulation systems were established in the epizonal portions of all batholiths, locally producing very low $\delta^{18}O$ values (particularly in feldspars) during subsolidus exchange. Some granitic plutons in such environments also were emplaced as low-^{18}O magmas probably formed by melting or assimilation of hydrothermally altered roof rocks. However, the water/rock ratios were typically low enough that over wide areas the only evidence for meteoric H_2O exchange in the batholiths is given by low D/H ratios (δD as low as -180); for example, because of latitudinal isotopic variations in meteoric waters, as one moves north through the Cordilleran batholiths of western North America an increasingly higher proportion of the granitic rocks have δD values lower than -120. The lowering of δD values commonly correlates with re-setting of K-Ar ages, and in the Idaho batholith two broad zones (10,000 km^2) can be defined where δD biotite < -100 and K-Ar "ages" have all been re-set to values less than 60 Ma, suggesting that the Ar loss was caused by the meteoric-hydrothermal circulation systems. In certain Precambrian batholiths, a much different type of very low temperature regional alteration by surface-derived waters took place over an extended period long after emplacement, producing "brick-red" feldspars and markedly discordant Rb-Sr isochron "ages." (Author's abstract)

TAYLOR, H.P., Jr. and COLEMAN, R.G., 1977, Oxygen isotopic evidence for meteoric-hydrothermal alteration of the Jabal at Tirf igneous complex, Saudi Arabia (abst.): Amer. Geophys. Union, Trans., EOS, v. 58, no. 6,

p. 516.

We propose that low-^{18}O meteoric ground waters, rather than NaCl-rich ocean waters, were involved in the hydrothermal convective system associated with the emplacement of this complex. The features in this complex are similar to those observed in the East Greenland dike swarm in the vicinity of the Skaergaard intrusion. (From the authors' abstract)

TAYLOR, H.P., Jr. and MAGARITZ, Mordeckai, 1977, Oxygen and hydrogen isotope studies of the Cordilleran granitic batholiths of western North America (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, p. 513.

TEWHEY, J.D., 1977, The effect of hydrothermal alteration on porosity and permeability in the Salton Sea Geothermal Field, California (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 1197-1198.

THEODORE, T.G. and PRIEGO DE WIT, Miguel, 1977, Potassic alteration at la Florida de Nacozari, Sonora, Mexico (abst.): Econ. Geol., v. 72, no. 4, p. 742.

See Fluid Inclusion Research -- Proceedings of COFFI, v. 9, p. 140 (ER)

TILLER, W.A., 1975, Cross pollenation of crystallization ideas between metallurgy and geology (silicate systems) (abst.): Amer. Geophys. Union Trans., EOS, v. 56, no. 12, p. 1082.

Using the extensive theoretical and experimental background on the crystal growth of metallic, semiconducting and other simple melt systems, a qualitative description of the formation events for a number of prominent geological mineral morphologies will be presented. Particular emphasis will be placed upon crystallization in silicate systems and some consequences arising from the insitu inhomogeneous fields of temperature, pressure and chemical composition (both uncharged and charged components) generated by the crystal growth process.

Attention will be directed to (a) bubble or inclusion formation by focusing on the freezing velocity profile, the corresponding solute redistribution profile, the bubble or inclusion formation conditions, migration and agglomeration influences and the residual morphology of bubble arrays and (b) eutectic and dendritic morphologies with their obvious relationship to zoning.

The overall purpose is to give an overview picture of what is involved in terms of physical principals, morphological scale predictions and general trends rather than a detailed analysis useful only to specialists. Emphasis will be on important concepts and approaches that can be of significant value to the geological milieu. (Author's abstract)

TILLING, R.I., 1977, Interaction of meteoric waters with magmas of the Boulder batholith, Montana: Econ. Geol., v. 72, p. 859-864.

TIMOFEEV, A.V., SHTEINSHNEIDER, T.L. and KHOTEEV, A.D., 1976, Temperature regime of mineral-formation and zonality of a U-Mo deposit (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 74 (in Russian; translation by A. Kozlowski).

1. The deposit is connected with the deep, abruptly dipping Main fault. It was formed during stages: pyritic (230-210°C), ore (220-170°C), ankeritic (190-160°C) and quartz-carbonate (160-140°C). For quartz from veins of the last stage, inclusions of three groups are typical: a) $G>50$ vol. %, T_H in G phase >400°C; b) G 35-45 vol. %, T_H in L phase 250-400°C; c) G 20 vol. %, T_H in L phase 120-210°C (sic.)

2. In quartz from the fault zone all three types were found, away from fault zone - only type C.

3. Mean T_H decreases from 205°C in the fault zone to 145°C in veins in wall rock. At depths above 600 m T_H = 145°C appears at ∿150 m distance from fault; below 600 m - the distance increases to ∿500 M; 3 km from fault all T_H range in interval 140-160°C.

4. T gradient (from Main fault) above 600 m depth equals 8-10° per 20 m and below - 10-13°C per 100 m. The Main fault provided the migration path for the solutions during the fourth stage. (Author's abstract.)

TOMILENKO, A.A., BERDNIKOV, N.V. and KARSAKOV, L.P., 1977, Cryometry of inclusions in rocks of Chogarskiy deep metamorphic complex (E. Siberia): Akad. Nauk SSSR Doklady, v. 234 no. 5, p. 1189-1192 (in Russian). First author at Inst. Geol. Geophys. Siberian Branch of the Acad. Sci. USSR, Novosibirsk.

P-T conditions of granulite facies metamorphism, derived from stability data of minerals and gabbro-eclogite transformation, were 10-11kb and 1000-1100°C. Quartz from bronzite-sillimanite (+sapphirine) quartzite bears fluid inclusions: 1) P one-phase LCO_2; 2) PS and S one-phase LCO_2; 3) S: a) one-phase L H_2O salt solution; b) two-phase G/L H_2O salt solution. P inclusions are euhedral, up to 5 μm long; T of melting of solid CO_2 after freezing varies from -65.5 to -58°C. Analysis of G composition of individual inclusions yielded following values (vol.% of total gases, 23 samples): CO_2(+ potentially H_2S, HF, HCl, SO_2, NH_3) 88.0-100.0, hydrocarbons 0.0-7.0, O_2 0.0, CO 0.0-3.0, H_2 0.0-2.0, N_2 + noble gases 0.0-12.0 (values for G phase of all kinds of inclusions). T_H of P inclusions range between -30 and -42°C, specific volume from 0.93 to 0.89 cm^3/g. PS and S one-phase inclusions have T_H -21 - -34.5°C, specific volume 0.96-0.91 cm^3/g, T of melting close to T of CO_2 triple point (-56.6°C). T_H of G/L inclusions 140-130°C. Some P and S inclusions bear solids, presumably xenogenic, since they did not homogenize. P determined from CO_2 density equals 11-13 kb. (Abst. by A.K.)

TOMILENKO, A.A., CHUPIN, V.P., and DOLGOV, YU.A., 1976, Conditions of formation of metamorphic rocks, derived from data of studies of inclusions: in Genetic studies in mineralogy, Yu.A. Dolgov et al., eds.: Novosibirsk, Inst. Geol. and Geophy. Sib. Branch Acad. Sci. USSR, p. 138-141 (in Russian).

Inclusions in kyanite, sillimanite and garnet bear solutions of the highest density, whereas quartz and feldspars are characterized by numerous varieties of inclusions, both from the extremal facies of metamorphism and from all degrees of retrograde alterations. Important components of metamorphic fluids in addition to water and CO_2 in some regions is nitrogen of high partial P_{N2}, up to 8 kb. P_{CO2} may achieve high value, up to 0.8 of P_{fluid}. Main salt is commonly NaCl; KCl and other salts are subordinate. Results of studies are summarized in the tables.

Table 30. Content of CO_2 and CO (cm^3/g) in granite-gneisses, Aldan shield

Facies	granulite							amphibolite		
CO_2	0.27	0.74	0.25	0.51	0.11	0.12	0.23	0.12	0.43	0.21
CO	0.11	0.10	0.14	0.07	0.03	0.12	0.04	0.02	0.03	0.02

Table 31. Results of determinations of T and P in inclusions of salt melts-brines in quartz of Precambrian rocks of Upper-Aldanian complex (vicinity of Suon-Tiit village)

Rock	T of disappearance of G bubble,°C	T_H (dissolving of last salt crystal),°C	T_H-T,°C	P, kbar at T_H
Anatectic pegmatites with granophyres, in migmatites	90-200	430-540	300-400	4.0-6.0
Alaskite granite in quartzites	140-160	480-500	340-350	4.0-4.5
Granitoid leucosomes in gneisses and schists	145-265	420-660	285-450	4.0-6.0
Granite-gneisses	140-180	535-600	360-450	4.5-6.0
Quartzites (monomineral, feldspathized and sillimanite-bearing)	110-200	400-560	255-390	3.5-6.0

Table 32. Results of studies of metamorphic inclusions in minerals

Location	Facies	Mineral	T heterogenization, °C	T_H, °C	Specific vol., cm^3/g	P, bar	Essential component
Aldan	Granulite	Quartz	-	up to -3	1.07	up to 6.8	CO_2
Do.	Amphibolite	Do.	-	up to -3	1.07	up to 6.8	
Sutama R.	Granulite	Do.	-	-10 to -16	1.02 -1.00	7.0-8.3	
Aldan	Amphibolite	Sillimanite	-	+2 to -4	1.09 -1.06	6.0-6.5	
Sutama R.	Granulite	Do.	-	-10 to -16	1.02 -1.00	7.0-8.3	
Aldan	Do.	Garnet	-	+5 to -3	1.11 -1.07	6.5-6.8	
Mama region	Do.	Kyanite	-32 to -18	-22 to -7	0.94 -1.00	5.2-8.5	
S. Chuyskiy Mt.	Do.	Quartz	-149 to -160	-	2.194-1.672	2.4-4.8	N_2
	Do.	Andalusite	-149 to -164	-	2.194-1.597	2.4-5.7	
	Do.	Kyanite	below -190	-	1.280	8.3	

(From the authors' text, translated by A.K.)

TOURAY, J.C. and PERTHUISOT, V., 1977, Hypersaline inclusions, witnesses of the geological history of diapirs: examples from Tunisia (abst.): Inst. Mining and Met., Trans., Sect. B, v. 86, p. B160.

(Abstract not printed)

TOURET, Jacques, 1977, The significance of fluid inclusions in metamorphic rocks: in Thermodynamics in Geology, D.G. Fraser, ed.: Dordrech-Holland, D. Reidel Pub. Co., p. 203-227. Author at Lab. Pétrographie, Muséum Hist. Naturelle, 61, rue de Buffon, 75005 Paris, France.

A review with 64 references, covering lab techniques and interpretation of the resulting data, and a set of problems, with answers. (ER)

TROSHIN, Yu.P., BOYKO, S.M., and MARKOVA, M.Ye., 1976, Conditions of formation of postmagmatic mineralization in the Kukul'bey ore region in Transbaikalia (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 188 (in Russian; translation by A. Kozlowski).

Mesozoic tectonic-magmatic and hydrothermal activisation began with the intruding of relatively basic granitoid massifs, as well as with the formation of Au and Mo deposits. The ore-bearing solutions often have

CO_2>Cl>F. Later magmatism became more acid, and Au-Mo deposits were replaced by W-Sn. In the composition of post-magmatic solutions the role of CO_2 and HCl decreased and role of F increased strongly. In the region three stages of ore formation were distinguished: CO_2-Cl, H_2O-F and F ores, with formation of Au-Mo, W and Sn mineralization respectively. (Authors' abstract)

Table. Equivalent ratios in water leachates from inclusions in ore-bearing quartz from the Kukul'bey ore region

Type of ore	Deposit	No. of samples	Cl/F	Na/K	$\frac{Cl+F}{HCO_3}$	Age, m.y.
Mo	Shakhtama	2	46.5	4.4	0.7	166-173
Au-Mo	Alenguy	4	7.15	5.4	3.7	
W	Bukuka	3	0.55	0.38	2.7	
W	Belukha	3	1.35	3.84	4.6	131-164
W	Antonova Gora	3	3.2	3.34	10	
W	Arbuy	3	0.93	0.81	3.6	
W	Molosoktuy	3	0.65	4.36	10	150
W-Sn	Sherlovaya Gora	14	5.0	3.4	60	147-154
W-Sn	Aldokachanskoe	3	2.7	4.9	2	
Sn-Rs*	Sopka Bolshaya	16	3.8	1.6	0.1	144

*Sic. (A.K.)

TRUESDELL, A.H., 1976, Summary of Section III: Geochemical techniques in exploration: Proceedings 2nd U.N. Symposium on The Development and Use of Geothermal Resources, San Francisco, 1975, v. 1, U.S. Govt. Printing Office, p. liii-lxxix. Author at U.S. Geological Survey, Menlo Park, California, 94025.

A thorough review, with extensive references and data tables. (ER)

TRUESDELL, A.H. and FOURNIER, R.O., 1977, Procedure for estimating the temperature of a hot-water component in a mixed water by using a plot of dissolved silica versus enthalpy: Jour. Research U.S. Geol. Survey, v. 5, no. 1, p. 49-52.

TRUESDELL, A.H., NATHENSON, Manuel, and RYE, R.O., 1977, The effects of subsurface boiling and dilution on the isotopic compositions of Yellowstone thermal waters: Jour. of Geophys. Research, v. 82, p. 3694-3704.

See also same authors and title, Jour. Geophys. Research, v. 82, no. 26, p. 3694-3761, 1977.

TRUESDELL, A.H. and NEHRING, N.L., 1977, Steam production at the Geysers, California, comes from liquid water near the well bottoms (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 1206. Authors at U.S. Geological Survey, Menlo Park, California 94025.

TRUFANOV, V.N., 1976, Thermodynamic (stages) in the formation of deep mineral-forming fluids, in Thermobarogeochemistry of mineral formation, N.P. Ermakov, ed.: Rostov, Rostov Univ. Press, p. 13-29 (in Russian).

Full paper corresponding to abstract in Fluid Inclusion Research volume 7, p. 229, 1974.

TRUFANOV, V.N., MAISKIY, Yu.G. and MAISKAYA, Z.V., 1976, Decrepitation activity of quartz raw material as criterion of its quality (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 148 (in Russian; translation by A. Kozlowski).

For successful use of decrepitation for evaluation of quartz quality for industrial purposes it is necessary: 1. to choose unit of decrepitation activity suitable for metrologic service; 2. to make decrepitometers and methods uniform; 3) to determine the ranges of decrepitation of raw materials during use in various technologies. (From the authors' abst.)

TSERTSVADZE, D.V., AREVADZE, D.V. and KUCHER, M.I., 1976, Physicochemical parameters of formation of arsenic ores (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 83-84 (in Russian; translation by A. Kozlowski).

1. In the central part of the S slope of the Great Caucasus, the Sb deposits occur along the Main thrust in hornfelses (primitive clayey shales of the Lower Lias) and in Paleozoic granitoids. Sandy-clayey beds of the Upper Lias and the Middle Jurassic bear monominerallic Hg deposits. As-Hg deposits are connected with the lower part of the carbonate flysch complex of the Upper Jurassic, and in the flysch beds of the Cretaceous age. As deposits occur.

2. At the Lukhunskoe and Kodis-Dzirskoe deposits, associations with quartz and calcite were distinguished: 1) pre-ore pyrite (at Lukhunskoe with arsenopyrite), T_H 310-240°C; 2) ores a. antimonite (at Kodis-Dzirskoe with cinnabar), T_H 250-155°C; b. realgar-orpiment, T_H 170-110°C, and 3) post-ore, T_H 120-40°C.

3. Pressure in three-phase (with L CO_2) inclusions of the antimonite association equals 200-180* bars and in inclusions in minerals of the As_2S_3-As_2S_5 (sic.)--150 bars.

4. Gases in inclusions in minerals, by mass spectrometry (MV-2302), are as follows: N_2, CO_2, CH_4, NH_3, O_2, H_2S, Ar, He, H_2, H_2O and Cl. CO_2 content increases in As_2S_5 (sic.) to 73.83 and in As_2S_3 to 58.73 wt. %. In quartz and calcite of the ore association, CO_2 concentration is 19.77 to 21.37 wt.%. (Authors' abst.)

*Values revised by D.V. Arevadze to 900-1100 bars, (personal comm., A.K.).

TSERTSVADZE, Z.Ya. and ASTAKHOV, G.N., 1976, Aureoles of impregnation and endogene dispersion (used) during prospecting of Hg, Sb and As deposits in Caucasus (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 135-136 (in Russian; translation by A. Kozlowski).

During prospecting, geochemical aureoles and decrepitation studies (maximum of decrepitation at low T) were successfully used. T_H and T_D found in aureoles vary from 300 to 70°C. (A.K.)

TSUI, T.-F., 1976, Laser microprobe analysis of fluid inclusions in quartz: Ph.D. dissert., Harvard Univ., Cambridge, Mass.

See Fluid Inclusion Research--Proceedings of COFFI, v. 9, p. 145. (ER)

TUCHOLKE, B.E., BRYAN, G.M., and EWING, J.I., 1977, Gas-hydrate horizons detected in seismic-profiler data from the western North Atlantic: The American Association of Petroleum Geologists Bulletin, v. 61, no. 5, p. 698-707.

TUGARINOV, A.I., 1975, Sources of ore material according to isotopic data: Geol. Rudn. Mestor., 1975, no. 4, p. 30-43 (in Russian; trans. in Intern. Geol. Rev., no. 19, p. 265-275, 1977).

TURCHENKO, S.I., 1976, T-P conditions of sulfide ore formation in Karelia (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 94 (in Russian; translation by A. Kozlowski).

Early Proterozoic mobile belts bear numerous sulfide polygenic ores, consisting mainly of pyrite and pyrrhotite. Primary pyrrhotite ores are connected with chemical sedimentary processes, following accumulation of volcanogenic sedimentary rocks which were then metamorphosed. (...) Early metamorphism (amphibolite facies) caused formation of the strata-bound recrystallized ores at T 550-500°C. Later differentiation of metamorphic processes into epidote-amphibolite and greenschist facies, together with formation of schistose structures and folding, caused formation of lens-like ore bodies at T 450-400°C. Retrograde metasomatism (quartz, epidote, muscovite mineralization, formation of the quartz-pyrrhotite veins and late pyrrhotite with Cu-Zn mineralization) appeared at T_H and T_D 360-260°C. All T derived from inclusions (Author's abst.)

TURESEBEKOV, A., 1976, Temperature of formation of anhydrite and barite at the ore deposit Almalyk (Uzbek SSR) (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 62 (in Russian; translation by A. Kozlowski).

No inclusion data in the abstract. (A.K.)

TURESEBEKOV, A.Kh., 1977, On the problem of temperature zoning of copper-molybdenum deposits of the Almalyk ore region (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. I, p. 169-170 (in Russian; translation by A. Kozlowski). Author at Inst. Geol. Geophys. Acad. Sci. Uzbek SSR.

Studies of ∿10,000 samples yielded following T_H and T_D zoning of minerals, occurring in sequence from the upper to the lower levels: calcite 250-90°C, barite 260-80°C, galena 280-180°C, sphalerite 300-180°C, anhydrite 340-90°C, quartz 380-170°C, chalcopyrite 380-210°C, pyrrhotite 410°C, pyrite 420-260°C, etc. (Abstract by A.K.)

TVALCHRELIDZE, A.G., NAROZAULI, I.G. and CHKHAIDZE, Ts.Sh., 1976, Condition of formation of the copper-pyrrhotite deposits of the Great Caucasus (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 89 (in Russian; translation by A. Kozlowski).

Stratiform Cu-pyrrhotite deposits of the S. slope of the Great Caucasus (Kizil-Dere, Kats-Dag, Adange etc.) formed in stages: a) sulfide hydrothermal-sedimentary (sic) of lower Jurassic age, low T <150°C, increase of pH to 7, influx of S and Fe; b) Cu-pyrrhotite hydrothermal-metamorphogenic of the stratiform replacement type of Middle Jurassic age; T_H testify to crystallization at T 330-300°C and

P ≈ 300 atm from S-free, weakly-mineralized, almost neutral solutions; c) polymetallic, late ores, connected with alteration of pyrrhotite into pyrite-marcasite pseudomorphs, T_H 200-150°C. (...) (From the author's abst.)

TYCHINSKIY, A.A., PONOMAREV, V.G., GRINENKO, L.N, and SHIPILOV, L.D., 1977, Peculiarities of process of ore formation of stratiform lead-zinc deposits of Siberia (abst.), in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Sib. Branch, v. II, p. 103-104 (in Russian; translation by A. Kozlowski). First author at Inst. Geol. Geophys. of Siberian Branch of Acad. Sci. U.S.S.R., Novosibirsk -90.

The studied stratiform Zn-Pb deposits occur in the folded areas at the margins of Siberian platform: Yenisey area, N. and NW Forebaikalia, W Transbaikalia and SE Yakutia. Pb-Zn-pyrite deposits in black shales and terrigenous volcanogenic carbonate rocks are syngenetic with wall-rocks. T of formation of ores ≤100°C, T of metamorphism of ores under regional conditions were 420-460°C, and in several parts -- 520-585°C. Ores of Zn and Pb formed syngenetically and epigenetically in carbonate rocks, T were up to 200°C, whereas ore veins formed at 300-400°C. Pb-Zn ores bearing fluorite are of typical hydrothermal-metasomatic origin at T 200-400°C (method of study of fluid inclusions, i.e., T_H or T_D, was not specified, A.K.) (Abst. by A.K.)

TYLER, R.D., 1977, Chloride metasomatism in the southern part of the Pierrepont Quadrangle, northwest Adirondacks, New York (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, p. 325-326.

Fractures in granulite facies rocks, northwest Adirondacks, New York, have acted as conduits for chloride metasomatism of adjoining country rock. Metabasite (plag-hbd-cpx-opx) lenses and interlayers, within biotite-quartz-plagioclase gneiss, were most affected by the Cl-bearing solutions. Hornblende, scapolite and quartz are the most common replacement phases in the metabasites. In leucocratic granitic and charnockitic assemblages, biotite is the dominant Cl-bearing phase within the fracture zones. Hornblende appears to have formed by the reaction: $\text{Plag} + \text{Cpx} + \text{Opx} + \text{Cl}^- + H_2O = \text{Hbd} + \text{Qtz}$. Scapolite is present both as a primary vein-filling and a replacement phase (after plagioclase). Microprobe analyses of minerals from three mineralized metabasites indicated the following Cl contents: hornblende - 1.55 to 3.19 wt. per cent; and scapolite -1.99 to 2.42 wt. per cent. Biotite from a mineralized fracture in a charnockitic gneiss sample showed a mean of 3.31 wt. per cent Cl. Modal, chemical and microprobe analyses of host metabasite vs. mineralized zones indicates CO_2, H_2O, K_2O, and total Fe, as well as Cl, were introduced along the fractures.

The presence of orthopyroxene within the mineralized zones suggests temperatures of formation were in excess of 700°C. These high temperatures indicate the mineralization must have taken place in the waning stages of the Grenville orogenic event. Three possible origins for the Cl-bearing solutions are considered: 1) in situ - redistribution from trapped interstitial waters or minor Cl-bearing phases in the host rocks; 2) segregation of volatile components from anatectic melts or igneous intrusions; or 3) mobilization of evaporites in nearby carbonate units. (Author's abstract)

TYOMKIN, D.Ye. and CHERNOV, A.A., 1977, Conditions of trapping of a foreign particle by a crystal growing with variable speed from melt: Kristallografiya, v. 22, no. 5, p. 933-938 (in Russian). First author at the Central Sci.-Research Inst. of Black Metallurgy.

Behavior of a spherical particle at the growth front was studied, when the growth immediately increases its speed up to value $V_2>V_c$ (critical speed for a given particle), and then after time t decreases again to the initial value V_1. Small particles ($\lesssim 10^{-2}$cm) are not trapped by the crystal due to such fluctuation, if $V_2 t \lesssim 13 h_o^* (V_c/V_1)^2 (1-V_c/V_2)$, where characteristic range of separation between particle and crystal is $h_o^* \sim 10^{-7}$cm. For big particles a qualitatively close correlation was found, in which the role of h_o^* is displayed by another characteristic length value, connected with the gradient of temperature and equal $(1-3)\times 10^{-6}$cm. Quantitative evaluations prove that t-values applicable for the above criteria may be much lower than typical periods of fluctuation of the growth speed. This means that crystals without inclusions may be obtained only when both mean and maximum values of the varying speed are lower than V_c. (Authors' abst., transl. by A.K.)

TYOMKIN, D.Ye., CHERNOV, A.A., and MEL'NIKOVA, A.M., 1977, Trapping of foreign particles by crystal growing from melt bearing admixtures: Kristallografiya, v. 22, no. 1, p. 27-34 (in Russian). Authors at Inst. of Cristallography of Acad. Sci. USSR.

The influence of admixture in a melt on trapping of a foreign spherical particle of solid phase during oriented crystallization of melt with isotropic kinetics on the growth front was explained. For admixtures with trapping coefficient $K \ll 1$ an equation was found for critical speed of crystallization V_c; when this speed is achieved, the stationary repulsion of particle is no longer possible and particle is trapped by crystal. This critical V_c is lower than in the case of pure melt, and it is connected with radius of particle R with a relation $V_c \sim R^{-4/3}$. Influence of admixture of a given concentration is observable only for sufficiently big particles. On the contrary, for a given radius of particles, the influence of admixture acts above a relatively low initial value of admixture concentration. For example, a particle with $R=1\mu m$ has a transition from $V_c \sim R^{-2}$ to $V_c \sim R^{-4/3}$ when the concentration equals $\sim 3.10^{-2}$ wt.% (if the slope of liquidus line m=3°/wt.% and $K-10^{-2}$). Such amount of admixture decreases melting point in volume of the system only over an interval 0.1°C. (Authors abst. translated by A.K.)

UCHAMEYSHVILI, N. Ye., and KHITAROV, D.N., 1976, Influence of sorption on the composition of water leachates (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 177-178 (in Russian; translation by A. Kozlowski).

The sorption of ions from synthetic solutions by powders of various minerals was studied. Concentrations of ions were in ranges comparable to those in leachates from quartz, calcite, fluorite and barite. The data prove that sorption is insignificant, except for alkaline earth elements. Sorption during opening of inclusions by decrepitation was also studied. (Authors' abst.)

UGRYUMOV, A.N. and MINIGULOV, I.M., 1977, Conditions of formation of gold-bearing jasperoids in the Aldan shield (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Sib. Branch, v. II, p. 55-56 (in Russian; translation by A. Kozlowski). Authors at the Sverdlovsk Mining Inst.

Quartz-free ores and jasperoids (quartz metasomatites in carbonate rocks) formed from weakly alkaline chloride solutions at 500-400 and 350 down to 200-150°C, respectively. P during jasperoid formation was ∿0.7 kb. (Abst. by A.K.)

UNNI, C.K. and SCHILLING, J.-G., 1977, Effects of melt compositions on Cl and Br degassing from lavas during volcanism (abst.): Amer. Geophys. Union, Trans., EOS, v. 58, no. 6, p. 525-526.

We have shown that both Cl and Br (and S and Se) get a significantly degassed from Iceland-Reykjanes Ridge basalts and Hawaiian lavas erupted at water depths less than 400 m (40 bars) and under subaerial conditions. Based on solubility considerations alone, the two halogens could not have exsolved from these melts. Degassing appears to be partly controlled by the effervescence of other major volatiles like H_2O and CO_2. Further scrutiny of data reveals that both Cl and Br degassing is apparently a sensitive function of the bulk composition of the tholeiites analyzed and decreases with increasing degrees of fractionation as reflected in increasing $\Sigma FeO/\Sigma FeO+MgO$ and Na_2O/CaO in these lavas (e.g., in weight ratios; $\%Cl\ loss = -654 \times Na_2O/CaO+195$; $\%Br\ loss = -966 \times Na_2O/CaO+249$). Thus, be extrapolation, basalts with $Na_2O/CaO > 0.3$ should not lose any appreciable fraction of their original Cl and Br prior to subaerial eruptions. Hawaiian nephelinites and, within the alkali series, lavas more differentiated than the alkali olivine basalts should contain their original Cl and Br, whereas Hawaiian tholeiites only a fraction of their initial Cl and Br depending on melt composition. The close correlation of volatile Cl and Br with K or refractory LIL elements like La in melts is retained because of the regular dependence of % degassing on melt composition. We conclude that Cl and Br degassing is thus not only controlled by the abundance of major volatiles, temperature and pressure, but also by some major components (e.g., Na_2O/CaO) present in the melt. (Authors' abstract)

UVAD'YEV, M.D., 1976, Decrepitation of quartz during studies of zoning of the gold ore deposits in the region neighboring Tashkent (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept.,1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 151 (in Russian; translation by A. Kozlowski).

1. Subsurface deposits occur in Carboniferous trachyandesite-dacite volcanites. Ores are connected with quartz veins and zones of silification. (...)

3. T interval of decrepitation and the shape of the decrepigraphs are similar for the same varieties of quartz from various parts of the deposit. Beginning of decrepitation appears at a lower T at the higher levels of the ore bodies than at the deeper levels. (From the author's abstract)

VACHER, A., 1977, The life of inclusions, their birth and death: Le Monde et les Mineraux, 1977, no. 16, p. 426-428 (In French).

A review with photomicrographs. (ER)

VAI, G.B. and RICCI, L.F., 1977, Algal crusts, autochtonous and clastic gypsum in a cannibalistic evaporite basin: a case history from the Mesinian of Northern Apennines. Sediment, v. 24, p. 211-244. Authors at Ist. Geol. e Paleon. dell'Univ., via Zamboni 67, I-40127 Bologna, Italy.

Solid inclusions in gypsum crystals are described, and their significance is discussed. (Piero Lattanzi)

VAKHRUSHEV, V.A., MAKAGON, V., SINITSKAYA, E.K., and TATARINOV, A.A., 1977, Amethyst mineralization in iron-ore deposits of the Siberian platform: Ezhegodnik Sibirsk Inst. Geokhim. (Yearbook Siberian Inst. Geochemistry) for 1976, p. 149-152 (publ. 1977; in Russian with English abstracts).

Amethyst mineralization is found in skarn-magnetite deposits on the Siberian platform. Crystals of amethyst contain solid inclusions of syngenetic pyrite and bitumens. Thermometric data show that amethyst crystals were formed from hydrothermal high-temperature solutions (240-420°C). (Authors' abstract)

VALERA, R., 1974, Notes on the morphology, thermometry and composition of fluid inclusions in fluorite from Sardinia: Rendiconti Soc. It. Mineral. Petrol.; v. 30, p. 459-480 (in Italian). Author at the Istituto di Giacimenti Minerari, Facoltà d'Ingegneria dell' Università, Cagliari, Italy.

During our researches on fluorspar mineralizations of Sardinia, particular attention has been devoted to the analysis of fluid inclusions. This study has shown to be a useful tool in solving correlation problems, giving data and helping in genetic interpretation.

According to our observations, Sardinian fluorspar mineralizations can be subdivided schematically into three main groups, i.e.:

I Group: Rare negative crystals, homogenization temperatures between 80° and 110°C, two-phase composition.

II Group: Uncommon negative crystals, homogenization temperatures between 115° and 150°C, two-phase composition.

III Group: Common negative crystals, homogenization temperatures between 155° and 400°C, polyphase composition.

(Author's abstract)

Note by Piero Lattanzi: Composition data are limited to the number of phases present, and to the identification of some daughter minerals (halite, hematite?, fluorite?).

VASILENKO, V.N., 1976, Peculiarities of formation of copper-nickel ore mineralization of the SW of the Russian platform (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 91 (in Russian; translation by A. Kozlowski).

Ore deposits were studied in the SE Voronezh crystalline massif, Middle Predneprov'ie and part of the junction of Voronezh massif with the Ukrainian shield. Cu-Ni ores of the liquation type (610-590°C) formed during the final stage of the evolution of ultrabasites and they occur only in individual samples from the N Voronezh massif. Main part of the ores formed during the late hydrothermal-metasomatic stage by regeneration of the magmatic ores. Common granitization removes Ni from silicates and precipitates it in the altered basic rocks at 500-550°C. (Author's abst.)

VASILENKO, V.N. and KURSHEV, S.A., 1977, Certain physico-chemical peculiarities of formation of native gold in the NW Caucasus, S regions of Siberia, and in the Far East (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council On Ore Formation, Sib. Branch, v. II, p. 16-17 (in Russian; translation by A. Kozlowski). Authors at the Rostov Univ.

In the copper-pyrite deposits of the NW Caucasus gold mineralization occurs in the latest low T_H (80-130°C) associations. A second peak is also noted in the decrepigraphs at 220-240°C, presumably connected with bornite origin. Thermovacuum decrepitation of gold yielded moreover a weak peak at 400°C. Presumably the low T gold was redeposited. By water leachates, solutions were found to be of SO_4-HCO_3 composition, pH 10, Eh -0.6 volt. Transport of gold was as sulfide complexes.

Gold-bearing quartz in deposits from Kuznetskiy Alatau crystallized at 260-280°C, more rarely up to 300-320°C. Late gold (60-120°C) filled cracks in quartz; more rarely T of gold precipitation was 160-220°C. Association quartz + sulfides yielded higher T_D 300-340°C; quartz-bismuth mineralization crystallized at 200-260°C, but gold at 80-100°C.

Quartz-gold-sulfide veins from W. Tuva formed at 180-280°C. The decrepigraphs of gold-bearing and barren quartz permit detecting the gold ore mineralization. Important inclusions are of CO_2 and water-colloid types.

Gold-ore quartz from Karyakskoe Hills and Siberia yielded mean T_H and T_D 170°C, P 580 atm (by the method of Naumov and Malinin). Quartz from Pikul'neyskiy crest formed at 240-260°C; gold in this association--70-110°C.

Algerian gold ore deposits yielded T_H 200-360°C for quartz and 120-200°C (maximum commercial ores 160-180°C) for gold. In general, gold in gold-quartz formation crystallized in two intervals: 80-130 and 160-200°C. (From the authors' abst.)

VASIL'EV, B.D., VASILENKO, V.N., DRUZHKOV, V.P., BOYARKO, G.Yu. and ZYKOV, Yu.Ye., 1977, Contribution to conditions of precipitation of gold in deposits of the eastern slope of Kuznetskiy Alatau and Western Tuva (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council On Ore Formation, Sib. Branch, v. II, p. 18-19 (in Russian; translation by A. Kozlowski). First author at Tomsk Polytechnical Inst. USSR

Gold mineralization in E. Kuznetskiy Alatau and W. Tuva occurs in quartz veins, stockworks and vein zones. Quartz bears mainly L, rarely G inclusions (i.e., L>G, rarely G>L?-A.K.). Inside L inclusions, rims of crystalline gel-like substance occur, forming encrustations on the cavity. Inside G inclusion crystals appear to have formed seemingly by sublimation from G phase. Gold from Kommunarovskiy stockwork in Kuznetskiy Alatau decrepitates, releasing G, at 20-60 and 80-120°C; paragenetic quartz has additional T_D 260-280°C. Quartz from commercial Au-Bi mineralization has two T_D peaks: 80-100 and 200-260°C; however, there occur also quartz-gold veins with higher T_D: 160-180 and 300-320°C. Non-commercial late galena-sphalerite-quartz association yielded T_D 220-280 and 300-340°C.

Quartz from gold deposits of W. Tuva may be divided into 3 groups:

1) paragenetic with gold of low quality, T_D 80-100 and 160-200°C; 2) paragenetic with gold of high quality, T_D 180-200 and 220-280°C; 3) with T_D 60-80, 220-260 and 280-300°C. Chalcedonic quartz from various Tuva deposits has T_D consisting of 4 peaks: 100-120, 180-200, 380-420 (sic; either a misprint or the fourth T_D interval omitted--A.K.). Thus, in gold deposits of E. Kuznetskiy Alatau and W. Tuva main quartz crystallization was at 220-280°C, and gold precipitated at two intervals: 80-120 and 160-200°C. All T_D were obtained by thermovacuum method, measuring release of gas. (From the authors' abst.)

VILLAS, R.N. and NORTON, D., 1977, Irreversible mass transfer between circulating hydrothermal fluids and the Mayflower stock: Economic Geology, v. 72, p. 1471-1504.

Heat and mass transport processes related to the Mayflower stock in the Park City district, Utah, have been simulated using calculations based on geological observations and numerical methods which approximate convective and conductive heat transfer in permeable media.

This analysis of the Mayflower hydrothermal system suggests that the original igneous minerals were altered by acid-sulfate, Na-K-rich solutions at moderate temperatures, <400°C, and pressures, $\leq$ 1 kb. These solutions added large masses of Mg, K, S, and C to the stock and, concomitantly, altered the original igneous minerals. In order to account for the observed masses and compositions of alteration products, fluid fluxes on the order of 10^{-7} g/cm^{2}s are required for at least 2x10^5 years. This large mass ($\sim 10^{16}$ g/km^2 of area) of hydrothermal fluid was evidently derived from a variety of environments within and around the stock. (From the authors' abstract)

VILOR, N.V., GANTIMUROVA, T.P., KONOVALOV, I.V., SHKARUPA, T.A. and SHKANDRIY, B.O., 1977, Composition of gases in quartz veins from the W. part of Baikal-Patoma Highland: Akad. Nauk SSSR, Doklady, v. 232, no. 5, p. 1175-1178 (in Russian). Authors at Inst. of the Earth's Crust of the Siberian Branch of the Acad. Sci. USSR, Irkutsk.

Most quartz veins, occurring in metamorphic and igneous rocks, bear volatiles of essentially CO_2-H_2O composition; only in some veins connected with small granite stocks may one observe higher contents of H_2 and CH_4. Veins from metamorphic rock zones rich in biotite, garnet and staurolite have higher amount of CO in total gases. Veins rich in sulfide, especially molybdenite, associated with albitites, have a low content of CO. Analyses of gases were performed by gas chromatography method, after release of gases from quartz (T_D = 260°C) in temperature range 250-800°C, in He medium. (Abst. by A.K.)

VLADIMIROV, V.G., MANUCHARYANTS, B.O., and PRUSHINSKAYA, E.Ya, 1976, Conditions of formation of the gold and gold-antimony ore mineralization in NE Yakutia (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 185 (in Russian; translation by A. Kozlowski).

The mineralization belongs to two independent types: low-sulfide gold-quartz and gold-antimony. Gold-bearing quartz veins formed at 280-220°C. The veins were metamorphosed at 380-340°C under the action of granite intrusions. Metacrystalline quartz of the commercial gold-antimony mineral association, syngenetic with antimonite, formed at

235-170°C. Native antimony crystallized at T > 320-250°C. Gold and gold-antimony quartz veins formed from hydrotherms rich in CO_2 (400-600 g/1000g H_2O) under P 1600-650atm. In G phase CH_4 and N_2 were found. Ore-forming solutions had Eh from -0.5 to -0.8 volt. When pH was constant, changes Eh did not exceed 0.2 volt. (Authors' abst.)

VOCHTEN, R., ESMANS, E. and VERMEIRSCH, W., 1977, Study of the solid and gaseous inclusions in the fluorites from Wölsendorf (Bavaria, F.R. of Germany) and Margnac (Haute Vienne, France) by microprobe and mass spectrometry: Chemical Geology, v. 20, p. 253-263. First author at Laboratorium voor Technische en Fysische Mineralogie, Universiteit Antwerpen, Antwerp, Belgium.

In order to investigate the nature of the enclosed gases in a dark-blue variety of fluorite, a comparative study has been made of fluorite specimens from Wölsendorf (Bavaria, F.R. of Germany) and Margnac (Haute Vienne, France), using a special technique developed to analyse the expelled gases after crushing the specimens under vacuum. The major components of the enclosed gas phase are identified by high-resolution mass spectrometry as SO_2, SOF_2, S_2F_2, H_2S and Ar.

The results obtained do not confirm the conclusions of some authors, indicating only the presence of free fluorine and O_3. Most of the solid inclusions are localized along cleavage planes. The radioactive inclusions were surrounded by well-pronounced radiation zones.

The solid inclusions were investigated for heavy metals by means of the microprobe technique. U, Th, Pb and traces of other heavy metals were found. (Authors' abstract)

VOCHTEN, R.F.C. and GEYS, J.F., 1977, Solid inclusions in a fluorite variety from the Wölsendorfer Range (Bavaria, Fed. Rep. Germany): Schweiz. mineral. petrogr. Mitt., v. 57, p. 23-30 (in English). First author at Laboratory for Technical Mineralogy, State University Center, Middelheimlaan 1, B-2020 Antwerpen, Belgium.

Solid inclusions in the dark purple variety of fluorite, commonly known as "Stink-fluss", mainly consist of U and Fe compounds. These inclusions are concentrated along cleavage planes in the fluorite. They are often surrounded by halos and radiation belts, whose diameters correspond with the ranges of α-particles, originating during the decay of uranium. (Authors' abstract)

VOLKOV, V.M., 1976, Conditions of formation of the gold ore deposits in central Transbaikalia (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 187 (in Russian; translation by A. Kozlowski).

Vein quartz and near-ore altered rocks were studied at the Lyubavinskoe deposit. Water leachates showed the following ions: Na, K, Ca, Cl, SO_4, HCO_3, NH_4, Fe, and F. In altered rocks solutions are of SO_4-HCO_3 composition with a low content of Cl and F. Cl, HCO_3, SO_4 contents increase and F decreases in the deeper parts of metasomatites, Na/K ratio changes from 2.3:1 to 1:5.3. Ore-bearing quartz has a decreasing Cl and Na content from early to late generations, and increasing SO_4 and K; maximum SO_4 concentrations appeared during precipitation of minerals of the gold-polymetallic stage. Content of HCO_3 increases and NH_4 decreases toward the end of the ore-forming process. Following intervals of T_D and T_H were distinguised in vein quartz: 60-180°C (carbonate stage); 200-320°C (gold-polymetallic stage); 320-420°C (main man of quartz and early sulfides). Author's abst.)

VOROB'YEV, Ye.I., 1976, Prospecting for salts on the basis of inclusions in volcanic pipes, (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 144-145 (in Russian; translation by A. Kozlowski).

Salt-bearing beds of the Siberian platform are cut by volcanic pipes associated with essentially calcite hydrothermal deposits. Inclusions in calcites from magnetite ores of deposits: Korshunovskoe, Rudnogorskoe, Neryundinskoe, Oktiabr'skoe, Krasnoyarovskoe and Kopaevskoe, are three-phase (solution-melt) of chloride composition with total salts up to 600 g/1. Same inclusions found also in calcite of kimberlite pipe "Udachnaya." These inclusions presumably are connected with deep salt-bearing beds, thus constitute a prospecting tool for salt deposits. This assumption was confirmed by borehole in the Kansko-Taseevskaya rift zone. (Author's abst.)

VOROB'YEV, Ye.I. & REZNITSKY, L.Z., 1977, P-T conditions of formation of phlogopite veins in Sludyanka (South-West Cisbaikalia): Ezhegodnik Sibirsk Inst. Geokhim. (Yearbook Siberian Inst. Geochemistry) for 1976, p. 135-137 (publ. 1977; in Russian with English abstracts).

Studying fluid inclusions in minerals of phlogopite-bearing veins in Sludyanka and using the Graf-Goldsmith geothermometer permits an evaluation of the thermobaric regime of formation.

Vein formation in Sludyanka occurred under unstable P-T conditions. Their changes are not a continuous reduction of the given parameters, but have a periodic character. Thus, they are of a rather high temperature (avg. 580°C) and originated at a sharp fall in pressure of 0.3-0.2kb. (Authors' abstract)

VORTSEPNEV, V.V. and MEL'NIKOV, F.P., 1977, On magmatogenic origin of the disseminated ores of the Talnakh copper-nickel deposit (abst.) <u>in</u> Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. I, p. 37-38 (in Russian; translation by A. Kozlowski). Authors at the Moscow State Univ.

P melt inclusions in olivine from picritic gabbro-dolerite (5-70 μm long) usually occur in the central part of the grain. Inclusions are filled by silicate and sulfide melts with ratio varying over wide range. S melt inclusions in olivine contain silicate melt and up to 10 vol.% of G phase. In reflected light sulfide melt from P inclusions was identified as similar to sulfide substance from ores in the host rocks and consists of pyrrhotite and chalcopyrite. Up to T 900°C changes of inclusion filling in olivines were not observed. T_H of P melt inclusions in pyroxene--1100-1120°C, and in plagioclase--1100-1150°C. (Abst. by A.K.)

VOYTKEVICH, G.V., ALEKSEENKO, V.A., KHOVANSKIY, A.D. and KLEVTSOV, S.F., 1977, Temperature peculiarities of formation of the Tekeli group of deposits in the Dzhungarian Alatau (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977); Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. II, p. 65-66 (in Russian).

The stratiform Tekeli deposits are connected with carbonate-terrigenous rocks and their ores consist of pyrite, galena and sphalerite. Ore bodies have lenticular shape. By vacuum decrepitometry (samples: 426 wall-rocks, 98 ores, 62 monomineralic samples of pyrites, sphalerite, galena, quartz and calcite) the following T_D intervals were obtained (°C): 1) 100-175, 2) 220-280, 3) 300-380 and 4) 400-480. Most of the samples yielded T 1) and 4). The T data suggest polygenic origin of the ores, including a sedimentary stage. (Abst. by A.K.)

VOYTOV, G.I., 1977, Isotopic characteristics of the naturally-escaping gases in Khibiny: Akad. Nauk SSSR Doklady, v. 236 no. 4, p. 975-977 (in Russian). Author at the Moscow Geol.-Prospect. Inst.

Pertinent to composition of G phase in fluid inclusions; includes eight chemical analyses of G (H_2, He, N_2, CO_2, CH_4, C_2H_6, C_2H_4, C_3H_8, C_3H_6, C_4H_8, $C_{>4}$) and data on $\delta^{13}C$, δD, $^3He/^4He$, isotopes of Ar and Xe. (A.K.)

VOZNYAK, D.K., 1977, Discussion on information of national subcommittees, in: IGC-Carpatho-Balkan Geological Association, Materials of Commission of Mineralogy and Geochemistry, no. 3, p. 34-37 (in Russian). Author at Inst. Geochem. and Physics of Minerals of the Acad. Sci. Ukrainian SSR, Kiev, USSR.

Euhedral quartz crystals occurring in sandstones of the Carpathian flysch, so called "Marmarosh diamonds," contain, in water-gaseous inclusions, petroleum-like liquid and gases: CH_4(67.9-94.9%), N_2(23.0-3.5%), CO_2(2.0-1.6%) H_2O(7.1-0.0%); H_2, CO and Ar are absent. Inclusions believed earlier as being essentially gaseous (L_1 2 to 5%) consist of methane of high density, both L and G. T_H (partial) -112 to -68°C in L and -68 to -65°C in G. Cryometric studies suggest that the methane solution consists of several components; at room T those inclusions bear 2-5% of L hydrocarbons with blue UV luminescence. Tentative calculations of P are 280 to 1000 bar. Also naturally decrepitated inclusions were found. (Abst. by A.K.)

VOZNYAK, D.K. and GALABURDA, Yu.A., 1977, Stage for cryometric research of inclusions in minerals: Mineralog. Sbornik, v. 31, no. 1, p. 63-65 (in Russian).

A description of a stage for research on liquid inclusions in minerals from room temperature to -192°C is given. (Authors' abstract)

VOZNYAK, D.K. and KALYUZHNYI,V.A., 1977, Use of the breaking of inclusions to reconstruct the PT-conditions of mineral formation (for example of quartz from Volyn pegmatites): Mineralog. Sborn., v. 31, no. 2, p. 22-30 (in Russian).

The relative time of coming up of the high-temperature solutions (sic.) and breaking of the fluid inclusions in pegmatites was determined by studying inclusions of different age in quartz and topaz. Zones of different light-refraction in topaz around liquid-gas inclusions corroborate the fact of short-time rise of the temperature of the mineral-forming fluid. (Authors' abstract)

VOZNYAK, D.K., KOVAL', V.B. and PODLESSKIY, V.I., 1977, Genesis of reticulate quartz as indicated by experimental data and fluid inclusion studies (exemplified by Volyn pegmatites): Akad. Nauk SSSR Doklady, v. 236 no. 4, p. 961-964 (in Russian). Authors at Inst. Geochem. Phys. Minerals Acad. Sci. Ukrainian SSR, Kiev.

Experiments proved: 1) during rapid cooling of quartz, reticulate* fractures form only in a thin layer (about 2 mm) at the surface of crystal due to the very low thermal conductivity of quartz; 2) reticulate fractures may form also on rapid cooling of quartz at $T<T$ of high-low quartz inversion. Authors propose that reticulate fractures in whole volume of big quartz crystals may form either during inversion low → high quartz (sic.) or on extremely slow cooling and with possible overcooled high quartz then rapidly inversed into low quartz. Healed reticulate fractures in natural quartz bear, near the crystal surface, G/L inclusions with entrapped chips of minerals, "sucked" into fractures, but the inner part of quartz crystal bear the same G/L inclusions without chips of minerals, thus fracturing should be an one-event process. (Abst. by A.K.)(*"Reticulate" quartz = "honeycomb" quartz; ER)

VYNAR, O.N. and REMESHILO, B.G., 1976, Post-magmatic fluids of granites and pegmatites from the Kirovograd-Zhitomir complex of the Ukranian shield (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 124 (in Russian; translation by A. Kozlowski).

Inclusions were studied in porphyric and even-grained granites, and pegmatites from the western and central parts of Ukranian shield. Endogene solutions in inclusions (by water leachate method) bear total salts up to 206 ml*/kg in granites, from 10.2-32.0 (Zhitomir complex) to 20.0-65.0 ml*/kg (Kirovograd complex) for pegmatites. (In inclusions, A.K.) in granites Na/K 0.8-1.2; in pegmatites 4.6-4.1. In solutions in inclusions from pegmatites from the western part of Ukranian shield Ca concentration is 2.6-7.7%, Mg - 0.7-6.9%. Fluids from granites are of HCO_3 type with significant amount of F (up to 5%); from pegmatites of HCO_3-Cl type with F content 0.4-2%. Gases consist of CO_2 (57-89 vol. %), CH_4 and N_2; CH_4/N_2 is roughly constant, but it decreases in pegmatites of the central Ukranian shield. The lowest T postmagmatic solutions from quartz and granites are of approximately similar range of T_H 365-200°C. (Authors' abst.).

* Probably a misprint - should be mg? (A.K.)

WALEŃCZAK, Zygmunt, 1977a, Optical ultramicroscopic observations of vesicles in opaque minerals of the Pultusk Meteorite (Poland): Bull. Acad. Polonaise des Sciences, Serie des Sciences de la Terre, v. 25, p. 15-18 (in English).

The usefulness of optical ultramicroscopy for the defectoscopic tracing of fine-dispersive phases in opaque minerals is proved. Vesicles of submicron size exist in kamacite, troilite and in other opaque minerals occurring in the Pultusk meteorite. The vacuoles are filled with gaseous or liquid substance. The number of vacuoles in one cubic cm is 10^9 to 10^{14}. Their presence should be regarded as a peculiar feature of planetary matter. Such fine-dispersive systems of gaseous (or liquid) phase do not disappear in the processes of differentiation of the chemical and mineral composition that take place inside planetary bodies. They cannot be removed in laboratory investigations by means of melting, or even by the partial evaporation of meteoritic substance. (sic.) (Author's abstract).

WALEŃCZAK, Zygmunt, 1977b, Liquid phase vesicles in the Pultusk Meteorite: Bull. Acad. Polonaise des Sciences, Série des Sciences de la Terre, v. 25, no. 1, p. 19-22 (in English).

In the Pultusk meteorite there are inclusions filled with a liquid phase in different quantities. Their size is up to 3 µm and some of them are almost completely filled with liquid CO_2. A fine-dispersive liquid (gaseous) phase is present in the form of submicroscopic vesicles in all minerals of the meteorite. The vesicles, which occur in quantities of $n \cdot 10^5$ to $n \cdot 10^8$ per 1 cm^2, are filled with gaseous and liquid vacuoles. The vacuoles shift inside the vesicles due to molecular movements. The fine-dispersive vesicle-containing systems form in the meteoritic matter a specific defect spot system, which does not disappear during the processes of differentiation of chemical composition. (sic.) (Author's abstract).

WALLACE, R.C., 1977, Anorthoclase-calcite rodding within a kaersutite xenocryst from the Kakanui Mineral Breccia, New Zealand: Amer. Min., v. 62, p. 1038-1041. Author at Geol. Dept., Otago Univ., Dunedin, New Zealand.

Unusual white rods of anorthoclase and calcite are described from a kaersutite xenocryst from the Kakanui mineral breccia, New Zealand. The calcite and anorthoclase are interpreted as secondary infillings of parallel tubicles in the kaersutite. These tubicles are thought to be large elongate fluid inclusions that resulted from the growth of gaseous "bubbles" on the crystal contemporaneously with crystal growth. (Author's abstract)

WALTER, J. and ALTHAUS, E., 1976, Fluid inclusions in apatite crystals from carbonatites: Fortsch. Min., v. 54, Beiheft 1, p. 101 (in German).

See Althaus and Walter, 1976, Fluid Inclusion Research -- Proceedings of COFFI v. 9, 1976, p. 2. Abstract also published in Jour. Geol. Soc. London, v. 134, 1977, p. 387 (Althaus & Walter). (ER)

WAMPLER, J.M., 1977, Release of argon by chemical reaction: an alternative method for incremental release of argon for isotopic analysis (abst.): Amer. Geophys. Union, Trans., EOS, v. 58, no. 6, p. 537.

WERNER, M.L., ZALEWSKI, S.A. and GATES, T.M., 1977, Hydrothermal minerals in the northern Newark Basin (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 3, p. 328-329.

Fault and fracture-filling mineralization from the northern end of the Newark Basin consists of discrete syn- and post-tectonic assemblages. The syn-tectonic assemblage (quartz + calcite + chlorite + stilbite) is related to cooling-attendant albitization of the Palisades diabase and Watchung basalts and is temporally and spatially related to the igneous body in which it occurs. Fluid inclusion homogenization temperatures of this assemblage commonly exceed 150°C. By contrast, homogenization temperatures of the post-tectonic assemblage (analcime + datolite + apophyllite + calcite + chlorite + stilbite) are generally less than 150°C. K/Ar dates of the post-tectonic zeolites suggest that they formed during a Late Cretaceous hydrothermal event. (Authors' abstract)

WESTRICH, H., 1977, Fluoride-hydroxyl exchange equilibria in several hydrous minerals (abst.): Amer. Geophys. Union Trans., EOS, v. 58, p. 1243.

WHITNEY, J.A., 1977, A synthetic model for vapor generation in tonalite magmas and its economic ramifications: Economic Geology, v. 72, p. 686-690.

The evolution of an aqueous vapor phase from a simplified tonalite (quartz diorite) magma during intrusion and crystallization has been quantitatively modeled for a stock of square cross-section using the procedure developed for a quartz monzonite composition by Whitney (1975b). Vapor generation from tonalitic compositions may continue from a significant portion of the body to greater depths than was encountered in the quartz monzonite model. In addition, higher initial temperatures in tonalites may allow intrusion and vapor generation at shallower depths than previously determined. This model suggests vapor fractionation may be a viable method of separating economic elements from tonalitic magmas over a greater pressure and depth range than was found for quartz monzonite compositions. (Author's abstract)

WILKINS, Ronald W.T., 1977, Fluid inclusion assemblages of the stratiform Broken Hill ore deposit, New South Wales, Australia: Science, v. 198, p. 185-187. Author at CSIRO Division of Mineralogy, North Ryde, New South Wales, Australia 2113.

Minerals of the Broken Hill lode in New South Wales, Australia, have a rich assemblage of fluid inclusions. Most typically they contain a high-salinity aqueous liquid and a high-density carbon dioxide and methane gas. Northerly trending shear zones in the area are characterized by a distinct assemblage of inclusions. The inclusions provide a record of the sequence of metamorphic fluids since the period of high-grade metamorphism. Inclusions from the period of ore formation have been eliminated by repeated deformation and recrystallization.

WILKINS, R.W.T. and BARKAS, J., 1977, Fluid inclusions, deformation and recrystallization in quartz-bearing tectonites (abst.): Abstracts of Second Australian Geological Convention, Monash Univ., 2-4 Feb., 1977, p. 88 (National Library of Australia card number and ISBN- 0 86910 072 6). Authors at CSIRO Division of Mineralogy, North Ryde and Dept. of Geology and Geophysics, University of Sydney.

In moderately deformed quartz-bearing tectonites, small (<10 μm) fluid inclusions are commonly associated with boundaries of deformation bands and lamellae. During syntectonic recrystallization such inclusions are almost entirely eliminated. The sweeping of solid, liquid and gaseous inclusions by migrating grain boundaries is well documented in the metallurgical literature and no doubt the process also occurs during the recrystallization of oxides and silicates. However, as syntectonic recrystallization of quartz appears to proceed by growth of suitably oriented subgrains, it is also necessary to explain how fluid inclusions are eliminated from the cores of developing grains.

It is commonly observed that, immediately in advance of a recrystallization front, stringers of inclusions develop along subgrain boundaries. We propose that voids develop along subgrain boundaries by a process similar to grain boundary sliding, and fluid diffuses from the fluid inclusions in the interior of the subgrains to the subgrain boundary region through the arrays of dislocations which accompany grain interior slip. The new fluid inclusions which accumulate in the subgrain boundary region eventually coalesce into stringers. The intimate association of fluid inclusions with deformation and recrystallization features in quartz-bearing tectonites raises the question of whether the inclusions play an active or passive role in these processes. (Authors' abstract)

WILKINS, R.W.T. and SVERJENSKY, D.A., 1977, The role of fluid inclusions in the exsolution of clinopyroxene in bustamite from Broken Hill, New South Wales, Australia: Amer. Min., v. 62, p. 465-474. First author at CSIRO Div. Mineral., North Ryde, Australia 2113.

Rods and laths of clinopyroxene apparently exsolved in host bustamite are described from the lode rocks of Broken Hill, New South Wales, Australia. The rods are commonly oriented with c clinopyroxene || b bustamite. They are associated with fluid inclusions which may be in contact with the clinopyroxene rods (type A) or not (type B).

Freezing-point depressions recorded for the inclusion fluids range from 3° to 50°C. Although there is a region of overlap, type A inclusion fluids have salinities in the lower part of the range, whereas type B inclusions contain fluids in the higher part of the range. In bustamite samples containing only moderate numbers of clinopyroxene rods where relationships can be clearly observed, the rods are seen to be arranged within curved sheets localized along healed former fractures. Where fluid inclusions of both types are present within any one sheet, they have approximately the same salinity. Homogenization temperatures fall in the range 240-360°C, but the trapping temperatures are unknown owing to uncertain corrections for pressure.

The clinopyroxene rods are believed to have originated by a mechanism of exsolution, in which fluid inclusions act as centres of nucleation and growth in the high-temperature solid-solution phase as it cools below solvus temperatures. The rods propagate either from the solid or liquid inclusion-terminated end, but the preferred mechanism is by solution growth, the fluid inclusion advancing ahead of the rod through the host grain. (Authors' abstract)

WILLIAMS, D.E. and ROGERS, P.S., 1977, Partition equilibria of zinc and iron in high-temperature two-liquid chloride-oxide systems: Inst. Mining and Metal, Trans., v. 86, Sect. C, p. C157-C159.

WILLIAMS, T.L. and TREVENA, D.H., 1977, Improved and extended theory of the Berthelot tube method of studying liquids under tensile stress: Nature, v. 265, p. 612-613.

WILLMS, J., 1977, Fluorite deposits in southern Norway (abst.): Inst.

Mining and Met., Trans., Sect B, v. 86, p. B160.

A preliminary report of fluorite deposits in the Telemark and Kongsberg areas presents a general picture of the geological environment of these deposits. Structural features, petrological data and age relationships are regarded as evidence of Precambrian genesis of the Telemark deposits and Precambrian emplacement of the Kongsberg deposits, each deposit being connected with magmatism of the same age as the deposit itself. Results of microthermometry show that lower temperatures and salinities obtained during the deposition of the Telemark deposits than for the Kongsberg deposits. (Author's abstract)

WILSON, J.C., 1977, Ore fluid-magma relationships in a vesicular quartz latite porphyry dike at Bingham, Utah: Econ. Geol., v. 73, p. 1287-1307. Author at The Anaconda Co., 555 17th St., Denver, Colo. 80202.

An isolated 20-m-long, quartz latite porphyry dike with unusual sulfide-bearing vesicles is described. The dike occurs within the Bingham porphyry copper orebody and contains xenoliths of previously veined, altered, fractured, and mineralized monzonite. The dike is massive, highly porous but impermeable. It contains 0.5 percent Cu as chalcopyrite in vesicles which range in size from microscopic to 15 cm in diameter. The dike is zoned, with the brown, highly vesicular core zone and a late aplitic phase containing more K_2O, MgO, Cu, S, and porosity and less Fe_2O_3, CaO, and Na_2O than the green rock which forms the border of the dike. The dike is composed of quartz, altered plagioclase, biotite, and very large orthoclase phenocrysts in a groundmass of orthoclase, quartz, biotite, and vesicles. Crystallization of the groundmass is believed to have produced a strong permeability contrast with the highly fractured monzonite host rocks and resulted in a closed chemical system in the center of the dike. The proportions of minerals and void space in the vesicles and fluid inclusion data are used to calculate the composition of the fluid which filled the vesicles. The composition is: $CuFeS_2$ 9 wt. %; SiO_2 8; NaCl 21; KCl 11; (Na,K)F 11; and H_2O 40. These constituents comprised about 15 percent of the magma just before the groundmass froze. Fluid inclusion studies indicate the quartz in the vesicles crystallized from a boiling fluid at 480°C. Other authors calculate the confining pressure to be less than 800 bars. The magma which formed this dike was probably subaluminous, rich in halogens, alkalies, and water and probably remained magmatic in its behavior to temperatures well below 600°C. The consistency of these conclusions with published experimental results is discussed. (Author's abstract)

WOLERY, T.J. and SLEEP, N.H., 1976, Hydrothermal circulation and geochemical flux at mid-ocean ridges: Jour. Geol., v. 84, p. 249-275.

WOOD, M.I. and HESS, P.C., 1977, The role of Al_2O_3 in immiscible silicate melts (abst.): Amer. Geophys. Union, Trans., EOS, v. 58, no. 6, p. 520.

WYLLIE, P.J., 1977a, Peridotite-CO_2-H_2O, and carbonatitic liquids in the upper asthenosphere: Nature, v. 266, p. 45-47.

WYLLIE, P.J., 1977b, The effect of H_2O and CO_2 on planetary mantles (abst.): Papers presented 20-23 Sept. 1977, Basaltic Volcanism Study Project, Lunar Sci. Inst., Houston. Author at Univ. of Chicago, Dept. Geoph. Sci., Chicago, IL 60637.

WYLLIE, P.J., 1977c, Mantle fluid compositions buffered by carbonates in peridotite-CO_2-H_2O: Jour. Geol., v. 85, p. 187-207.

The compositions of mantle magmas are strongly influenced by the distribution of carbonate, amphibole and phlogopite in the peridotite, as indicated by estimates of their maximum stability ranges on the solidus for peridotite-H_2O-CO_2. (From the authors' abstract)

YAJIMA, Junkichi, 1977, New occurrence of the tin minerals from the Toyoha mine, Hokkaido, Japan - Studies on the ore minerals from the Toyoha mine. Part 1: Mining Geology (Japan) v. 27, p. 23-30. (in Japanese with English abstract).

The formation temperatures estimated by fluid inclusion study of quartz associated with cassiterite, of coarse-grained sphalerite and of banded quartz are in the range of 241°-230°C, 218°-215° and 202°-109°C respectively. (From the author's abstract).

YAKOVLEV, Ya.V. and FLEROV, B.L., 1977, Temperature of formation of the mineral parageneses of the tin ore deposits in Yakutia (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v., I, p. 145-146 (in Russian; translation by A. Kozlowski). Authors at the Geol. Inst. of the Yakutian Division of the Siberian Branch Acad. Sci. USSR.

Tin ore deposits of Yakutia formed over a wide T range, from 505 to 110°C (T_H), but the main mass of minerals precipitated at 400-300°C. T_H of fluid inclusions in cassiterite was 440-210°C, including 440-350°C for syngenetic pegmatites and tin-bearing greisens, 390-305°C for cassiterite-quartz veins, 375-210°C for cassiterite-sulfide veins, 180-140°C for galena-sphalerite ores with sulfosalts, 220°C in skarns at Chybagalakh. Wolframite formed at 325-310°C, muscovite at 365-290°C, tourmaline at 370-340°C. Solutions were hydrothermal; only in certain parts of the deposits were boiling and pneumatolytic inclusions found. (Abs. by A.K.)

YANSHIN, A.L., and ZHARKOV, M.A., (eds.), 1977, Problems of salt deposition, vols. 1 & 2: Novosibirsk, "Nauka" Pub. House, 318 and 328 pp. (in Russian).

This book contains 111 short papers submitted to the All-Union Meeting "Physico-chemical and paleogeographical problems of salt accumulation and formation of deposits of potassium salts", June 3-6, 1974, in Novosibirsk. Vol. 1 contains parts I-VII, and volume II contains parts VIII-XII. (A.K.)

I. Regularities of spatial and age discrimination of the salt-bearing series and paleogeographical problems of salt deposition.

II. Physico-chemical problems of halogenesis.

III. Underground waters of salt-accumulating basins.

IV. Perspectives of development of the raw materials for potash fertilizer and salt industry of the USSR.

V. Recent salt accumulation in the USSR.

VI. Geology, conditions of formation, and raw materials of the Neogene salt-bearing sediments of the USSR.

VII. Geology, conditions of origin and raw materials of the Mesozoic salt-bearing deposits in the USSR.

VIII. Geology, formation conditions and raw materials of the Permian salt-bearing deposits in the USSR.

IX. Geology, conditions of formation and raw materials of the Devonian salt-bearing deposits in the USSR.

X. Geology, conditions of formation and raw materials of the Cambrian salt-bearing deposits in the USSR.

XI. Salt-bearing basins and deposits of potassium salts in other countries.

XII. Salt tectonics and occurrence of oil and gas in basins of salt accumulation.

YAROSHCHUK, M.A., 1977, Alteration of the composition of rocks in the Krivorozh'e ferrosiliceous formation as a cause of the development of ore-forming processes during metamorphism: Litologiya i Poleznye Iskopaemye, no. 2, p. 97-106 (in Russian; translated in Lithology and Mineral Resources, v. 12, no. 2, 1977, pp. 203-210; Plenum Pub. Co.).

Involves a discussion of the H_2O/CO_2 ratios of the fluids during metamorphism (ER).

YASHCHENKO, N.Ya., KHOVANSKIY, A.D., FAYZULLIN, E.S. and KORT, V.A., 1977, Temperature conditions of formation of the pyrite-polymetallic deposits Maykain, Aleksandrovskoe, Suvenir (Central Karakhstan) (abst.), in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Sib. Branch, v. II, p. 105-106 (in Russian; translation by A. Kozlowski). Authors at Central-Karakhstan Geol. Office of Ministry Geol. of Karakh SSR.

116 samples of pyrite ores, 15 samples of polymetallic ores and 30 samples of pure pyrite, galena, chalcopyrite, quartz, barite and hematite were studied by means of vacuum decrepitometry. At the deposit Maykain early pyrite ores yielded T_D 50-200°C; later quartz 150-165°C, hematite 140-165°C, chalcopyrite 130-175°C, barite 125-145°C, pyrite from quartz-muscovite metasomatics 225-300°C, etc. At Aleksandrovskoe deposit T_D of pyrite-polymetallic ore 310-360°C, chalcopyrite 265-290°C and 300-330°C, galena 270-300°C and 300-335°C and at Suvenir deposit T_D of pyrite 180-205°C and 235-260°C, quartz, 235-260°C. "Decrepitation" effects at T 320-720°C for pyrite and chalcopyrite are at the same T as exothermic effects of the DTA curves. (Abst. by A.K.)

YASINSKAYA, A.A., 1976, On classification of inclusions in meteorites and lunar rocks (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 126-127 (in Russian; translation by A. Kozlowski).

Inclusions in olivine, pyroxene and plagioclase were studied. Following shapes of inclusions were distinguished: irregular and flat oval; oval and spherical (globules); negative crystals; tubular;

myrmekite and dendritic; necked down, of complex shape. Phase filling is as follows: 1. Solidified inclusions of melts, a) P (normal): amorphous glass, recrystallized glass, combined (recrystallized glass + G, amorphous glass + G); b) S: of "resorption" type, connected with pyrogenic metamorphism; diaplectic (thetomorphic), formed during impact metamorphism; c) product of immiscibility of silicates at late stages of crystallization of lunar magma; g) polyphase in lunar minerals, with dms. 2. G inclusions: G, G>amorphous glass, G + L with CO_2, etc.

In minerals of meteorites small glass inclusions are quite common, usually as inclusions of G + glass, recrystallized glass, glass + recrystallized glass, recrystallized glass + G, with immobile bubbles, often bearing CO_2. (Author's abst.)

YASINSKAYA, A.A., 1977, Some recent data of cosmic mineralogy. IV. On the classification of the inclusions in meteorites and lunar rocks: Mineralog. Sbornik., v. 31, no. 2, p. 15-22 (in Russian).

A scheme of classification of the inclusions in the cosmic minerals (meteorites and lunar rocks) is proposed. The classification is based on such main criteria as the specific genesis, composition, and aggregate state of inclusions. (Author's abstract)

YEH, H.W. and EPSTEIN, S., D/H ratios and late-stage dehydration of shales during burial (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, no. 7, p. 1236-1237. Authors at Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, California 91125.

D/H ratios of different size fractions of clay minerals from three sequences of deeply buried shales were determined.

The data indicate that hydrogen isotopic fractionation does occur when a fraction of pore water is expressed out of shale. The initial hydrogen isotopic fractionation is such that the filter is depleted in deuterium by about 10 per mil relative to the residual pore water. Evidences also show that montmorillonite --→ illite conversion is a major mechanism for late-stage dehydration of shales. (From the authors' abst.).

YEN, Chie-Chung, 1976, Trapping temperature and pressure of the fluid inclusions in the gangue minerals of gold-silver-copper deposits at the Chinkuashih mine, Taiwan; Proc. Geol. Soc. China 1976, v. 19, p. 127-133 (in English).

Homogenization temmps. of inclusions in quartz, barite, and alunite of the mine were 160-300°. Estd. load pressure during formation was 600-1000 bars. (Chemical Abstracts, 1978, 88:9844c)

YUDIN, I.M. and ADRYANOVA, S.I., 1977, Temperature regime of formation of metasomatic and quartz-vein bodies of a gold-ore deposit (Central Kyzylkum) (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Sib. Branch, v. II, p. 58-59 (in Russian; translation by A. Kozlowski). Authors at Central Sci.-Res. Geol-Prosp. Inst. of Geol. Ministry.

A deposit occurring in aleurite-psammite rocks consists of metasomatites and quartz veins. Homogenization studies on inclusions in quartz veins in various metasomatites (128 preparations, 1200 measurements), yielded T_H as follows (°C): quartz-biotite-amphibole 200-580; quartz-feldspathic 160-600; early quartz-albite 120-360; chlorite 220-420; late quartz-albite 160-520; berezite-like 100-420. Also decrepitation studies gave following T_D values: metasomatites 240-700°C in general (maximum activity 280-580°C), quartz veins 140-600°C in general (maximum activity 300-580°C). (Abst. by A.K.)

YUDIN, I.M., and RAKHMANOV, A.M., 1976, Application of decrepitophonic method during search and prospecting for endogene deposits, in Thermobarogeochemistry of mineral formation, N.P. Ermakov, ed.: Rostov, Rostov Univ. Press, p. 126-129 (in Russian).

Full paper corresponding to abstract in Fluid Inclusion Research volume 6, p. 171-172, 1973.

(Authors and title changed from the earlier version.)

YUSHKIN, N.P., 1977a Theory and methods of mineralogy-selected problems, 292 pp. Leningrad Branch of the "Nauka" Publishing House, Leningrad (in Russian). Author at the Komi Division of Acad. Sci. USSR, Geol. Inst., Syktyvkar.

The book bears several reference examples of use of fluid inclusions (p. 35, 248, 254, 255). (A.K.)

YUSHKIN, N.P., 1977b Experiment in mineralogy: purposes, methods and problems: Trudy Inst. Geol., Komi Filial, Akad. Nauk SSSR, 1977, no. 23 (Experiment in mineralogy and modelling of mineral-forming processes"; N.P. Yushkin, ed.), p. 3-31, in Russian.

Short characterization of the importance of experiments on inclusions (solid, liquid, gas, polyphase) in minerals (p. 13); also three photographs of alteration of habit of inclusion in crystal of alum (duration 600 days after formation) are presented on p. 16, Fig. 7. (A.K.)

ZAKHARCHENKO, A.I., 1974, Processes of transitions of granite melts into fluids, their features and ore content: in Geology of Deposits, Proceedings of the Xth Congress, 1973, Carpatho-Balkan Geological Assoc. Bratislava, Geol. Ustav Dionyza Stura (pub. 1974) Section VII, p. 194-200 (in Russian with English abstract).

For the first time the author succeeded in establishing and studying gradual transitions from melts to fluids on the basis of their inclusions in quartz, beryl and topaz in chambered pegmatites, formed among parent granites under calm conditions. During the transition of granites into inner zones of pegmatites and then to topaz crystals in pegmatite cavities the inclusions show gradual decrease (in volume %) of 90-80% to 60-40-20% and to complete disappearance of mineral aggregates that are formed from melts and an increase of fluxing gases (from 10-30% to 40-60%), alkalies (especially rare ones),+ halogens (especially F). From 40-60% of euhedral daughter crystals (feldspars, quartz, micas, fluorite, etc.) formed from fluids in the gradual transition of melt inclusions into fluid ones. T_H decreased from 800-700° (in granites), to 600-530°C (in pegmatites). At lower temperatures only fluid hydrotherms with decreasing concentrations exist.

It is significant that among magmatogene emanations at 700-650°, easily volatile gases predominate, where hydrogen and hydrides play the main role in preventing the transportation of heavy metals and the formation of their deposits. Water solutions appear only at the temperature below 700° and sharply increase at 600-550°, with the transition of melts into fluids. Due to this and the chemical features, fluids to 600-550° are non-metalliferous. Only at the post-magmatic stage in the range of 450-300°C hydrotherms rich in K, F, and rare alkalies, mobilize intensively rare metals (Sn, W, Mo, Be and other) and form their deposits closely related genetically with granites enriched in them (the Ore mountains, Tsinovets, etc).

In the range of 350-250°C at the change of chemistry into essentially sodium-chloride solutions, the hydrotherms mobilize intensively and form deposits of Mo-Cu, Au (the Rosena deposit, Verlibryazh deposit near Burges etc), and then (250-150°C) these solutions, with the increasing role of sulphates mobilize and form deposits of polymetals (Rodopy and others), with less relation and dependence on magmatic rocks (Modified by ER from the author's abstract)

ZATSIKHA, B.V., 1976, Inclusions of mineral-forming media and typomorphism in mercury paragenetic associations of Transcarpathians (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 73 (in Russian; translation by A. Kozlowski).

1. Inclusions in calcite, quartz, dolomite, chalcedony, barite, cinnabar and realgar of Vyshkovskoe, Dragovo-Uglianskoe, Olenevskoe, Perechinskoe ore fields as well as the Chernogolovo-Soimovskaia ore subzone, are filled with: 1) solutions of low (≤1-2 wt. %) salinity; 2)complicated hydrocarbon-aqueous heterogeneous systems: 3)colloid media. All above types of inclusions are typomorphic for stages of hydrothermal Hg and Hg-Sb-As parageneses at Transcarpathian region.

2. Hydrocarbon inclusions appear in early quartz ("Marmarosh diamonds").

3. Inclusions of water solutions have T_H 250-60°C.

4. Solutions consisting of CO_2 and H_2O of heterogeneous state are typomorphic for the pre-ore stage.

5. Inclusions of colloid were found in small drop-like infiltrations of chalcedony with opaline outer core (Morongosh deposit). Colloids and metacolloids suggest a connection of most of the mercury deposits of Transcarpathians to the volcanogenic "opalite" type. (Author's abst.)

ZAW, U. Khin and CLARK, A.H., 1977, The E-Zone scheelite skarn orebody, Canada tungsten mine, Tungsten, Northwest territories: a petrological and fluid inclusion study (abst.): Geol. Assoc. Canada-Min. Assoc. Canada Program with Abstracts, v. 2, p. 57. First author at Dept. Applied Geology, Rangoon Natural Science Univ., Burma.

In the Cantung E-Zone orebody (61°57'N.; 128°15'W.) scheelite (max. 0.55 wt. % Mo) and chalcopyrite occur disseminated in a hexagonal pyrrhotite-silicate exoskarn immediately overlying the irregular roof of a quartz monzonite pluton. Intrusion and ores were emplaced in the Late Cretaceous (91±2 Ma). Sphalerite compositions indicate that the confining pressure during mineralization was 1000±250 bars.

The orebody, comprising veins, stockworks, and massive, stratabound, lenses, formed through metasomatism of relatively pure Lower Cambrian marble, previously metamorphosed to the hornblende hornfels facies and intensely fractured. The skarn is zoned, broadly parallel to the intrusive contact: an early clinopyroxene-garnet zone (stage I) overlies a larger zone dominated by actinolite (stage II) and closest to the pluton, magnesian biotite (stage III). The "hydrous" skarns are not retrograde, sensu stricto, but crystallized predominantly through direct replacement of marble. Formation of the biotite skarns was accompanied by emplacement of scheelite-bearing, but non-economic, greisen-bordered quartz veins in the apex of the pluton. Scheelite, chalcopyrite, and pyrrhotite were deposited in each of the three skarn stages.

Fluid inclusions in stages I and III skarn minerals are dilute brines (max. 8 equiv. % NaCl). Pressure-corrected homogenization temperatures range from 520-450°C (I: scheelite, quartz and pyroxene) to 465-360°C (III and quartz veins: scheelite and quartz). The skarns are only moderately enriched in fluorine, and fluorite is absent; stage III mica compositions indicate that log f_{H_2O}/f_{HF} in the later skarn-forming fluids averaged 4.0±0.2.

The locus of skarnification and contemporaneous ore deposition at Cantung migrated progressively towards the roof of the cooling pluton. (Authors' abstract)

ZENTILLI, M. and REYNOLDS, P.H., 1977, Dating of fluid inclusions in ore deposits with the $^{40}Ar/^{39}Ar$ method (abst.): Geol. Assoc. Canada — Min. Assoc. Canada Program with Abstracts, v. 2, p. 57. Authors at Department of Geology, Dalhousie University, Halifax, Nova Scotia, Canada, B3H 3J5.

Fluid inclusions in some ore environments contain brines with measurable concentrations of potassium. The possibility of obtaining geologically-signficant data from the $^{40}K/^{40}Ar$ ratios in fluid inclusions has been investigated using the $^{40}Ar/^{39}Ar$ technique. Gas release patterns derived from incremental heating experiments can be evaluated in relation to the behaviour of the inclusions on a microscope heating stage up to leakage and decrepitation temperatures. Low potassium content or complex release patterns make data unreliable in many inclusions studied, and the possible presence of excess radiogenic argon trapped at the time of sealing of the inclusions must be considered. However, we have obtained a date for sylvite-bearing inclusions in quartz from mineralized veinlets from the core of a major porphyry-type orebody that is in agreement with the geological age ascribed to that deposit. Used in conjunction with other observations and in addition to the more conventional dating of magmatic and alteration phases, the $^{40}Ar/^{39}Ar$ dating of fluid inclusion materials appears to be a potentially valuable tool in the detailed study of certain ore environments. (Authors' abstract)

ZEUCH, D.H. and GREEN, H.W., II, 1977, Naturally decorated dislocations in olivine from peridotite xenoliths: Contrib. Mineral. Petrol., v. 62, p. 141-151.

Of interest to any study of melt inclusions in olivine. (ER)

ZHOVTULA, B.D., 1976a. SiO_2 content in magmatic fluids (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 102 (in Russian; translation by A. Kozlowski).

T_H of glass inclusions in phenocrysts of quartz from liparite and its tuff are 1355-950°C, in plagioclase from hyalodacite — 1470-1320°C, in pyroxene from hyalodacite — 1310-1280°C, in quartz from granodiorite porphyry — 1480-1145°C, in plagioclase, same rock — 1390-1280°C. SiO_2 content in melt was found by measurements of the refractive indices (n) of inclusion melt. Inclusion melts from the Vygorlat-Gutinskaya Sarmatian-Pontian volcanic range have n value 1.491 at depth 150 m (75% SiO_2), and 1.535 at 50 m (55% SiO_2). In effusives (Tortonian-Sarmation) at depth 300 m n is 1.484 (80% SiO_2), and at 150 m — 1.488 to 1.495 (75-70% SiO_2). (Author's abst.)

ZHOVTULA, B.D., 1976b, Studies of inclusions in quartz from liparite tuffs in Beregovo hill country: Mineral. Sb., v. 30, no. 1, p. 60-64 (in Russian with English abst.). Author at Inst. Geol. Geochem. Fuel Raw Materials of the Acad. Sci. Ukrainian SSR, L'vov, Naukova 3a., USSR.

Quartz phenocrysts bear P magmatic and S hydrothermal inclusions. P inclusions are 5-100 µm long, G 5-15 vol.% + glass; sometimes G is absent. G + glass inclusions are often partly or completely crystallized, glass one-phase inclusions were not crystallized. Contemporaneous trapping of G + glass and glass inclusions proves boiling of the magma. Crushing of individual inclusions under glycerol proves that P was low.

Homogenization T were measured by use of new heating stage. In the thermoresistant insulating block (120 mm by 50 mm high) there was a silite (sic) rod 14 mm in dia. In the middle of the rod there is cut out a flat area 14x20 mm for the specimen plate, with a hole for illumination of plate. The hole is covered with 0.3 mm thick silica glass plate. T measurements were made by use of Pt-PtRh thermocouple; T range of work 20-1500°C, voltage of heating 28 volt at 1500°C; accuracy of measurements ±10°C. T_H of glass inclusions 980-1345°C, recrystallized-1360-1495°C, S G/L inclusions 210-240°C. Part of melt inclusions decrepitated during heating and melt came into cracks. Refractive indices of glass in inclusions was 1.484-1.488. Microspectrographical analysis of inclusions yielded presence of Si, Al and Cu; G composition: CO_2 67.5, O_2 0.86, N_2 22.9, CH_4 9.8 (vol.%). S inclusions have low total salinity (1-3%); ions present: Cl 0.7, Ca traces, Mg 0.6, K-not found, SO_4 0.7-1 (g per 1), gases: CO_2 48.4, N_2 51.6 (vol.%). (Abst. by A.K.)

ZHUKOVA*, T.B., MEL'NIKOV, I.V., TIMOFEEV, A.V., and SHTEYNSHNEYDER, T.L., 1976, Chemical composition of hydrotherms during formation of the rare-metal deposits (abst.), Abstracts of Fifth All-Union Conference on Thermobarogeochemistry, Ufa, USSR, 20-23 Sept., 1976: Ufa, Bashkir Section, Acad. Sci. USSR, Inst. of Geol., p. 191-192 (in Russian; translation by A. Kozlowski).

1. Stages of albitization and quartz-hydromica alteration were as follows: quartz-sulfide-carbonate, quartz-molybdenite-pitchblende, and fluorite-calcite. In inclusion fluids HCO_3 content increases at the end of each stage; Cl is constantly low; F-increases at the beginning of the last stage during formation of fluorite; Na and K increase at the beginning of each of two first stages; K<Na, and the solutions were generally of F-HCO_3-Ca type, except at the beginning of the first stage, when Na>Ca.

2. At the second deposit four stages were distinguished: pyrite-carbonate, molybdenite-pitchblende, ankerite and quartz-carbonate. During the development of the ore-forming process HCO_3 content increases, Cl decreases and F increases especially in the third stage. Concentration of alkaline earths increases at the end of process, with Mg>Ca except of last stage, when Ca>Mg. Na>K, and solutions are of Cl-HCO_3-Mg plus Ca

type; in the last stage Mg + Ca>Na. (...) (From the authors' abst.)

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* After publication the authors wanted to change sequence to: Mel'nikov, I.V., Zhukova, T.B., etc. and change the title to: "Peculiarities of changes of chemical composition of hydrotherms during formation of U-Mo deposits". This English text contains also several changes made by the authors from the original Russian version. (A.K.)

ZIEF, Morris and MITCHELL, J.W., 1976, Contamination control in trace element analysis: New York, J. Wiley and Sons, 262 pp.

A detailed discussion of the wide variety of problems in loss and contamination in trace element studies, of considerable pertinence to any study of fluid inclusion analysis. (ER)

ZIEGENBEIN, D. and JOHANNES, W., 1977, Gas chromatographic analysis of experimental high pressure hydrothermal fluids: N. Jb. Miner. Abh., v. 130, no. 1-2, p. 145-149.

Fluids which are present in high pressure high temperature experiments can be analysed qualitatively and quantitatively by gaschromatography. A special device has been constructed which enables not only puncturing of the sealed capsules of the type used in high pressure apparatus but also repeated analysis of the gas sample. Standard deviations of analysis are found to be: <1% for main components, <3% for minor components, <6% for traces. (Authors' abstract)

ZLOBIN, V.A., GAS'KOV, I.V., ZAZULENKO, L.V. and KOLOBOV, V.Yu., 1977, Physico-chemical parameters of formation of quartz-vein mineralization in sedimentary-metamorphic complexes of the gold-ore provinces (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Sib. Branch, v. II, p. 20-21 (in Russian; translation by A. Kozlowski). Authors at Inst. Geol. Geophys. Siberian Branch of Acad. Sci. USSR, Novosibirsk.

T_H and T_{Frz} were measured for inclusions in quartz from veins of the Enisey region, S. Urals (Kumak deposit) and Little Khingan. Quartz veins were divided into: 1) metamorphogenic, 2) early hydrothermal-metasomatic, 3) late hydrothermal filling of open fractures. Veins in phyllites formed at 400-250°C, in phyllite-like clay schists--250-150°C; T gradient (Enisey region) was 37°C/km. T_H for type 2--340-310 (Kumak) and 350-260°C (Enisey), and for type 3--250-200 (Kumak) and 290-190°C (Enisey). P for type 1--1800-1000 atm (epidote-amphibolite facies) to 200 atm (clay schists); for type 2 and 3--the P ranges are similar. CO_2 varies in hydrothermal fluids from higher concentrations in deeply metamorphosed rocks to lower in weakly metamorphosed ones. Solutions are of Cl-Na, and in gold-ore veins, of Cl-K type. Rock-crystal of gold precipitation stage formed at 260-190°C, 140 atm. (From the authors' abst.)

ZOLOTAREV, V.G., GRINENKO, L.N. and SUKHAREV, N.G., 1976, Genesis of the sulfide-polymetallic ores of the Shubinskoe deposit (Rudnyi Altai): Vyestnik Moskovsk. Univ.-Geology,series IV, v. 31, no. 6, p. 41-50 (in

Russian). First author at Dept. of Geochemistry, Moscow Univ., Moscow.

Cu and Cu-Zn sulfide ores have low T of beginning of decrepitation: 60-140, sometimes 180°C; in the central part of the ore bodies T_D is higher: 220-260 to 320°C. T_D also increases from upper to lower levels of the ore bodies. Most frequently T_D ranges from 180 to 240°C. Decrepitation effect is absent in 42% of Cu-Zn and in 16% of pyrite ores. Monomineral sphalerite (T_D 60-100°C) has low decrepitation intensity, typical for low-T supergene minerals. Most inclusions in quartz from the ore parageneses are one-phase. Two-phase inclusions are rare: F 98-99 vol.% in Cu-Zn ores, and 90 vol.% in pyrite ores. Maximum T_H for Cu-Zn ores are 50-80°C, Cu ores--50-120°C, pyrite ores--50-140°C. Ores are of volcanogenic exhalation-sedimentary origin with metasomatic activity. Part of ore was redeposited: T_H in redeposited sphalerite was 135-168°C. (Abst. by A.K.)

ZOLOTUKHIN, V.V. and RYABOV, V.V., 1977, Problems of the genesis of sulfide copper-nickel ores (exemplified by the Noril'sk ores) and the essential parameters of the process (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. I, p. 50-52 (in Russian; translation by A. Kozlowski). Authors at the Inst. Geol. Geophysics of the Siberian Branch of Acad. Sci. USSR, Novosibirsk.

Melt inclusions in pyroxenes of the main magmatic stage yielded T_H 1200-1300°C. Major ore-bearing pegmatoids (taxitic gabbro-dolerites, gabbro, talnakhites) formed at lower T, 1180-1070°C. S G/L and L/G inclusions in magmatogenic minerals, but P in later ones homogenized at 900°C and lower, belonging to three intervals: 900-500, 500-200 and 200°C. Minerals paragenetic with ores and ore minerals yielded T_H and T_D as follows: quartz 320-250°C, anhydrite 550-300°C, garnet 780-440°C, prehnite 315-300°C, magnetite 640-630°C, plagioclase-up to 900°C. Under vacuum, with x-ray control after run, pyrrhotite gave T_D 800-460 down to 240-220°C, and chalcopyrite-560-240°C. Main G was CO_2, only several % of the sum of (H_2S, SO_2, HCl, HF); N_2 content increased at pegmatoid stage. Fluids in post-magmatic stage contained HCO_3, SO_4, Cl, F, Ca, Mg, Na, K; total salt concentration 4-34 mg/100 g of rock. (Abst. by A.K.)

ZOR'KIN, L.M., VOYTOV, G.I., STADNIK, Ye., V., YURIN, G.A., ZUBAYRAYEV, S.L., SHIROKOVA, I.Ya., CHERVICHNAYA, L.F. and KUZ'MIN, V.M., 1977, On gaseous inclusions in crystalline rocks of Tatarskoe slope uplift: Akad. Nauk SSSR Doklady, v. 237, no. 1, p. 203-206 (in Russian). Authors at the All-Union Sci.-Research Inst. of Nuclear Geophysics and Geochemistry, Moscow.

Gases were investigated in Archean gneisses, crystalline schists, plagio-granites and diabases from boreholes by means of crushing 2 g sample under Ar flow in a steel crusher. He, N_2, O_2, CO_2 were determined with G chromatograph LHM-7A; hydrocarbons including C_6, isomers C_4-C_5 and oleffins C_2-C_4 were determined using G chromatograph UH-2 with flame ionization detector (sensitivity 10^{-5} vol.%). Results were obtained as in table (mean values, N_2 not included). Rocks rich in CO_2 and CH_4 are strongly cracked and silicified. (Abstract by A.K.)

(Continued on next page)

Groups of rocks	No. of samples	H_2	CO_2	CH_4	C_2H_6	C_2H_4	C_3H_8	C_3H_6*	Iso-C_4H_{10}	n-C_4H_{10}
1. Plagiogranites and plagiogneisses	20	$\frac{88.01}{0.81}$	$\overline{8.66(3)}$	$\frac{10.54}{0.097}$	$\frac{0.81}{0.0075}$	$\frac{0.17}{0.0016(13)}$	$\frac{0.27}{0.0025(11)}$	$\frac{0.19}{0.0018(3)}$	not found	not found
2. Biotite and biotite-garnet plagiogneisses blastomylonites	71	$\frac{86.73}{0.94}$	$\overline{9.25(4)}$	$\frac{11.72}{0.127}$	$\frac{0.55}{0.006(65)}$	$\frac{0.27}{0.001(49)}$	$\frac{0.27}{0.001(29)}$	$\frac{0.23}{0.0024(11)}$	$\frac{0.09}{0.001(2)}$	$\frac{0.14}{0.0015(1)}$
3. Pl-mi granites, leucocratic gneisses	16	$\frac{61.15}{0.91}$	$\overline{6.53(3)}$	$\frac{23.79}{0.36}$	$\frac{1.65}{0.022(15)}$	$\frac{0.38}{0.0058(9)}$	$\frac{0.46}{0.007(7)}$	$\frac{0.19}{0.0028(5)}$	$\frac{0.18}{0.0027(3)}$	$\frac{0.30}{0.0045(1)}$
4. Biotite-pyroxene gneisses with ores	6	$\frac{61.89}{0.96}$		$\frac{17.41}{0.27}$	$\frac{19.34}{0.30}$	$\frac{0.13}{0.002(5)}$	$\frac{1.096}{0.017(1)}$	$\frac{0.13}{0.002(1)}$		
5. High-alumina schists	13	$\frac{79.18}{0.87}$		$\frac{19.20}{0.213}$	$\frac{0.69}{0.0076}$	$\frac{0.35}{0.0038(9)}$	$\frac{0.29}{0.0032(8)}$	$\frac{0.29}{0.0032(1)}$		
6. Amphibole-pyroxene schists	1	$\frac{97.88}{1.20}$		$\frac{2.04}{0.025}$	$\frac{0.04}{0.0005}$	$\frac{0.04}{0.0005}$	not found	not		
7. Ti-magnetite-chlorite schists	7	$\frac{82.30}{0.61}$		$\frac{16.98}{0.130}$	$\frac{0.35}{0.0027}$	$\frac{0.20}{0.0015(1)}$	$\frac{0.17}{0.0012(2)}$	found		
8. Diabases **	2	$\frac{96.05}{57.78}$		$\frac{2.38}{1.43}$	$\frac{0.78}{0.47}$	$\frac{0.01}{0.0075}$	$\frac{0.46}{0.28}$	$\frac{0.008}{0.0048}$	$\frac{0.04}{0.027}$	$\frac{0.12}{0.071}$

*In Russian text printed C_3H_8, obviously a misprint for C_3H_6 (A.K.).

** C_4H_8 $\frac{0.005}{0.003(1)}$; Iso-C_5H_{12} $\frac{0.09}{0.052}$; n-C_5H_{12} $\frac{0.057}{0.030}$

Note: above line-vol.%, under line-cm^3/kg, in parentheses-no. of samples (when lesser than indicated), in which the component was found. Blanks – not found

ZYRYANOV, V.N., 1977, Temperature of microcline-orthoclase transition, based on experimental data and natural parageneses: Akad. Nauk SSSR Doklady, v. 233 no. 6, p. 1192-1195 (in Russian). Author at the Inst. of Experimental Mineralogy of the Acad. Sci. USSR, Chernogolovka, Moskovskaya obl.

Translations

Items presented here are selected on the basis of (1) availability of a translation that has not been published elsewhere; (2) significance to inclusion research; and (3) date of publication. Thus several particularly significant older items are included. The Editors would welcome suggestions from readers as to other papers that should be translated, and would particularly appreciate copies of privately-made translations not here-to-fore published.

GEGUZIN, Ya.Ye. and DZYUBA, A.S., 1977, Precipitation of gas bubbles at the crystallization front of a melt: Kristallografiya, v. 22, no. 2, p. 348-353 (in Russian; partial translation courtesy A. Kozlowski). Authors at the Kharkov State Univ., Kharkov, Ukrainian SSR.

Usually solubility c_S of G in solid phase is lower than solubility c_L of G in L phase ($c_S/c_L = K<1$), hence G bubbles will accumulate on the face of crystallizing substance, especially if diffusion of G in L is slower than its precipitation. Trapping of such bubbles was studied experimentally, using distilled water or naphthalene, crystallizing in a thin layer (0.1-0.25 mm) to eliminate convection, which might disturb the diffusion processes under study. Rate of crystallization was from 10^{-3} to $1.5 \cdot 10^{-2}$ cm/sec. The processes were filmed with speed 8 to 20 pictures per sec., using microscope and heating/cooling stage. The higher the rate of crystallization, the smaller the trapped bubbles. When the rate was low, bubbles during trapping contacted longer time with L, and due to continuous influx of G, their shape after trapping was tubular. When the rate was $\gtrsim 3.5 \times 10^{-3}$ cm/sec., the shape was close to spherical. Initially, G bubbles do not form by spontaneous nucleation from supersaturated solution, but mainly on major imperfections of growth front, where local increase of G concentration occurs. This mechanism of forming of G bubbles begins to work earlier than the other one, which causes the nucleation of G bubbles on various mechanical impurities. The latter mechanism works when rate of crystallization v is higher than v corresponding to bend on the $2\bar{R}=f(v)$ plot, where $2\bar{R}$ is the average diameter of trapped G bubble. This bend was found experimentally at $v{-}v^*$ (fig. 3), and presumably may be connected with change of mechanism of nucleation of G bubbles: when $v<v^*$, bubbles essentially nucleate on the imperfections of the growth front; when $v>v^*$, nucleation may occur on various mechanical impurities in the liquid phase. The limiting supersaturation, when the second mechanism begins to work, may be evaluated from the phenomenon that trapped G bubbles practically are not deformed (i.e. they are spherical) only under the condition, that the speed of movement of the crystallization front v is higher than the speed of increase of G bubble $\dot{R}$ due to G influx into the bubble. Formally the latter needs the following:

$$v > \dot{R} \simeq D \frac{\Delta c^*}{c_L^\circ R};$$

where D-coefficient of diffusion of G in L, $\Delta c^*/c_L^\circ$ - lower limit of supersaturation, C_L° - initial concentration of G dissolved in L, R - radius of the bubble.

The limit of supersaturation is derived from the above:

$$\frac{\Delta c^*}{c_L^\circ} > \frac{vR}{D};$$

Since $D \approx 3 \times 10^{-5} cm^2 \cdot sec.^{-2}$, $R = 2.10^{-3} cm$, $v = 3.5 - 10^{-3}\ cm \cdot sec^{-1}$, thus $\Delta c^*/c_L^\circ > 2 \cdot 10^{-1}$. The values of R and v used were determined by the point of bend on the cruve $2\bar{R} = f(v)$ (Fig. 3).

There exists also the possibility of determination of $\Delta c^*/c_L^\circ$, using the equation of stationary distribution of G in L in the coordinate system connected with the boundary melt/solid:

$$c_L(y) = c_L^\circ [\frac{1-k}{k} \exp(-y/\lambda 0+1];$$

where $\lambda = D/v$ - characteristic thickness of the concentration increase at the moving phase boundary, y - distance from the moving front, v - speed of movement of front (rate of crystallization), depending on the conditions of heat conductivity and heat loss. Value y may be accepted here as a linear dimension of the nucleation void R. Hence, the equation may be transformed as follows:

$$\frac{\Delta c^*}{c_L^\circ} = \frac{1-k}{k} \exp(-vR^*/D);$$

the unknown value K was evaluated from $\Delta c^*/c_L^\circ$ value, found as described previously. For the figures given above and $R < 2 \cdot 10^{-3}$ cm, the value of K was $\lesssim 0.86$. The obtained K value is applicable for the accepted non-equilibrium conditions of crystallization, used in the experiments.

The measurements performed make possible the calculation of frequency of nucleation of G bubbles on the unit surface of the moving front of crystallization $[\varphi] = cm^{-2} sec^{-1}$. If the trapped bubbles are almost spherical, the frequency of their nucleation may be described by the equation:

$$\varphi = \rho^{2/3} \zeta^{-1};$$

where $\zeta = \ell/v$, and $\ell = \rho^{-1/3}$ - average distance between nucleating G bubbles, ρ - number of inclusions trapped in solid phase; thus:

$$\varphi = \rho v$$

Figure 4 presents the function $\varphi(v)$, calculated from experimental data by use of above equation.

There is also interest in the relative number of atoms of G collected into bubbles n_1/n_L° and included into crystalline phase n_2/n_L°. Of course $\frac{n_1+n_2}{n_L^\circ} = 1$, where $n_L^\circ = \frac{dN}{M}$ - number of atoms of G in unit volume, educting on the moving front, d - density of L phase, N - Avogadro number, M - molecular weight of L. For water $c_L^\circ = 1.22 \times 10^{-5}$, $d = 1 \text{gcm}^{-3}$, $M = 18 \text{ gmol}^{-1}$, $N = 6.06 \times 10^{23} \cdot \text{mol}^{-1}$, thus $n_L^\circ = 4 \cdot 10^{17} \cdot \text{cm}^{-3}$. Volume of G in bubbles in unit volume of solid phase equals $\Theta = 4\pi R^3 \rho/3$. Of course, $n_1 = P\Theta/kT$, where P - pressure of G in bubble, k - Bolzmann's constant, T - temperature. In the performed experiments $P = 10^6$ dynes/cm^2, T = 273K. Using experimentally found relations R(v) and ρ(v) (Fig. 3), it is possible to calculate $\Theta(v)$ and $n_1(v)/n_L^\circ$. Results are given in Fig. 5.

Explanation is needed for the maximum occurring in the n_1/n_L° versus v curve. It is the natural consequence of changing, with v changes, the role of two various groups of atoms of G. With the increase of v, also increases the role of G bubbles, hence their number increases and distances between bubbles decrease. When v is high, also big portions of L may be trapped by solid as deep tubular channels, observable in experiments. Molecules of G have no time to escape from such channels and to get on the flat front of crystallization before healing of the channels. Role of such nonequilibrium trapping should increase with the increase of speed v due to a) increase of number of channels, and b) difficulties with release of G to quickly "escaping" front. Parts of channels adjacent to the front may be sources rather than reservoirs of G, as it was mentioned during elucidation of reasons of frequent nucleation of G bubbles close to defects of front of crystallization.

Fig. 1. Appearance and trapping of G bubbles on the moving front of crystallization of naphthalene, x30; time interval between following photos, 3sec.

Fig. 2. Relation between size and number of G inclusions and the speed of crystallization of water, x20; a-v = $1.5 \times 10^{-3} \text{cm} \cdot \text{sec}^{-1}$, b - 1.1×10^{-2} cm·sec^{-1}.

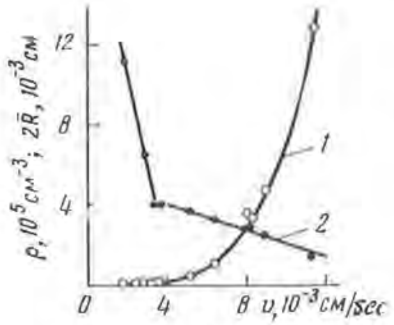

Fig. 3

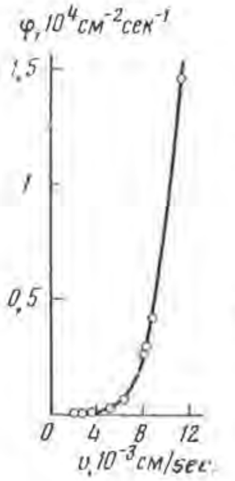

Fig. 4

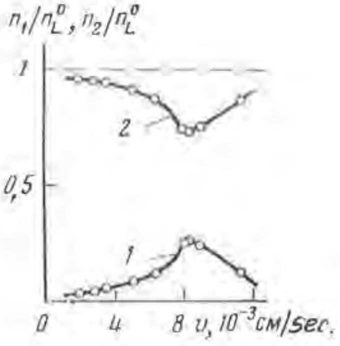

Fig. 5

Fig. 3. Relation between number of G bubbles trapped by solid (1), their average diameter (2) and speed of movement of front of crystallization of water.

Fig. 4. Relation between frequency of nucleation of G bubbles on the front of crystallization and speed of crystallization v.

Fig. 5. Dependence of the relative amount of G accumulated in bubbles (1) and in solid phase (2) on the speed of crystallization of water.

KALYUZHNYI, Vl.A. and GIGASHVILI, G.M., 1976, New cryometric stage with liquid thermostating medium for studies of inclusions of fluids in minerals: Mineral. Sb., L'vov. Univ., v. 30, no. 1, p. 34-36 (in Russian with English abstrac). Authors at Inst. Geol. Geochem. of Fuels of Acad. Sci. Ukrainian SSR, L'vov.Translation courtesy A. Kozlowski

Phase changes in inclusions of mineral-forming media on changes of temperature are the main source of information on phase composition, T and P of the mineral-forming fluid, as well as indirectly on elemental composition and amounts of components of gaseous, liquid and solid solutions.

Studies of phase changes in inclusions at T>0°C are traditional and they are performed by use of heating stages of various constructions (2,4,5,6 etc.). Systematic studies of inclusions at T<0°C have been begun relatively not long ago (1,3,7-9,11). These cryometric stages have several imperfections, mainly poor thermal isolation, as well as the impossibility of the use of short-focus objectives. Moreover, studies of mineral plates are performed in a gaseous medium, having poor heat transfer features. E. Roedder (11) used acetone as cooling medium, pumped from thermostat into cooling stage at T≥-35°C. G.G. Tsurinov and V.A. Vol'nova (10) first used liquid nitrogen, permitting cooling down to -196°C.

The main features necessary for good heating and cooling stages are as follows: 1) high accuracy of measurements of T of observed phase changes; 2) high resolving power of optical system; 3) exact handling of T changes of the stage.

Accuracy of T measurements depends on degree of uniformity of T field surrounding the mineral plate and the measuring element (thermometer or thermocouple), i.e., medium surrounding them ought to have good heat transfer features. One such medium may be liquid, thoroughly isolated from the surrounding atmosphere in the stage. Vacuum is the best thermoinsulator, permitting minimization of the volume of insulating system and making possible the use of short-focus objectives for observations.

Liquid nitrogen applied in existing cooling stages results in additional difficulties in technical realization of exact regulation of cooling. Rapid boiling of liquid in connecting pipes and in the stage causes turbulent influx of gas and irregular changes of T between the inclusion and the temperature sensor. Cooling by gaseous nitrogen, proposed by the authors, does not have these imperfections and simplifies the cryometric stage. However, the regulation of T is better during combined use gaseous and liquid nitrogen, depending on needed rate of cooling.

This scheme first was proposed and applied in construction by one of the authors (7), and here it is presented.

The cooling stage is a thermoresistant glass Dewar (8 cm high and 8 cm dia.) with parallel polished bottom plates (see figure). The mineral plate is put on the bottom and the Dewar is filled with ethyl alcohol (T_{Frz}=-117°C). A copper pipe forming a double coil for flowing gaseous or liquid nitrogen, is immersed in alcohol. This shape of coil causes uniform cooling of alcohol and the preparation. Observations are made from below, through the bottom of stage, using microscope MIM-6.

The flow of nitrogen is regulated by a heating coil immersed in a metal Dewar of liquid nitrogen closed with a plastic stopper. Two copper pipes go through this, one almost to the bottom of the Dewar (for flow of liquid nitrogen); the other ends above the surface of liquid nitrogen (for gaseous nitrogen). Both pipes connect with plastic tubes and a glass Y, then to a copper pipe, and then to the copper coil in the cooling stage. The heating coil in the Dewar (regulation by transformer LATR) increases the pressure; this moves liquid or gaseous nitrogen (depending on which pipe is open) into the coil of the stage. During flow of liquid nitrogen the cooling is rapid; fine regulation of T is performed during flow of gaseous nitrogen. The same nitrogen stream may also be heated with an electric coil placed on the copper pipe, leading to copper coil in cooling stage.

The cooling stage construction makes possible use of short-focus objective (9x) and long-focus objective OSF (22x), i.e., inclusions with dimensions down to 0.01-0.005 mm are easily visible.

Temperature measurements are made with mercury (to -38°C), alcohol (to -80°C) or penthane (to -110°C) thermometers with accuracy 0.1 to 0.5°C, depending on the thermometer scale. Cu-constantan thermocouples and resistance-thermometers are used for T to -175°C.

A uniform thermal field in cooling stage around mineral plate and thermometer is caused by stirring the alcohol with a weak stream of gaseous nitrogen. Calibration was made using T_{Frz} of standard pure liquids (distilled water, chlorobenzene, etc.) in sealed glass capillaries. T_{Frz} was accepted as T of melting of the last crystal of the frozen standard.

Temperature changes in the range close to temperature of phase changes in inclusions or in standard were made with a rate 1°C per 5-8 minutes, giving complete reproducibility of results within the accuracy ranges of the method.

The stage was tested during two years of use. It may be recommended for wide use for studies of fluid inclusions in minerals and synthetic physico-chemical systems at low temperatures.

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Paper submitted to the editor in April 10, 1975.

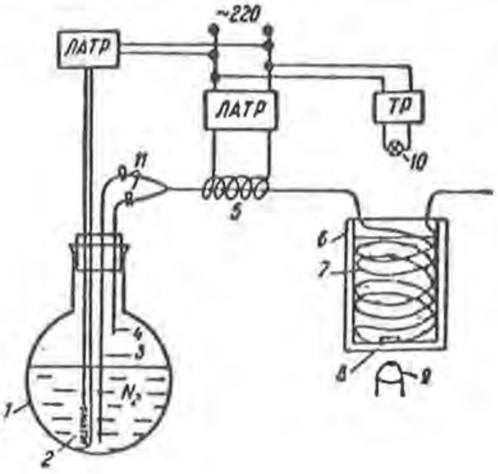

Figure. The scheme of the cryometric stage; 1-steel Dewar bearing liquid nitrogen; 2-heating coil; 3,4-copper pipes; 5-heating wire; 6-glass Dewar cryometric stage, bearing ethyl alcohol; 7-coil made from copper pipe; 8-sample preparation (mineral plate); 9-objective of microscope; 10-bulb of the illuminator; 11-valves on the two plastic pipes. (Three boxes labelled TP are transformers.)

KALYUZHNYI, Vl. A. and VOZNYAK, D.K., 1965, Graphical method of determination of the temperature and pressure of homogenization of the closed system H_2O-CO_2 in application to liquid inclusions in minerals: Mineralogical Thermometry and Barometry; Institute of Geology and Geochemistry of Fuels, Izdat. "Nauka", Moscow, 1965, p. 88-92 (in Russian; translation courtesy of M. Fleischer)

In recent years there is noted a considerable increase of interest in studies of systems with CO_2. The composition of gas-liquid inclusions in minerals shows the constant presence of CO_2 in post-magmatic solutions. Sometimes the content of CO_2 in the homogeneous mother fluid is comparable to the amount of the principal component of deep solutions — water (Kalyuzhnyi and Shchiritsa; 1962). Hence, there is an urgent need for deeper knowledge of the properties of CO_2, and especially of the system H_2O-CO_2 under conditions of high pressure and temperature.

A considerable gap in the field of the studies of the system H_2O-CO_2 was filled by the experimental works of Khitarov and others (1956, 1958) and Malinin (1959). The results obtained on the dependence of temperature and pressure on composition and total specific volume of mixtures of H_2O and CO_2, and also the reciprocal solubility of H_2O and CO_2 at high P and T permit one to propose a graphical method of finding the temperature and pressure of homogeneous states of closed systems (T_{hom} and P_{hom} of the autoclave or of inclusions in minerals) of known composition X and degree of filling, F. The graph of F-T_{hom} for a solution of NaCl in water, appearing to be very valuable for the method of inclusions, generalized for all possible cases of relations of temperature and pressure of homogenization, was published previously by Lemmlein and Klevtsov (1956-2). The construction of similar dependence for solutions of CO_2 pursues not only a theoretical, but also a practical purpose, i.e., the temperature of homogenization of most complex inclusions of CO_2 cannot be measured by the usual heating, because of bursting of vacuoles before attaining a homogeneous state. According to the relations of the phases in the inclusions (or autoclave), by means of F-T diagrams, the temperature and pressure of homogenization are found without using heating. The proposed method can be used in experimental studies with CO_2.

The closed system of the autoclave, used in the experiments for the study of the P-T dependence (Khitarov et al., 1956), can be considered to be completely identical to a complex inclusion of CO_2, having a correspondingly equal composition and degree of filling. The course of the change of T and P of such a system can be described by means of the curve AB (Fig. 1), the lower part of which corresponds to two-phase equilibrium liquid-gas, and the upper part to the dependence of thermodynamic parameters in a one-phase medium. Point C, bounding both branches of the curve, will correspond to conditions at the moment of homogenization of the system. In the case of a comparatively large total density of the system, the position of this point is experimentally recorded by some region of bending in the curve AB. However, this region is rather broad and not clearly expressed. Therefore it is not possible from it to determine the specific point corresponding to the moment of homogenization. The solution of this problem is assisted by graphical construction based on solubility studies (Malinin, 1959; Khitarov et al., 1958).

The P-T-x diagram of the system H_2O-CO_2 with projections of isothermal and isobaric sections was published previously (Kalyuzhnyi,

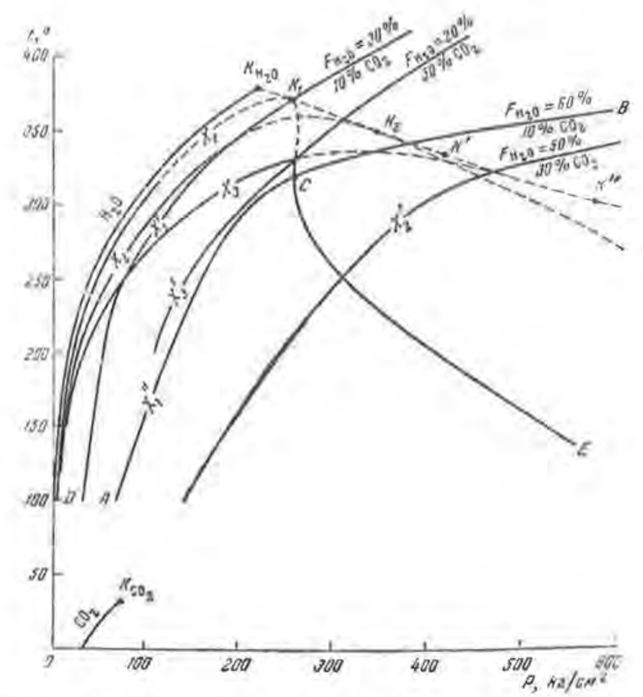

Fig. 1 (p. 89) Projection on the PT plane of the P-T-X diagram of H_2O-CO_2, according to the data of Khitarov and Malinin (1956, 1958). X_1, X_2, X_3 - projections of the section of constant total composition of the system corresponding to weight ratios H_2O:CO_2 (in %): 90: 10, 70:30, 50:50; X'_1, X''_1, X'_2, X'_3 - curves of the change of pressure on heating the system H_2O+CO_2 at different degrees of filling by water (numerator) and contents of CO_2 (denominator); AC-P-T dependence of system up to its homogenization, CB-after homogenization (in the liquid or gaseous phase); H_2O, CO_2, K_{H_2O}, K_{C_2O}-- curves of two-phase equilibrium of pure components and their critical point K_{H_2O}, K'' - critical curve of mixture of H_2O+CO_2; K_1, K_2 - critical points of mixtures of composition X_1 and X_2; K', K'' - critical points of mixtures, obtained from P-X graph of Malinin (1959).

1960). For our purpose, the important sections are those of constant composition. One of these is the P-T section X_1, shown in Fig. 1. The curve DE[1] corresponds to the intersection of the dome-like surface of the two-phase equilibrium with the plane of constant composition X_{1-2}. The curve AB and the P-T section are characterized by the same composition (X_1 = 10% CO_2). Thus, the point of intersection C of the curve AB and the line DE of the section correspond to the condition of homogenization of the closed system (autoclave or inclusion).

Each point of the curve of constant composition DE corresponds to a definite volume of the system (which is reflected by its filling by the liquid phase at the given temperature). Consequently, within the limits of the given ratio of composition (H_2O:CO_2 = 90:10), the construction is possible of an innumerable number of P-T curves for different fillings and the occurrence in places of their intersections with the curve DE, corresponding to temperature and pressure of homo-

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[1] Under DE there is implied on Fig. 1 the complex curve X_1, passing through the point DK, CE.

genization. For example, on the graph of Fig. 1 there are given on three P-T sections (X_1, X_2, X_3) and some of the curves of P-T dependence (X_1', X_1'', X_2', X_3'). According to published results, we calculate the curves T_{hom} (Fig. 3) for the system containing CO_2 = 5% (within the limits of filling F_{H_2O} = 50-60%), 10% (F-20-60%), 15% (F = 50-60%), 20, 30, and 40% (F = 20-50%), and 50% (F = 20-40%). In the construction there were used additional isobaric sections of the P-T-X diagram. The isobars were found by interpolation.

The diagram F-T_{hom} is not complete because of limited experimental data. The accuracy of drawing the curves is comparatively small (error of temperature, not considering error of measurement of the experiments, is about ± 2-5°; of pressure ± 5-10 kg/sq. cm.). The latter is caused by an insufficient number of measurements of solubility, especially in the region of the bend of the dome-like surface, where interpolation is difficult. Greater detail and accuracy of experimental measurements permit one to find by the graphical method completely reliable temperatures and pressures of homogenization.

Complex inclusions of CO_2 contain the phases: aqueous solution (L_1) - liquid CO_2 (L_2) - gas (G), occurring in different volume ratios. According to the amount of liquid CO_2, one can calculate the total content of CO_2 (in wt. %) in the vacuole. The latter is necessary to find T_{hom} and P_{hom} from the graph F-T_{hom}. If one does not take into account the effect, negligible at room temperature, of the volume effect of the solubility of CO_2, the amount of water in the vapor phase and the thermal expansion of the liquid phase in the ranges of temperature 0-4° and 4-15°, then for aqueous solutions of CO_2, according to the published results of O. Khakhnelya (1920) and Ya. D. Zel'nevskii (1937), one can calculate the ratios of the volumes L_1:L_2:G. On Fig. 2 and in the table are given the results of such a calculation for

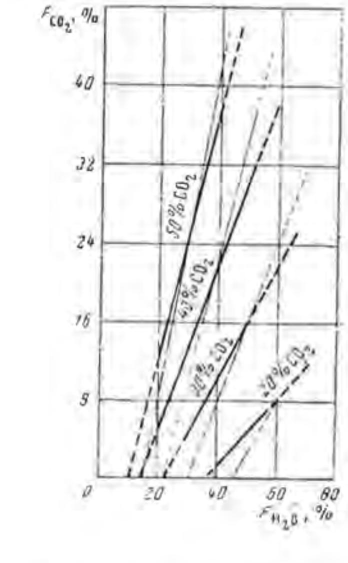

Fig. 2 (p. 91). Graph of the dependence of total content of CO_2 in the inclusions (in wt. %) on the degree of filling of them by water (abcissa) and liquid CO_2 (ordinate). Heavy lines - for temperature 0°; fine lines for +15°. Intermediate magnitudes of CO_2 are found by interpolation.

temperatures 0° and 15°. The total content of CO_2 was determined by addition of the amounts in all three phases of the inclusions, occurring under conditions of the given temperature and internal pressure of the gas phase CO_2.

The diagram F-T_{hom} can be used for the determination of T_{hom} and P_{hom} of real complex inclusions of CO_2, if the concentration of salts in the solutions of the inclusions is small. The general rules, obtained for hypothetical inclusions of $H_2O + CO_2$, apparently remain in effect also for systems of inclusions in minerals with high content of salts. Especially they confirm the decrease of temperature of homogenization, obtained experimentally in heating chambers, of complex inclusions of CO_2 in topaz from the Urals (Ermakov, 1950) and in quartz from Volhynia (Sukhorskii, 1953).

The proposed graphical method of determination of temperature and pressure of homogenization of the closed system H_2O-CO_2 and the diagram F-T_{hom} for complex inclusions of CO_2 (for degrees of filling by H_2O of 20-40% and contents of CO_2 from 10 to 50 wt. %) permits one to draw the following conclusions.

1. Temperatures of homogenization in the liquid and gaseous phases decrease with increasing contents of CO_2,

2. The pressure of homogenization: (a) at constant degree of filling increases with increasing amount of CO_2; (b) at constant concentration of CO_2 increases with increasing degree of filling, except for systems that contain less than 5% CO_2 and that are of homogenized in the liquid phase (which is dependent on the preponderence of the change of T_{hom} over the change of the absolute amount of CO_2).

3. The critical degree of filling (as in the system H_2O-NaCl) increases with increasing content of CO_2. At low concentrations of CO_2 it is close to F_{crit} for water (31.3%); at high concentrations approaches F_{crit} of CO_2 (45.0%).

Table (p. 91)

Results of calculation of ratios of liquid phases H_2O and CO_2 in the inclusions, %

Total wt. content of CO_2 in vacuole	Filling of inclusion H_2O (L_1)	Filling of inclusion by liquid CO_2 (L_2)	
		at 0°	at +15°
10	10-60	—	—
20	20	—	—
20	30	—	—
20	40	1.6	—
20	50	5.0	2.7
30	20	—	—
30	30	4.8	0.2
30	40	10.4	8.3
30	50	16.1	16.6
40	20	5.3	—
40	30	13.6	11.1
40	40	22.0	22.8
40	50	30.5	36.0
50	20	13.3	9.5
50	30	25.8	26.3
50	40	38.3	43.1

4. Additional constructions of projections of sections of the P-T-X diagram show that: (a) the critical curve of the system H_2O-CO_2 in isobaric sections occupies (along the temperature co-ordinate) the highest position; (b) conversely, in sections of constant composition, the point of the critical curve is situated below the maximum of the curve (along the temperature axis). This feature is dependent on the disproportionate distribution of CO_2 between the liquid and gas phases at different temperatures. Because of this the decrease of the degree of filling of the inclusions as compared to F_{crit} (at constant content of CO_2) by 5-10% leads to increase of the temperature of homogenization in the gas phase (Fig. 3). Further decrease of the filling is accompanied (as with inclusions of pure water) by decrease of the temperature of homogenization.

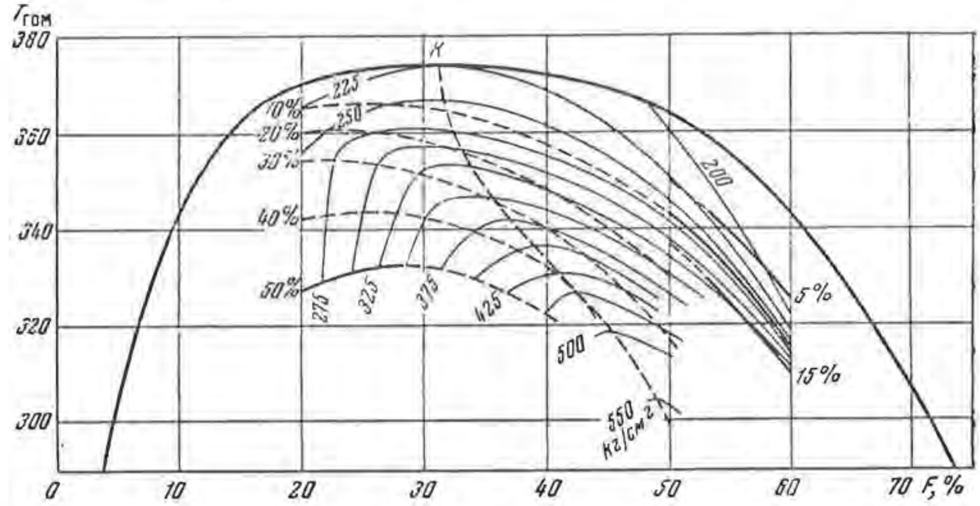

Fig. 3 (p. 92). Dependence of temperature of homogenization of complex inclusions of CO_2 ($H_2O + CO_2$) on the degree of filling by water and the content of CO_2. The outward dome-shaped curve and the parts of curves located below it (designated by heavy lines) are the dependence F-T_{hom}, respectively, for pure water and inclusions containing different weight amounts of CO_2 (shown by numbers). K_{H_2O}- temperature of homogenization of inclusions of H_2O with critical filling. Curves going out close from the point K_{H_2O} are lines of critical temperature and filling of mixtures of $H_2O + CO_2$. Fine continuous lines are isobars.

Institute of Geology and Geochemistry of Fuels
Translated by M. Fleischer, Sept. 24, 1979.

KLEVTSOV, P.V. and LEMMLEIN, G.G., 1959, Determination of the minimum pressure of formation of quartz for the example of crystals from Pamir: Zapiski Vses Mineralog. Obshch. v. 88, no. 6, p. 661-666 (in Russian). Translation courtesy M. Fleischer

> Editor's note: A translation of this rather old paper has just become available, and is printed here, since the paper is still widely quoted and used in fluid inclusion studies.

In our 1955 paper, devoted to the determination of the composition and concentration of solutions in quartz from Pamir[1], it was already noted that in multi-phase inclusions the gas phase often disappears on heating before the complete solution of the solid phase. More often one of them is the phase halite.

Above the temperature of the disappearance of the gas phase, the physico-chemical system comprising the inclusion becomes divariant; the solubility of NaCl depends both on the temperature and on the pressure. But the very small dependence of the solubility of NaCl on pressure at not very high temperatures, far from the critical (Still, 1916; Adams, 1931) permits one to neglect the effect of pressure during the determination of the content of NaCl in the aqueous solution.

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[1] The data described by us on the determination of the composition and concentration of salts in liquid inclusions in quartz of Pamir was obtained without preliminary completion of microchemical analyses of the contained inclusions. It was of interest to us to obtain the given analyses of aqueous extracts from samples of the studied quartz with the purpose of verifying the data obtained by the method of physico-chemical analysis on the composition of the inclusion solutions and obtaining knowledge of the contents of other possible components.

By microchemical analysis of the liquid inclusions contained in the quartz we found the following cations in the quantitative relations $Na^+ > K^+ > Mg^{++} = Ca^{++}$. Of the anions, Cl^-, $SO_4^=$, and HCO_3^- were found. Quantitative characteristics of the water-soluble part of the inclusions were as follows: pH 6.2, Na^+ 2.68, K^+ 0.99, $Ca^{++} = 0.86$, $Mg^{++} = 0.86$, $Cl^- = 1.7$, $SO_4 = 5.7$, HCO_3^- 5.3, SiO_2 1.5 (all in mg per 100g quartz). The aqueous extracts were prepared at room temperature.

Recalculation into moles gives the following probable composition of the salts (in moles per 100g quartz): chlorides 5.0×10^{-5}, sulfates $6.0 \cdot 10^{-5}$, carbonates 4.5×10^{-5}.

Microchemical analyses were kindly made in the laboratory of the Institute of Geochemistry, Academy of Science, USSR, for which the authors thank N.I. Khitarov and E.V. Rengarten.

The data obtained by microchemical analysis confirms that the isotropic solid phases observed in the liquid inclusions are none other than chlorides of sodium and potassium, i.e., halite and sylvite. Consequently, their quantitative content ought to exceed greatly the content of sulfate and of carbonate, slightly soluble at room temperature, which nevertheless is not given us by the data of the microchemical analysis, evidently because of the inadequacy of the method. The predominance of Na over K, according to the microchemical analysis, corresponds to the data obtained by the physico-chemical method. We have observed healed fractures, the liquid inclusions in which contain crystallites of sylvite of considerably smaller size than the crystallites of halite, or do not contain them at all.

Further heating above the temperature of disappearance of the gas phase sharply increases the pressure in the inclusion, and at the moment of complete solution the pressure attains magnitudes which may be taken as the lower limit of the pressure existing at the time of the formation of the crystal or of the healing of fractures in it. It can be found approximately from the data on the temperatures of the disappearance of the bubble, T_1, and of the solution of crystals, T_2, the densities of the solution at these temperatures, and the P-T-V dependence of the physico-chemical system, comprising the inclusion.

In the liquid inclusions in Pamir quartz studied by us the temperatures of complete solution of the crystallites of halite exceeded the temperatures of disappearance of the gas bubble by 45° and 81° (for two different deposits). The included solutions, as has been shown, contained mainly chlorides of sodium and potassium.

For the study of the P-T-V relations of the thermodynamic system consisting of liquid inclusions in quartz of the first deposit, we carried out experiments in autoclaves with aqueous solutions of NaCl-KCl concentrations corresponding to those of the liquid inclusions considered: 122.5 ml NaCl, 61.5 ml KCl per 1000 ml H_2O (or 24% NaCl and 15% KCl). The degree of filling F and the temperature of disappearance of the gas phase, T_1, were determined approximately by a method similar to that for the binary system H_2O-NaCl (Lemmlein and Klevtsov, 1956a, 1956b). The amounts of the salts necessary for the prescribed solution were calculated from the formula, which in the general case of an n-component system has the form:

$$m_i = \frac{Va\bar{F}Ci}{\sum_{i=1}^{n-1} \frac{Ci}{dt_i} + \frac{CH_2O}{dH_2O}} \quad \text{, where}$$

Va is the volume of the system, C_i is the content in weight per cent of the $_i$ salt, dt_i is its density in the solid state, $\bar{F}$ is the provisional degree of filling, obtained by assuming additive magnitudes of volume while dissolving the salt in water.

The experiments were carried out with degrees of filling 85-97% up to a pressure of 1400 atm. The dependence of pressures in the system on the temperature after the disappearance of the gas phase is expressed, within the limits of error of measurement, by straight lines (Fig. 1). The lower final points of these straight lines determine the temperatures of the disappearance of the gas phase. They were found in the following way. According to the P-T-X diagram for saturated aqueous solutions of NaCl-KCl, experimentally obtained by Ravich and Borovaya (1950), there was determined the pressure P_1 in the system, corresponding to the calculated temperature of the disappearance of the gas phase. Experimentally obtained curves were drawn down to the pressure equal to P_1. Because the pressure in the system increases with temperature very slowly up to the disappearance of the gas phase, the error thereby introduced is small (∿1°). The results of the determinations are given in the table.

$\bar{F}$ (%)	F (%)	T_1°C	P_1 atm.	T_1° (exp.)
90	85.8	276	40	285°
92	87.6	227	16	235
96	92.7	162	4	156
100	96.1	130	2	138

In the inclusions we studied, there was dissolved, above the temperature, T_1, of the disappearance of the gas phase, the single solid phase halite. Experiments on the determination of the P-T dependence for solutions of corresponding concentrations of NaCl and KCl at $T_1 =$ 162°C (109 ml. NaCl, 61.5 m. KCl per 1000 ml H_2O, or 22% NaCl and 15.4% KCl), and at temperatures of homogenization also above $T \geq T_2 =$ 207°C, gave within the limits of error of measurement corresponding results for identical filling (the points designated by O refer to solutions with lower content of NaCl-fig. 1). This is explained by the small increase of the density of the solution d_2-d_1 at the expense of 13.5 ml NaCl (or $\sim$2%), dissolved in the temperature interval T_2-T_1, which we show below.

In specifying our task it will be necessary to determine the pressure in the system, corresponding to the temperature of complete solution of halite $T_2 =$ 207°C under the condition of disappearance of the gas phase at 162°C. The desired pressure is found by interpolation of the experimental data on the P-T-F relations for the solution under consideration. For this we have constructed according to the experimental data a correction diagram of the temperature of disappearance of the gas phase for pressure (Fig. 2) and with it the desired curve ab (Fig. 1).

Thus, it is found that the studied secondary liquid inclusions in the quartz of Pamir were formed under a pressure $P \geq 500$ atm at a temperature $T \geq$ 207°C.

In liquid inclusions in quartz of other Pamir deposits the gas bubble disappears at temperatures 325-338°, and the homogenization of the inclusions sets in at 400-406°C. In some inclusions, the crystallites of halite are dissolved at a higher temperature, but further heating was not carried out because of possible damage to the optical system of the microscope. The inclusions contain up to 37% NaCl and 20% KCl. For this composition of the solution, special experiments in autoclaves were not stable. Nevertheless, results of P-T-F measurements for a 30% solution of NaCl and a solution containing 24% NaCl and 15% KCl, permit one to estimate the minimum pressure of formation of the inclusions. From comparisons between the P-T-F diagrams of this and other solutions, it is seen that for the 39% solution of NaCl-KCl, $(\frac{dP}{dT})_F$ is greater than for the 30% solution of NaCl. One must expect that for the more concentrated 57% solution of NaCl-KCl, the slope of the curve in these co-ordinates will be even steeper. At equal slope of these curves and the isochore of the 30% solution, the pressure in the system at $T_2 =$ 400°C ($T_1 =$ 325-338°) would equal 800-850 atm. Consequently, the minimum pressure of formation of the liquid inclusions can be estimated as 800-1000 atm.

In the case considered, the process of heating will be isochoric after the disappearance, not of the gas phase, but of the solid phase. After the disappearance of the gas phase, further increase of temperature causes a more rapid growth of pressure, as compared to the case corresponding to the isochoric process with the density of the solution equal to the density at the point of disappearance of the gas phase. The excess pressure ΔP is determined by the increase of density at the expense of the amount of material dissolved in the temperature interval between the disappearance of the gas phase and later of the solid phase (T_1 and T_2).

If one knows the density of the solution at the temperature of the disappearance of the gas phase, T_1, and also knows the concentrations of salts in the solution at T_1 and T_2, then the density of the solution at the moment of homogenization, T_2, can be calculated.

In the general case, suppose we have an n-component system; an aqueous solution of n-1 soluble materials; at a temperature $T \leq T_1$, j-2 materials ($j < n$) are completely dissolved; n-j + 1 solid phases are dissolved completely in the temperature interval $T_1 < T \leq T_2$.

The density of the solution can be represented in the form of the sums of the density of each component at its uniform distribution over the total volume occupied by the solution, i.e.,

$$\text{at } T_1 : d_1 = \sum_{i=1}^{n}{}' d_i ; \text{ at } T_2 : \ d_2 = \sum_{i=1}^{n} d_i^{n}. \qquad (1)$$

At the temperature T_1, the volume occupied by the solution equals the volume of the whole system V at the expense of the volumes of all the n-j+1 solid phases, i.e.,

$V - \sum\limits_{i=j}^{n} \Delta V_i$. Whereas

$$d_i' = \frac{m_i'}{V - \sum\limits_{i=j}^{n}{}' \Delta V_i} , \ d_i'' = \frac{m_4''}{V}, \qquad (2)$$

where m_i' and m_i'' are the masses of the i-component in the solution at the temperatures T_1 and T_2 so that at $i = 1,2,3$----$(j-1)$ $m_i'' = m_i'$, because the content in the solution of the first j-1 component, at least above the temperature of disappearance of the gas phase, does not diminish at $i=j$, $(j+1)$,-----$n m_i'' > m_i'$.

Considering that $d_i' = d_1 W_i''$ and $d_i'' = d_2 W_i''$, where W_1 = the weight proportions of the i-component in the solution $\left(\sum\limits_{i=1}^{n} W_1 = 1\right)$, and

$\Delta V_i = \frac{\Delta m}{d_{ti}}$ where Δm_i is the mass of the solid phase of the i-component ($\Delta m_i = m_i'' - m_i'$), d_{ti} is the density of the solid phase at T_1 and considering the ratio d_2/d_1, after some transformations, we find:

$$d_2 = \frac{\left(1-\sum\limits_{j}^{n} W_i'\right)\left(1+d_1 \sum\limits_{j}^{n} \frac{W_i'}{d_{ti} - d_1 W_i'}\right) d_1}{1-\sum\limits_{j}^{n} W_i'' + \left(1-\sum\limits_{j}^{n} W_i'\right) \sum\limits_{j}^{n} \frac{W_i''}{d_{ti} - d_1 W_i'} d_1} \qquad (3)$$

Thus, knowing at T_1 and T_2 the concentration of the material, which is completely dissolved at temperatures higher than the point of disappearance of the gas phase, and the density of the solution at this temperature, according to formula (3) one can calculate the density at the temperature of homogenization, which on further supply of heat to the system remains constant at unchanged volume of the system.

If, after the disappearance of the gas phase, there remains completely insoluble only one solid phase, the formula for calculating the density is simplified. Assuming j = n, after transformation, we obtain:

$$d_2 = \frac{(1 = W_n') \; d_t d_1}{(W_n'' - W_n') \; d_1 + (1 - W_d'') \; d_t} \tag{4}$$

With T_2 $W_i'' > W_i'$ $(j \leq i \leq n)$, consequently also $d_2 > d_1$.

In the temperature interval between the disappearance of the gas phase and the solid phase, the pressure in the system depends both on the temperature and also on the density of the solution. The increase of pressure in the system during heating from temperature T_1 to T_2 can be represented in the form of the sum of two components, where the first member expresses the increase in pressure which takes place if the last of the solid phases was dissolved at the temperature of disappearance of the gas phase, appearing in this case as the temperature of homogenization; it expresses an isochoric process. The second member represents the correction of the pressure for the increase of density at the expense of the solid phase dissolved above the temperature of disappearance of the gas phase and increasing the density of the solution in the temperature interval $T_2 - T_1$ to $d_2 - d_1$; it is assumed that the solid phase is dissolved at constant temperature T_2. The correction for pressure (ΔP) for the increase of density can be determined in the presence of an equation of state describing the given system. In the light of the absence at present of an equation of state for the complex system, it is of interest to estimate this correction by means of the Van der Waals equation. The correction for pressure is written:

$$\Delta P = RT_2 \left(\frac{1}{\frac{\bar{\mu}_2}{d_2} - b} - \frac{1}{\frac{\bar{\mu}_1}{d_1} - b} \right) - a \left(\frac{d_2^2}{\bar{\mu}_2^2} - \frac{d_1^2}{\bar{\mu}_1^2} \right) \tag{5},$$

where $\bar{\mu}_1$ and $\bar{\mu}_2$ are the average molecular weights of the solution at T_1 and T_2; $\bar{\mu}_{1,2} = \sum_{i=1}^{n} N_i \mu_i$, Ni is the molar proportion of the i-th component in solution.

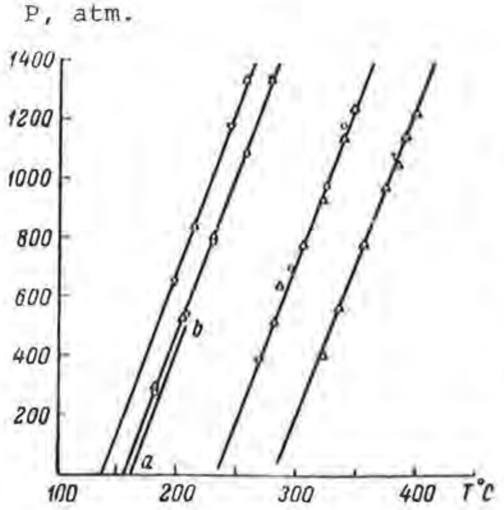
According to the obtained calculated method (Klevtsov, 1959) for the diagram of the density of solutions of the ternary system H_2O-NaCl-KCl, there was found $d_1 = 1.226$ g/cm^3. The magnitude d_2 was calculated according to the formula (4). The magnitude of the density of halite at T_1 entered into the formula was determined from handbook data (Birch et al., 1949). Calculated: $d_2 = 1.240$ g/cm^3, $\bar{\mu} = 24.767$ g/mole, $\bar{\mu} = 25.116$ g/mole. Substituting all known magnitudes in formula (5), it is found that the correction of pressure for the increase of density, in accord with experimental results, is close to zero. The magnitudes a and b taken for water were: $a = 0.1089$, $b = 0.001362$. If, for the considered case, these magnitudes are somewhat larger, the result is not changed, because the difference in the densities of the solution at T_1 and T_2, appearing to be the main influence on the increase of pressure, is very small.

Conclusions

For the ternary system H_2O-NaCl-KCl, the composition 24% NaCl and 15% KCl, characteristic for liquid inclusions in the quartz of Pamir, was studied experimentally for P-T dependence to 1400 atm at degrees of filling 85-97%.

Determination of the minimum pressure and temperature of healing of specific fissures in quartz of Pamir: $P \geq 500$ atm., $T \geq 207°C$ (one deposit); $P \geq 800\text{-}1000$ atm., $T \geq 400°C$ (another deposit). In the case considered, the increase of the density of the solution at the expense of crystals of NaCl dissolved above the temperature of disappearance of the gas phase is small (~ 0.01). The consequence of this pressure, caused by this increase of density, is very small. Its magnitude lies within the limits of error of measurement.

Fig. 1



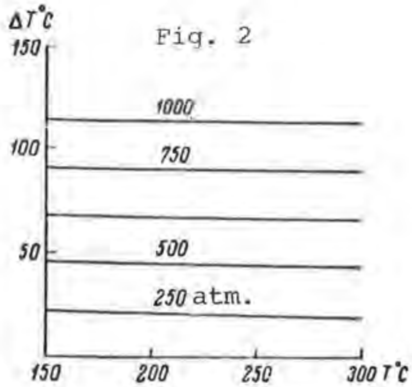


Fig. 2

Fig. I (p. 663) Relations P-T-F for solutions of the three-component system H_2O-NaCl-KCl. Concentrations: 24% NaCl and 15% KCl. The lower final point of the straight line is determined by the temperature of disappearance of the gas phase.

Fig. 2 (p. 663) Correction for pressure of the temperature of disappearance of the gas phase of aqueous solution of NaCl + KCl (24% NaCl + 15% KCl).

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Translated by Michael Fleischer, July 19, 1979

NAMBU, Masateru[*], SATO, Toshio[**], HAYAKAWA, Norihisa[*], and OHMORI, Yasuo[**], 1977, On the microanalysis of fluid inclusions with the ion microanalyzer (abst.): Mining Geology (Japan), v. 27, p. 40 (in Japanese). Authors at the *Faculty of Engineering, and the **Research Inst. of Mineral Dressing and Metallurgy, Tohoku University, Sendai, Japan.

Editor's note: This important study, which is the first application of this technique to aqueous inclusion analysis, was first published as an abstract, as referenced. The following extended English summary has been kindly supplied by Prof. Nambu. A paper covering much of this material was published later in a rather obscure journal, and with different authorship:

SATO, Toshio, NAMBU, Masateru, OMORI, Yasuo, and HAYAKAWA, Norihisa, 1977, On the analysis of fluid inclusions in quartz with ion microanalyzer: Bulletin of the Research Institute of Mineral Dressing and Metallurgy, Tohoku University, v. 33, no. 2, Rept. 745, p. 92-102 (in Japanese, with English abstract).
The illustrations and data in the following summary are taken from this latter publication.

Introduction

Fluid inclusions in various quartz minerals with sizes of less than 30 μm were analyzed by ion microanalyser by special techniques. The fluid inclusions were frozen in the specimen using a cooling system connected to the specimen stage. Electrons charged on the specimen surface were neutralized by an electron spray technique. Quantitative analysis seems possible by measuring the ion intensity relative to the synthetic specimens prepared by enclosing aqueous solutions containing various salts in fused silica capsules. Analytical results on fluid inclusions in various samples of quartz indicate the characteristic features of their components and relative ion intensities. Even in the same deposit, the composition of the fluid inclusions varies during the mineralizing period. Especially, noticeable variations in magnesium and aluminum contents were observed. Fluid inclusions in quartz contained heavy metal ions such as manganese, iron, copper and zinc. These facts support the conclusion that the fluid inclusions in quartz will allow the estimation of the mineralizing conditions of ore deposits.

In a crystal growing from an aqueous solution, a small number of liquid inclusions, mostly smaller than 100μm, were found to be trapped by irregular crystal growth. Quantitative analysis of elements contained in a given liquid inclusion gives us valuable information clarifying the mechanisms of ore deposition.

The present paper briefly discusses the method of analysis and the results obtained by using the ion microanalyzer.

Methods of Analysis and Apparatus Used

To avoid rapid evaporation of the liquid inclusion by sputtering from the primary ion beam at the time when the wall of crystal is breached, the inclusion was maintained in the frozen state. A specially designed cooling system close to the specimen chamber of the conventional ion microanalyser was added, as shown in Fig. 1. Beryllia, which provides high heat conductivity, served as the electrically insulating material between a copper connector and the cooling vessel. The cooling vessel was made of stainless steel and filled with liquid nitrogen.

A silver net served as the medium for heat conduction from the beryllia to the cooling plate and permitted the movement of the specimen stage to the desired position for ion beam analysis. The micro-size liquid inclusion remains in the supercooled state or frozen. Energy for cooling the specimen must balance the energy supplied by the primary ion beam and the electron spray.

For the preliminary test, surface temperatures of both the cooling stage and a 1 mm thick quartz plate on the cooling stage were measured and their results are shown in Fig. 2. The surface temperature of the specimen could reach -90°C at steady state conditions under the following ion beam conditions: Ar^+ ions were used as the primary beam; the accelerating voltage applied was in the range of ∿7 to 10keV; and the beam diameter was in the range of ∿50 to 150μm, taking the size of the liquid inclusion into consideration. To neutralize the positively charged specimen surface, an electron spray technique was applied, using an appropriate filament voltage as well as a suitable adjustment of the distance between the filament and the specimen surface.

Preliminary Experiment

In preliminary experiments, Na^+ ion intensities from a 20wt% NaCl aqueous solution enclosed in fused silica capsules and from a single crystal of NaCl were measured. The change in Na^+ ion intensity with time is shown in Fig. 3. The ratio of the Na^+ ion intensity of a 20wt% NaCl aqueous solution to that of the single crystal of NaCl was estimated to be 0.70, which indicated that NaCl dissolved in the aqueous solution showed chemically enhanced ionization in comparison with the solid crystal. Thus, a calibration curve was needed for the quantitative analysis of liquid inclusions. One such calibration curve is shown in Fig. 4, made by measuring Na^+ ion intensities of various concentrations of NaCl in NaCl-KCl aqueous solutions enclosed in fused silica capsules. Therefore, the quantitative analysis seems possible, by comparing the relative ion intensity to that from synthetic specimens prepared by enclosing aqueous solutions containing various salts in fused silica capsules and by use of the molarity of the inclusion fluid as estimated from the depression of the freezing temperature.

Analytical Results on Fluid Inclusions

The tested samples of quartz, enclosing fluid inclusions in the size range ∿10 to 120μm were from vein-type hydrothermal deposits in Japan, as described in Table 1. Before measuring the ion intensities, the specimen was ground and polished in order to make the distance between the specimen surface and a specified liquid inclusion as small as possible. This procedure greatly shortened the time required for the analysis of the liquid inclusion.

The results obtained on the relative intensities of various elements to the intensity of $^{23}Na^+$ are listed in Table 2. The freezing temperature (i.e., the melting of the last ice crystal on warming a frozen inclusion) of the fluid inclusions measured by means of a cooling microscope stage is also given. The average sputtering rate of the specimen was estimated to be in the range of ∿5 to 10μm/hr. The analytical results of the fluid inclusions in various quartz minerals indicate the characteristic features of their components and relative ion intensities. Even in the same deposit, the composition of the fluid inclusions varies with the stage of mineralization. Variations in magnesium and aluminum contents were especially noticeable. Fluid inclusions in quartz contained heavy metal ions such as manganese, iron, copper and zinc. Fig. 5 shows an example of the mass spectrum of a fluid inclusion in hydrothermally synthesized quartz. These facts suggest that the analysis of fluid inclusions in quartz will allow the estimation of the mineralizing conditions of ore deposits.

Conclusions

Frozen fluid inclusions in various quartz samples, with sizes of less than 30μm can be analyzed by an ion micro-analyzer, using special techniques.

Quantitative analysis seems possible, by comparing the relative ion intensities to those from synthetic specimens prepared by enclosing aqueous solutions containing various salts in fused silica capsules and by use of the molarity of the inclusion fluid as estimated from the depression of the freezing temperature.

Calibration methods are required for quantitative analysis, because the salt dissolved in aqueous solutions showed chemically enhanced ionization.

Table 1 Tested samples

Mine, Prefecture	Ore	Sample No.		Size of inclusion (μm)
Kaneuchi, Kyoto	scheelite, wolframite	1	Gessei Vein	75
		2	" "	100
		3	Doshin vein	75
		4	Suei vein	< 10
Ani, Akita	chalcopyrite	1	Hotei vein	100
		2	Fukuroku vein	75
Hosokura, Miyagi	sphalerite, galena	1	Oiwake No. 1 vein	≒ 40
		2	"	"
		3	"	"
		4	"	"
		5	"	50
		6	Hanayama vein	40
Tsuchihata, Iwate	chalcopyrite, galena, sphalerite	1	Hatabira ore body	30
		2	"	< 10
		3	"	50
Asahi, Fukushima	clay: kaolinite, halloysite, sericite	1	quartz veinlet in clay	125
		2	"	75
		3	"	< 10
		4	"	"

Table 2 Ion intensities of various elements relative to the intensity of $^{23}Na^+$

m/e	element	Kaneuchi mine				Ani mine		Hosokura mine						Tsuchihata mine			Asahi mine			
		1	2	3	4	1	2	1	2	3	4	5	6	1	2	3	1	2	3	4
7	Li+	0.06	0.03	0.22	0.27	0.11	0.21			0.04				0.15	0.7			0.04	0.01	
11	B+	--	--	0.12	--	0.01	0.01			0.27				--	--			--	<0.01	
19	F-		+	+	+	+	+	+		--	+		+			+				
23	Na+	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.0	1.00	1.00	1.00	1.00	1.00
24	Mg+	3.83	--	0.01	--	--	--	0.24	0.11	--	--	--	--	--	--	0.06	0.02	--	--	--
27	Al+	1.33	0.09	0.16	1.55	0.31	1.11	3.76	0.97	0.67	0.14	0.35	0.50	2.50	scale out	1.57	1.67	--	--	--
35	Cl-		--	+		+	+	+		+	+		+			+				
39	K+	1.17	0.06	0.16	0.09	0.30	0.27	0.47	0.46	0.63	0.27	0.55	0.02	0.50	0.6	0.10	0.62	1.30	0.03	0.49
40	Ca+	1.17	0.85	0.01	0.09	scale out	2.32	0.60	0.25	0.88	1.07	0.14	0.12	0.23	0.7	0.09	0.20	0.04	--	0.14
55	Mn+	--	--	--	--	0.04	0.05	--	0.10	0.44	0.06	0.08	--	0.01	0.1	0.05	--	--	--	--
56	Fe+	--	--	--	--	--	--	--	--	--	<0.01	--	--	--	--	--	--	--	--	<0.01
63	Cu+	--	0.05	--	--		--		--	--						0.02	--		<0.01	
64	Zn+		--	--	--		--		0.19	0.18						--	--		--	
freezing temp.		-6.8	-5.5	-4.2		-11.7	-15.5	-4.0~-4.2				-3.8	-2.0	-2.0		-5.0	-1.5	-3.2	-0.5	

--not detected; + detected as minus ion; blank colum, not measured

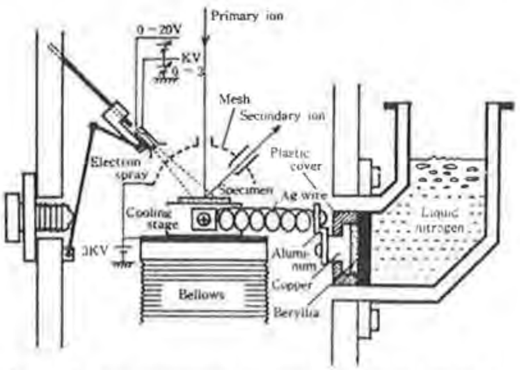

Fig. 1 Cross section of the cooling stage and electron spray devices.

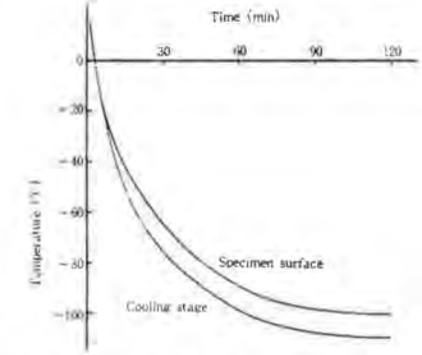

Fig. 2 An example of cooling curves of the cooling stage and specimen surface.

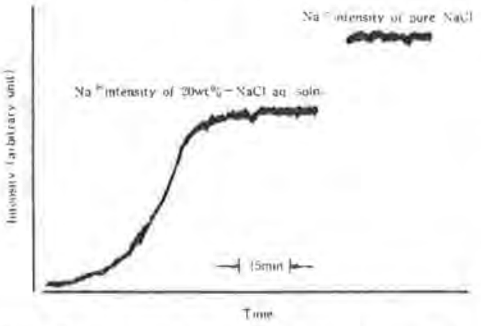

Fig. 3 Change of Na⁺ ion intensity of 20 wt% NaCl aqueous solution and NaCl single crystal with time.

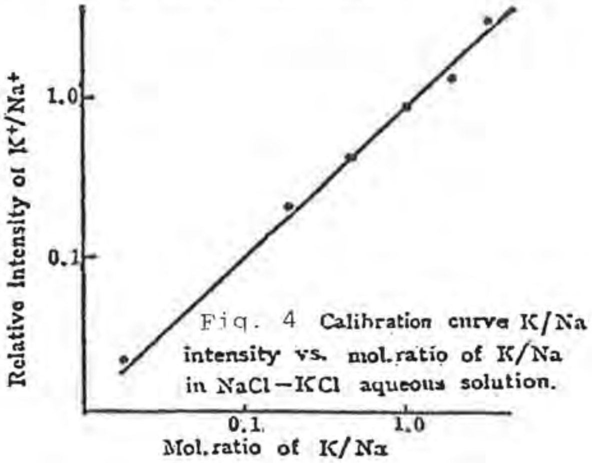

Fig. 4 Calibration curve K/Na intensity vs. mol.ratio of K/Na in NaCl-KCl aqueous solution.

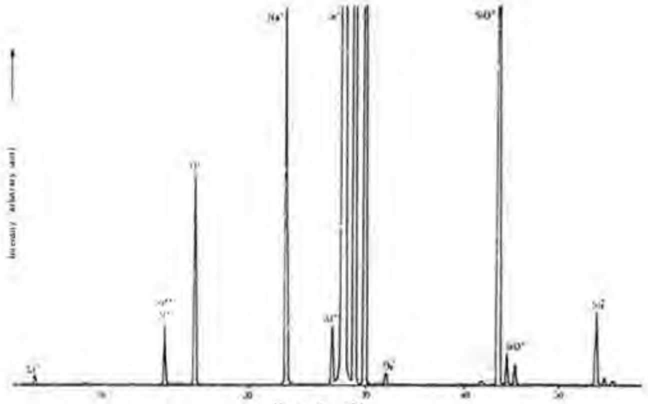

Fig. 5 Mass spectrum of fluid inclusion in hydrothermally synthesized quartz.

RAVICH, M.I. and BOROVAYA, F.E., 1949, Phase equilibria in ternary water-salt systems at high temperatures: Akad. Nauk SSSR, Izv. Sekt. Fiziko-Khimi. Anal., v. 19, p. 69-81 (in Russian; translation courtesy of Paul L. Cloke and Timothy R. Reynolds, Dept. Geological Sciences, Univ. Mich., Ann Arbor, Mich.)

The study of phase equilibria in water-salt systems at high temperatures, in addition to theoretical interest, also has immediate practical significance (for high parameter gas engineers). The development of such work should open new views of the technology of salt, and the determination of general mechanisms of crystallization of salts in the presence of vapor at high pressure has significance for understanding processes proceeding in the depths of the earth.

The crystallization of salt in the presence of aqueous vapor (requires) examination of the properties of solutions at a given composition and temperature and the equilibrium properties of the system at a given T and P for a given combination of salts.

Therefore, to determine salt crystallization conditions in the presence of an aqueous vapor, in addition to knowing the solubility, it is also necessary to construct vapor pressure (curves) of saturated solutions over a wide range in temperatures--up to the melting of anhydrous salt compositions.

In the present study we describe our methods and cite results of the study of the solubility and vapor pressure of saturated solutions in some ternary aqueous salt systems. The investigation was at temperatures up to 650°C and pressures to 350 atm.

The determinations were made in a specially constructed steel autoclave connected to a system of mercury manometers. Finally, a stirrer was adapted to the autoclave for use with potassium and sodium sulfates.*

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*A description of the techniques and apparatus will be published separately.

The usual method of determining the temperature at the beginning of crystallization of salts from solutions - visual and thermographic - proved very difficult to accomplish, as was taking of samples for analysis. Therefore, for the determination of temperature at the beginning of crystallization of salts we took advantage of the change in vapor pressure. A known mixture of salts and water was placed in the autoclave so that at some temperature the solution was known to be undersaturated. Saturation of the solution was accomplished by 1) concentration at constant temperature (removal of small amounts of water vapor with calculation of the amount remaining after each withdrawal of water), 2) by reduction of temperature at constant water content.

After each removal of water vapor or decrease in temperature the vapor pressure is measured and if there is a break on the P-X (where X is the water content) or P-T curves, crystallization has begun. The position of the break on the P-X curve shows the concentration and vapor pressure of saturated solutions at a given temperature. The position of the break on P-T curves shows the temperature and vapor pressure of saturated solutions at a given composition. Figs. 1 and 2 show several measurements of P-X and P-T curves. Some curves show two breaks, the first corresponding to the beginning of crystallization of one salt, the second the beginning of joint crystallization of both salts (the formation of eutonic solutions*)

The polythermal method (the construction of P-T curves) gives a clear picture for investigation of systems at temperatures higher than 450-500°C; for lower temperatures the isothermal (P-X) method is used.

Below are the results of investigations of the systems: $KCl-NaCl-H_2O$, $KCl-K_2SO_4-H_2O$, $NaCl-Na_2SO_4-H_2O$, and $KCl-KBr-H_2O$.

On figure 3 are shown P-T curves of solutions saturated in KCl, NaCl, and mixtures of these two salts (eutonics*). These curves begin at zero water vapor pressure and (end) at the temperatures of fusion of anhydrous salts. The eutecic curve starts at the fusion temperature of the most easily fusible solid solution (KCl-NaCl) and proceeds through the maximum vapor pressure. The general character of these curves is such that, as shown on the P-T curves for saturated solutions of easily fusible salts (1,2,3,4), the solubilities increase continuously with temperature. But the vapor pressure maximum of saturated solutions of the latter is measured in hundreds of millimeters of mercury, while the maxima for chlorides of potassium and sodium are measured in hundreds of atmospheres.

Note the decrease in the maximum vapor pressure of eutectic solutions (132 $kg \cdot cm^{-2}$) as compared to the corresponding pressures of the pure salts (224 $kg \cdot cm^{-2}$ for KCl; 401 $kg \cdot cm^{-2}$ for NaCl). Figure 4 shows polythermal solubilities in the system $KCl-NaCl-H_2O$ from our data above 300°C*. The path of the solubility isotherms shows that at high temperatures the field of crystallization of KCl and NaCl, approximately, uninterruptedly passes over (from) one to the other (evidently as a consequence of the crystallization of an uninterrupted series of solid solutions) which is in agreement with results of studies on the system KCl-NaCl (9, 10 (sic.; 17?)).

Figure 5 shows isobars of saturated solutions in the ternary system $NaCl-KCl-H_2O$. Salt compositions by weight are plotted on the abscissa and temperatures of saturated solutions on the ordinate; the numbers along the curves are water vapor pressures in $kg \cdot cm^{-2}$. The isobar corresponding to zero water vapor pressure appears as the liquidus of the anhydrous system KCl-NaCl. Each isobar consists of two divided curves, which is explained by the fact that the P-T curves of saturated solutions in the binary system $KCl-H_2O$ and $NaCl-H_2O$, and also of cross-sections, originating from the water corner of the ternary system $KCl-NaCl-H_2O$, are characterized by the presence of a vapor pressure maximum, owing to which each pressure corresponds not to one, but two, points (two temperatures, and correspondingly, two concentra-

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*Data for eutonic solutions were obtained by measurement of the vapor pressure at a known excess of both salts. The invariance of pressure following some escape of water vapor demonstrates the saturation by both salts. The eutonic curve thus represents all data obtained following the second break on the P-X and P-T curves, independent of the initial composition of the mixture. The P-T curves of saturated solutions of KCl and NaCl were also determined by Benedict [5] and Keevil [6].

*At 200 and 100°C the diagram utilizes the data of Akhumov and Vasil'ev [7] and at 0°C and lower those of Palkin.

tions). For the isobars corresponding to vapor pressures less than 132 kg/cm^2 (the maximum on the P-T curve of eutonic solutions), each of the two curves starts in the region of the diagram corresponding to one salt and ends in the region corresponding to the other. Two separate curves, corresponding to the same isobar, converge according to the degree of water vapor pressure increase. At a pressure of 132 kg/cm^2 these two curves converge in a point, in consequence of the fact that the isobars of saturated solutions, corresponding to a higher pressure, have already a different character. Each of the two curves of any given (i.e., higher; Ed.) isobar is started and completed on the side of the diagram corresponding to one salt; thus the gap between any two curves is proportional to the magnitude of the pressure.

The vapor pressure diagram of saturated solutions in the KCl-NaCl-H_2O system is the simplest typical example of a mixture of two salts, being melted with a temperature minimum, and characterized by uninterrupted increase of solubility in water with increase of temperature.

The vapor pressure diagrams of saturated solutions directly show conditions of salt crystallization in the presence of aqueous vapor. Examination of figure 6, in view of the representation scheme of separate isobars of saturated solutions of the simplest ternary salt systems, permits drawing the following conclusions:

1. At invariant water vapor pressure, salt crystallization occurs only within a definite temperature range (t_1-t_2, Fig. 6a,b,c,d for solid solution a_1) above and below which only liquid unsaturated solutions can appear in equilibrium with vapor. For a salt mixture of a given composition, this temperature interval is inversely related to the vapor pressure (Fig. 5).

2. If the aqueous vapor pressure is less than the maximum vapor pressure of eutonic solutions (Fig. 6a,c), the salt crystallization will occur either with or without a liquid saturated solution; given a sufficiently wide temperature range, it is not possible to avoid crystallization of salts.

3. If the aqueous pressure is greater than the maximum vapor pressure of eutonic solutions (Fig. 6,b,d, solid. soln. a_1), the crystallization of salts will occur only with a saturated liquid solution, with the exception of those cases when the composition of the initial salt mixture lies in a region of homogeneous solid solution (Fig. 6, solid solution a_3). At these pressures there exists a region of salt mixture compositions within which crystallization of salts will not occur at any temperature (Fig. 6d, solid soln. a_3). This region increases with increase in temperature, reaching to the composition of pure salts (Fig. 5). Diagrams of vapor pressure of saturated solutions likewise show the compositions of liquid solutions and make possible the graphic calculation of the relative amounts of liquid and solid phases. An aqueous vapor pressure greater than 224 kg/cm^2 will prohibit crystallization of salts in the KCl-H_2O system; the corresponding pressure in the NaCl-H_2O system is 401 kg/cm^2, and in the system KCl-NaCl-H_2O it is only 132 kg/cm^2. The prevention of crystallization of salt mixtures through significant reduction in vapor pressure relative to the salts involved is of great significance, indicating the necessity for suitable investigations of not only two- but multi-component water-salt systems.

Of particular interest is the study of phase equilibria at high temperatures in water-salt systems containing chlorides and sulfates of potassium and sodium. The sulfates of potassium and sodium are characterized, at high temperatures, by a negative temperature solubility coefficient; at 350°C their solubility in water becomes insignificant [11, 12]. However, even though these salts remain slightly soluble in water at high temperatures, they dissolve well in molten chlorides of potassium and sodium [13]. Therefore the possibility remains that in the $KCl-K_2SO_4-H_2O$ and $NaCl-Na_2SO_4-H_2O$ systems at high temperatures, when the chloride content in the solution is large, the sulfates of potassium and sodium can likewise prove significantly soluble. In this case, the maximum of the P-T curve of eutonic solutions ought to correspond to a far lower vapor pressure than the maximum of the P-T curve of saturated solutions of the corresponding chloride. In Figure 7 are depicted the P-T curves of saturated KCl solutions and eutonic solutions of the $KCl-K_2SO_4$ system. Figure 8 depicts the same curves of the corresponding sodium system.* In the potassic system the maximum vapor pressure at the transition from chloride to the eutonic mixture of it with sulfate drops approximately to 45 kg/cm^2, and in the sodic to 175 kg/cm^2, bearing witness to the significant solubility of sulfates of potassium and sodium in a saturated aqueous solution of the corresponding chloride at high temperatures.

Application of our method likewise permitted the study of the field of crystallization of chlorides in the systems $KCl-K_2SO_4-H_2O$ and $NaCl-Na_2SO_4-H_2O$ (P-T curves of saturated solutions of diverse cross-sections, cf. Figs. 7 and 8; isotherms of solubility, cf. Figs. 9 and 10). For the construction of the boundaries of the fields of crystallization of chloride and sulfate we utilized two breaks of the P-X and P-T curves, which show not only the vapor pressure and temperature, but also the relative amounts of water and one of the salts in the eutonic solutions. We are justified in this conclusion in view of the fact that chlorides and sulfates do not form solid solutions.

If one proceeds from solutions lying in the field of crystallization of chloride, then a double break shows the relative contents of sulfate and water; if one proceeds from solutions lying in the field of crystallization of sulfate (for this purpose a known excess of sulfate was previously taken), then a break shows the relative contents of chloride and water in the eutonic solution.

It is thus possible to describe the constitution of the eutonic solutions as a function of temperature in the form of two curves, one of which shows the percent water content when the sum of sulfate and water is assumed to be 100, and the other when the sum of chloride and water is assumed to be 100. These curves (Figs. 7 and 8) are started at zero water content and at temperatures of melting of the corresponding anhydrous eutectic solid solutions. Knowing the ratio of sulfate and water, and likewise chloride and water, for the given temperatures, it is not difficult to calculate the constitution of the eutonic solution by analytical and graphical means. By such means we constructed the boundaries of the fields of crystallization of sulfate and chloride at temperatures above 400°C (Figs. 9 and 10). At lower temperatures this method could not be utilized, in consequence of the nondetectability of the two breaks on the P-X curves of the solutions, lying in the chloride field, and at these temperatures the boundaries of the fields are drawn approximately, by dashes, to the eutonic point at 100°C, determined by a common analytical method (14, 15). The boundary of the fields of crystallization of sulfate and chloride at relatively low temperatures

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*For obtaining the eutonic curves we started from solutions lying in both the sulfate and chloride fields; all data agree well.

is found near the chloride-water side of the triangle; with increase of temperature the field of crystallization of chloride is strongly expanded, especially in the sodic system, which also explains the significant reduction of the maximum of vapor pressure of eutonic solutions in comparison with the vapor pressure maximum of a saturated solution of the corresponding chloride.

Thus, in the presence of chlorides, at determined water vapor pressures, the sulfates of both potassium and sodium at high temperatures are entirely in a liquid state and will not crystallize, even at significant concentrations.

In such cases, when pure salts are not crystallized, but [instead] their solid solutions, judging from the general character of vapor pressure diagrams of saturated solutions and from the path of the P-X and P-T curves, it is possible to draw some conclusions about the type of the solid solutions, about the path of their change of composition with increase of temperature, and about courses of crystallization, without resorting to the extremely difficult practical operation of separating samples of the liquid and solid phases in conditions of high temperatures, pressures and concentrations. As an experimental example there is our study of the KCl-KBr-H_2O system. Solubility polytherms of this system are represented in Figure 11.* The continuous course of the solubility isotherms in all temperature intervals of the field of crystallization of salts attests to the presence in this system, besides the field of ice, of only one field of crystallization of continuous KCl-KBr solid solutions. Nevertheless, it is impossible to draw any conclusion about the type of these solid solutions and paths of crystallization on the basis of this diagram.

The investigations of solid phases in this system at 0, 25 and 35°C (18, 19, 20, 21) attest to the crystallization of continuous solid solutions, of the second type. This type is characterized by the fact that the distribution curve intersects the diagonal of a square and shows the presence of a congruent point, in the direction of which move any given points representing the compositions of the liquid phases during isothermal evaporation of the solutions.

If the solid phases, being crystallized at higher temperatures, are likewise continuous KCl-KBr solid solutions of the same type, then the isotherms of vapor pressure of saturated solutions at these temperatures ought themselves to represent continuous curves with a minimum, whereupon the position of the minimum ought to show the composition of the congruent solution. In Figure 12 are depicted the isotherms of vapor pressure of saturated solutions corresponding to temperatures of 300, 400, 500 and 600°C. The presence of a skewed minimum in all curves show that in this system at all temperatures there actually are crystallized continuous solid solutions of the second type. The position of the minima on the isotherms of vapor pressure gives the possibility of laying out on the solubility diagram a line of final points of crystallization during isothermal evaporation (dashed on Fig. 11), in the direction of which go all paths of crystallization in this ternary system during isothermal evaporation. It is impossible to consider the position of this line on the diagram to be exactly established, just as the minimum on the isotherms

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*The 100°C isotherm was constructed according to the data of Etar (16), the 0°C isotherm and the boundaries of the ice field according to the data of A.G. Bergman and N.A. Vlasov (17).

of vapor pressure of saturated solutions is very skewed. Its approximate location, near the cross-section corresponding to the composition 80% KBr, is confirmed by the fact that the P-X curves corresponding to this cross-section, after the start of crystallization, have a horizontal path; at the time these same curves for other cross-sections show that, after the start of crystallization, the vapor pressure, is always reduced, although slowly.

The P-X curves after the start of crystallization of salt give the possibility of drawing some conclusions also about the cause of change of the quantitative constitution of crystallizing solid solutions with an increase of temperature.

If it is assumed that the distribution curve (constructed according to the data at 0, 25 and 35°C) is not changed with an increase of temperature, then, employing elementary graphical methods, it is possible to find the position of a given point of composition of a liquid phase on the corresponding isotherm of solubility after evaporating a fixed quantity of water from a solution of a given composition. Employing the curves of Figure 12, it is possible to indicate the corresponding vapor pressure. If these values are plotted on the diagram (Fig. 1, small crosses on the P-X curves, corresponding to composition 20, 40 and 60% KBr at 400 and 500°C), then the curves obtained show that path which should take place after the start of crystallization of salt if the distribution curves were not changed with an increase of temperature. In actuality the experimental P-X curves after the beginning of crystallization of salt at 400 and 500°C in all cases lie above the estimated (curves), affirming the fact that at these temperatures the composition of the liquid solution in the process of isothermal evaporation declines less from the initial than at room temperature. Consequently the composition of solid KCl-KBr solutions, crystallizing at high temperatures, is closer to the composition of the salt content of the liquid phase than at low temperatures; i.e., in the presence of an increase of temperature the tendency toward miscibility of KCl and KBr in the solid state is increased.

The study of the vapor pressure of saturated solutions gives a series of indications concerning the nature of solid solutions and courses of crystallization which have particular significance in those cases where separation of liquid and solid phases is difficult to accomplish.

CONCLUSIONS

1. The experimental investigation of the KCl-NaCl-H_2O; KCl-K_2SO_4-H_2O; NaCl-Na_2SO_4-H_2O and KCl-KBr-H_2O systems in the temperature interval from 200 to 650°C showed that the method of determination of P-X and P-T curves makes possible the construction of diagrams of solubility and vapor pressure of saturated solutions in water-salt systems. This has special significance in conditions when, due to high temperature, pressure and concentration, it is difficult to obtain samples for analysis, or to determine the temperatures of the onset of crystallization by visual and thermographic methods.

2. Obtaining diagrams of solubility and vapor pressure of saturated solutions defines the conditions of crystallization of salt mixtures in the presence of aqueous vapor and fixes the pressure of aqueous vapor above which crystallization of salts is not possible.

3. As a result of the study of the KCl-NaCl-H_2O system, there were shown conditions of crystallization of salt mixtures in the presence of aqueous vapor of the simplest cases (salts were characterized by positive

temperature coefficients of solubility, did not form chemical compounds and mixtures of them had melted with a temperature minimum).

4. As a result of the study of the $KCl-K_2SO_4-H_2O$ and $NaCl-NaSO_4-H_2O$ systems it was shown that potassium and sodium sulfates, the temperature coefficient of solubility of which at high temperature becomes negative, dissolve well at high temperatures in saturated solutions of the corresponding chlorides, and at a definite water vapor pressure can remain completely in the liquid phase, even at significant concentrations.

5. As a result of the study of the $KCl-KBr-H_2O$ system it was shown that the method of determination of the P-X and P-T curves allows one to draw a series of conclusions concerning the paths of crystallization, the type of solid solutions being crystallized and the directions of change of the quantitative composition of solid phases with an increase of temperature, without separating samples of liquid solutions and crystallizing salts.

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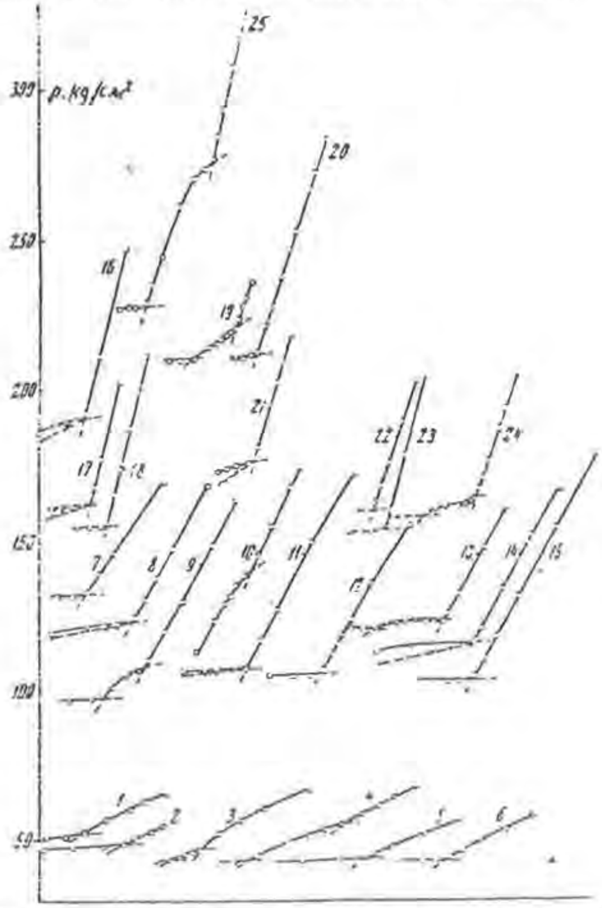
FIGURES

Translation of coordinate axes given in brackets [], abscissa (horizontal) first and ordinate (vertical) second.



No.	Percent			Temp.
	KCl	KBr	NaCl	°C
1	100			300
2	80	20		"
3	75		25	"
4	50		50	"
5	40	60		"
6		100		"
7	100			400
8	80	20		"
9	75		25	"
10	50		50	"
11	40	60		"
12		100		"

No.	Percent					Temp.
	KCl	KBr	NaCl	K_2SO_4	Na_2SO_4	°C
13	90			10		400
14	60	40				"
15	20	80				"
16	80	20				500
17	40	60				"
18		100				"
19			55		45	450
20			X		X	"
21	60	40				500
22	X			X		450
23	20	80				500
24	85			15		450
25			60		40	500

X = in excess

Fig. 1. [Scale of abscissa: 10 wt % H_2O; P, kg/cm^2]

Experimental P-X curves. To avoid superimposing one curve on another the beginning of the coordinate axis for the abscissa was displaced for each curve.

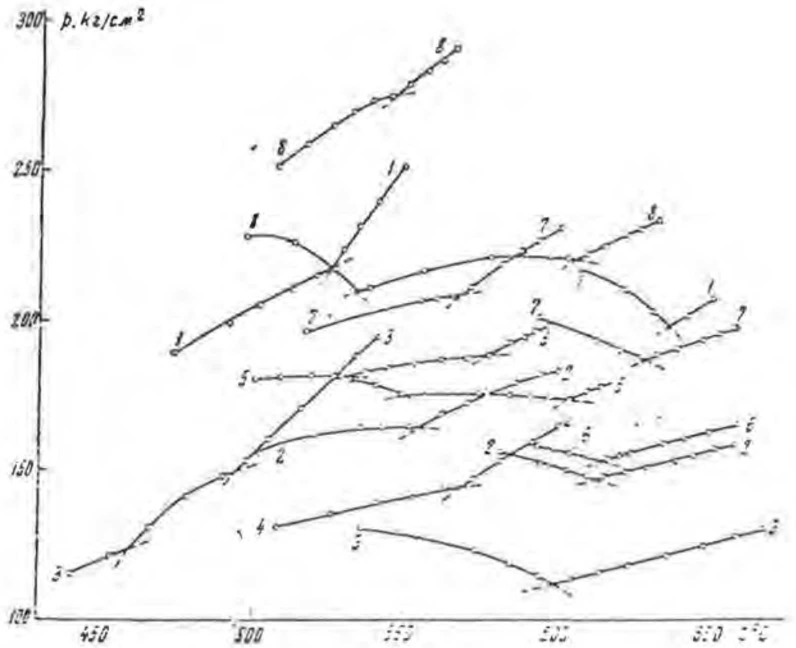


Fig. 2. [t °C; P, Kg/cm^2]

Experimental P-T curves.

1. KCl; 2. KBr; 3. 75KCl-25NaCl; 4. 50KCl-50NaCl; 5. 75KCl-25K_2SO_4;
6. 40KCl-60KBr; 7. 80KCl-20KBr; 8. 50NaCl-50Na_2SO_4.

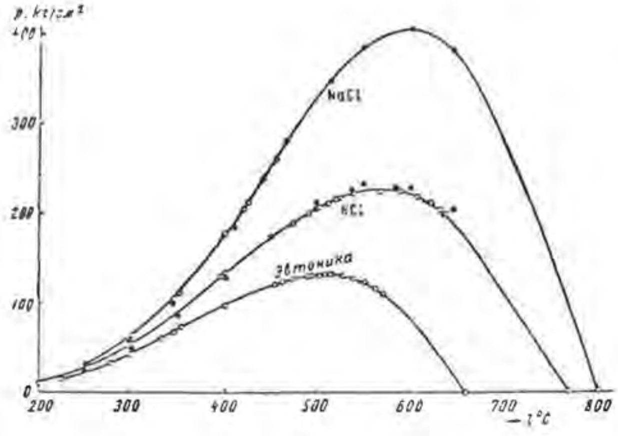


Fig. 3

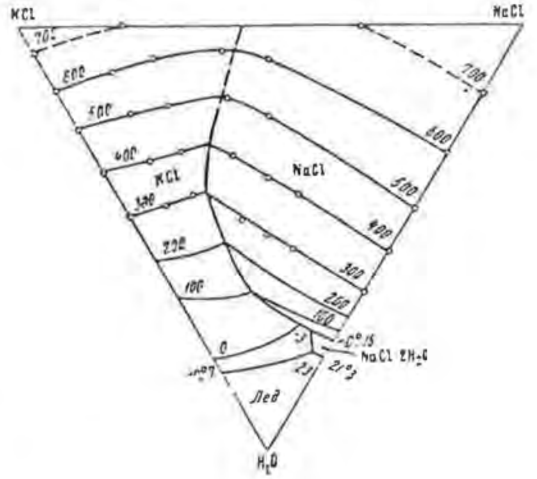
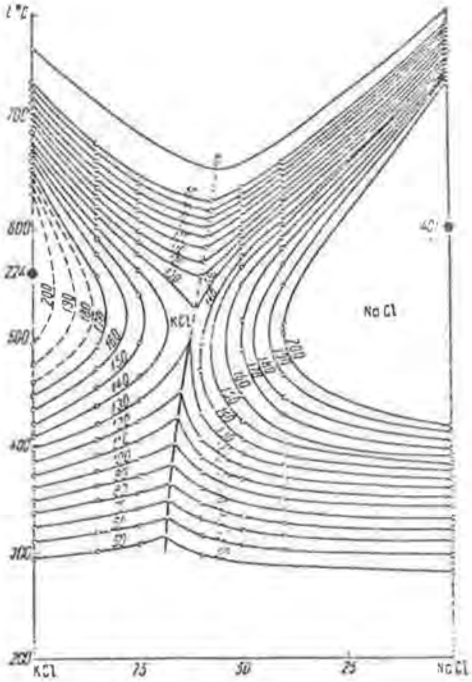


Fig. 4

Fig. 3. [T°C; P, kg/cm^2] Experimental P-T curves of solutions saturated in KCl, NaCl and a mixture of the two salts (the eutonic).
The solid black dots represent the data of Benedict and Keevil.

Fig. 4. Polytherms of solubility of the ternary system KCl-NaCl-H_2O.
Numbers on the isotherms are temperatures (in °C).



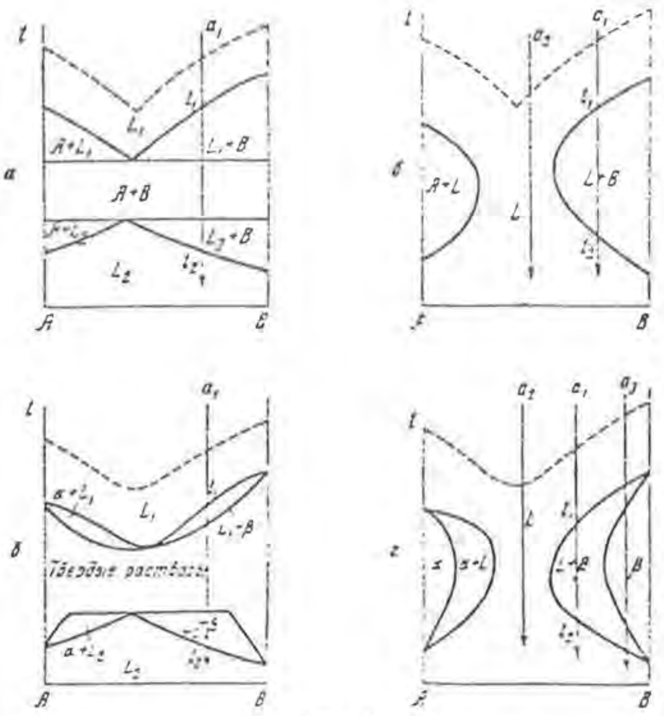


Fig. 6

Fig. 5. [KCl-NaCl; t °C]

Isobars of saturated solutions of the ternary system KCl-NaCl-H_2O. Numbers on the isobars are pressures (in kg/cm^2).

Fig. 6. [A-B; t]

Scheme of isobars of saturated solutions of the simplest ternary water-salt systems.

a: Vapor pressure below the maximum vapor pressure of eutonic solutions; solid solutions are not found; b: vapor pressure above the maximum vapor pressure of eutonic solutions; solid solutions are not found; c: vapor pressure below the maximum vapor pressure of eutonic solutions; solid solutions are formed; d: vapor pressure above the maximum vapor pressure of eutonic solutions; solid solutions are formed.

The zero isobar is shown dashed, i.e. the liquidus curve of the binary anhydrous system.

A: first salt; B: second salt, L: liquid solution; α: A-rich solid solution; β: B-rich solid solution.

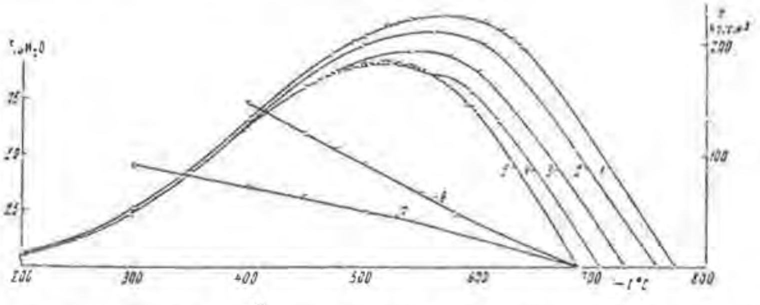


Fig. 7. [t °C; p, kg/cm^2, on right, curves 1-5; %H_2O, curves 6-7].

KCl-K_2SO_4-H_2O system. P-T curves of saturated solutions and contents of water in saturated solutions as a function of temperature (sum of one of the salts and water assumed at 100).

1. KCl; 2. 85KCl-15K_2SO_4; 3. 75KCl-25K_2SO_4; 4. 65KCl-35K_2SO_4; 5. KCl+K_2SO_4(eutonic); 6. K_2SO_4+H_2O=100; 7. KCl+H_2O=100.

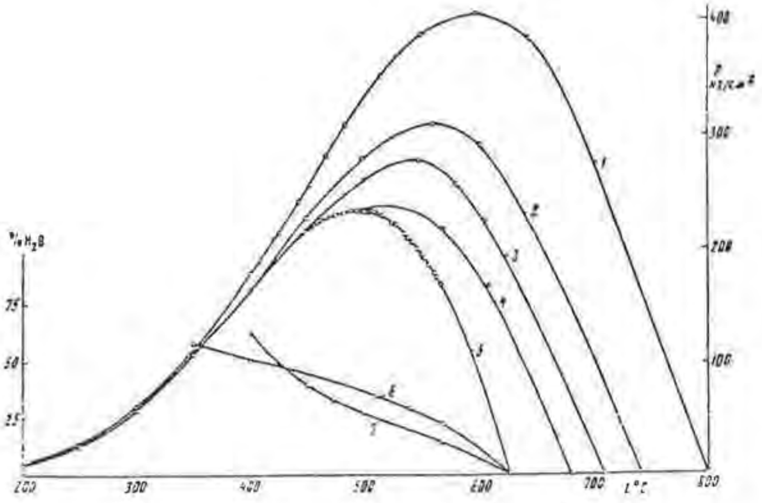


Fig. 8. [t °C; % H_2O. p, kg/cm^2 on right, curves 1-5; on left, curves 6-7].

The $NaCl-Na_2SO_4-H_2O$ system. P-T curves of saturated solutions and concentration of water in eutonic solutions as a function of temperature (sum of one of the salts and water assumed to be 100).

1. NaCl; 2. $60NaCl-40Na_2SO_4$; 3. $50NaCl-50Na_2SO_4$; 4. $42NaCl-58Na_2SO_4$; 5. $NaCl+Na_2SO_4$ (eutonic); 6. $NaCl+H_2O=100$; 7. $Na_2SO_4+H_2O=100$.

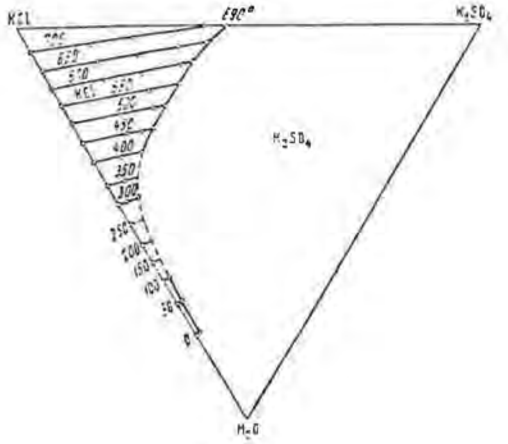


Fig. 9

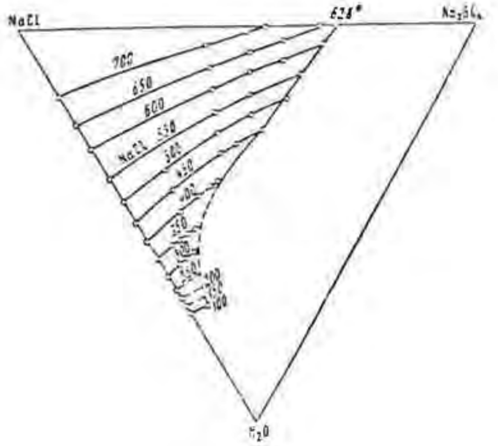


Fig. 10

Fig. 9. Field of crystallization of KCl in the system $KCl-K_2SO_4-H_2O$ at high temperature.

Numbers on the isotherms are temperatures in °C .

Fig. 10. Field of crystallization of NaCl in the system $NaCl-K_2SO_4-H_2O$ at high temperatures.

Numbers on the isotherms are temperatures (in °C).

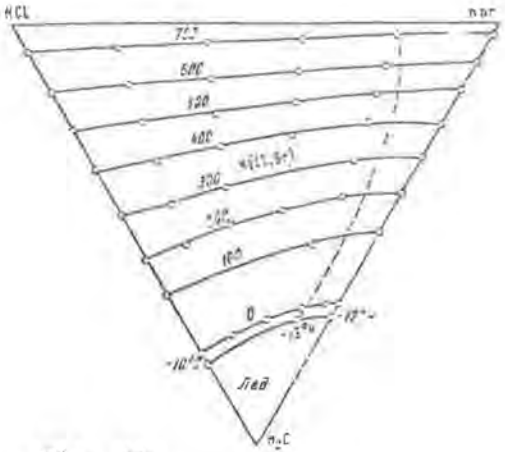


Fig. 11

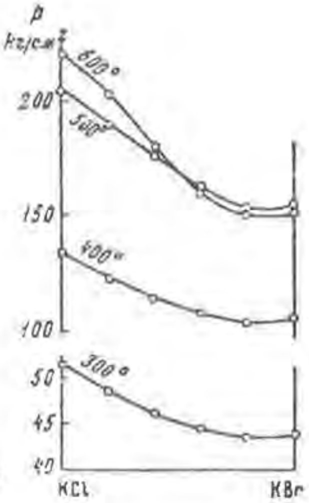


Fig. 12

Fig. 11. Polytherms of solubility in the KCl-KBr-H_2O system. Numbers on the isotherms are temperatures (in °C).

Fig. 12. [KCl-KBr; p, kg/cm^2]
Isotherms of vapor pressures of saturated solutions of the KCl-KBr-H_2O system.

SHUGUROVA, N.A., DOLGOV, Yu.A. and IVANOVA, G.M., 1976, Composition of gaseous inclusions in silicate spherules of various origin, in Genetic studies in mineralogy, Yu.A. Dolgov et al., eds: Novosibirsk, Inst. Geol. and Geophy. Sib. Branch Acad. Sci. USSR, p. 3-8 (in Russian; text shortened and translated by A. Kozlowski).

Accretion of the cosmic silicate material reaches hundreds to thousands of tons per day. All space particles submittable to observation, i.e., dia. >50 μm, passing through the Earth's atmosphere, melt and reach the Earth's surface as droplets or spherules frequently bearing G inclusions. An attempt was made to determine the composition of G in these inclusions by microvolumetric method of analysis of individual inclusions. The following materials were analysed:

1. Artificial spherules made from the meteoritic substance by melting in the electric arc between carbon electrodes, under conditions comparable with the ablation of meteorites. The enstatite achondrite Norton County and howardite Yurtuk were used. Iron meteorite Tobychan was covered by droplets of silicate melt believed to be the melted terrestrial material.

2. Spherules from the ancient sedimentary rocks include 3 types: from Neogene sands of Pridneprov'ye, from primary kaolins (after granites and granite-gneisses) of the upper part of the Glukhovetskoe deposit in the Vinnitskaya area, from the Jurassic limestones of Crimea Peninsula. All spherules were found among the heavy fraction of the accessory minerals, and they are believed to be the product of ablation of meteorites.

3. In kimberlites of the diamond-bearing pipe "Aykhal" spherical and other variable shape glass particles were found. They have black or pale-green color and have G bubbles visible through the glass.

4. Spherules from the location of the Tungusskiy phenomenon. They

were taken from various horizons of the peat deposit. Three kinds of silicate spherules were studied: a. colorless, transparent; b. blue; c. colored. Also three horizons were taken into account: I - including year 1908; II - overlying (recent); III - underlying 150-200 years old.

5. Typical industrial spherules of the widespread type: colored, transparent.

Results of determinations are listed in the Table 1:

Table 1. Composition of gaseous inclusions in silicate spherules of various origins

No. Shortening of bubble, times	Composition of gases in inclusions, vol. %							No. of determinations	Brief characteristics of spherule
	H_2S, SO_2, HCl, HF, NH_3	CO_2	CO	hydrocarbons	H_2	O_2	N_2 + rare gases		
I. Artificial spherules made from meteorite material									
1. 1.2-59.0	-	69.5--92.5	-	7.5-30.5	-	-	-	5	Colorless transparent, from enstatite achondrite Norton County
2. 10.8-21.2	-	85.5-90.2	-	-	-	-	9.8-14.5	2	Colorless and pale brown, from meteorite Yurtuk
3. 1-1.04	-	10.5-15.0	-	-	-	15.9-18.9	69.1-70.7	2	
4. 3.74-47.8	7.5-10.1	31.89-50	12.5-29.9	10.5-25		15.31-29.2		5	Colorless transparent, formed in connection with meteorite Tobychan
II. Ancient sedimentary rocks									
5. 5.1-9.1	8-8.9	91.2-92	-	-	-	-	-	5	Pridneprov'ye, Neogene
6. 2.26-84	13.5-23.5	62.4-70.5	-	-	-	-	10-16.8	8	Glukhovetskoe deposit
7. ?	18	44	18	n.d.*	20			1	Crimea, Jurassic
III. Diamond-bearing pipe "Aykhal"									
8. 14.85-61	-	2.2-10	-	22.5-25.7	4.8-5.5	-	57.7-96.9	9	Black and pale green
IV. Industrial spherules									
9.	-	-	10.5-11.0	-	-	17.3-17.9	71.3-71.5	3	Colorless

*n.d. = not determined

In all inclusions decrease of bubble size was observed during crushing, probably due to elevated T during formation. Same feature was observed in lunar impact spherules. Part of spherules, especially of group of transparent colorless ones, bears one big bubble in the center of spherule, filled with CO_2 and air (N_2:O_2=1:4 - sic, probably a misprint for 4:1, AK). Such inclusions almost don't change volume on crushing. In addition, such spherules bear minute bubbles in the outer core of sphere, that strongly decrease their volume on crushing and bear G without air component. Probably on rapid cooling the atmospheric component had no time to mix with G typical of the glass. In one case the big bubble contained G different than the minute ones and without air admixture; probably this spherule melted not in air.

On the basis of studies, mainly made in XIX century, any composition of gases, excluding O_2, may be anticipated for meteorites. Analysis of G in inclusions suggests the following:

1. Meteorite spherules have no typical, universal gas composition. CO_2 is one of the prevailing gases, plus hydrocarbons or N_2 + rare gases.

2. Spherules from ancient rocks are not similar to the known meteorites. They contain "acid gases" like lunar spherules, moldavites and impactites and prevailing CO_2. Maybe, presence of "acid gases" is the indication of impact origin.

3. Spherules from kimberlite have a surprisingly uniform and exotic composition: strong prevalence of N_2 + rare gases and admixture of hydrocarbons and H_2 plus some CO_2. Analogous compositions from cosmic material are not known. Industrial origin is excluded. Only unusual extremely reducing conditions inside kimberlite pipes may be accepted.

4. Spherules from the location of Tungusskiy phenomenon bear very

variable G mixtures. Presumably G of cosmic origin are contained in colorless transparent spherules (prevailing CO_2, admixtures of H_2, hydrocarbons and sometimes N_2 + rare gases), see Table 2.

5. Industrial spherules have relatively simple gas composition and they always bear the components of air.

Table 2. Composition of gaseous inclusions in silicate spherules from the place of the fall of the Tunguska meteorite

No.	Shortening of bubble, times	Composition of gases in inclusions, vol. %							No. of analyses	Characteristics of spherules	
		$H_2S, SO_2, HCl, HF, NH_3$	CO_2	CO	hydro-carbons	H_2	O_2	N_2 + rare gases			
1.			22.6-43.7				64-15.5	44.6-61.9	4	Horizon from yr. 1908	Colorless (I type)
2.	4.67		78.5	--	n.d.	21.5	--	--	1		
3.	7.7		65.8		9.65	25.35	--	--	1		
4.			77.5		n.d.	14.3	--	8.2	1		
5.		32.5	67.5	--	--	--	--	--	1		
6.	5.42	--	23.4				15.5	61.2	1		Blue (II type)
7.	12.5-44.7		77.5-83.6		16.4-22.5				2		
8.	23-125	4.5-17	83-95.5	--	--	--	--	--	4		
9.	1	--	39.2				6.5	54.3	1		Yellov (III type)
10.	7.3	--	91.4		n.d.	8.6			1		
11.	13.5	21.6-34.0	12-27.6	4.1-25	15	25		2-59	2	Hor-izon 1/6	Colorless (I type)
12.	3.3-23.6	100		--	--	--	--	--	3		Blue (II type)
13.	3.4	--	39				12	49	1	Hor-izon 16	Colorless (I type)
14.	6.5	--	78.5		7.9	10		3.6	1		
15.	2.94	--	46.7	15.9	n.d.	14.85	--	22.55	1		Colorless (BP-4)
16.	2.5	5.5	57.8	10.3	n.d.	8.6	--	17.9	1		

Indices

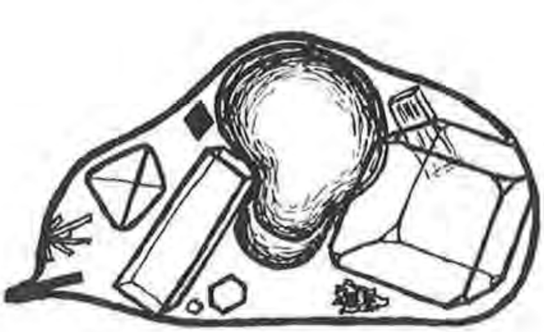
The user should keep in mind the following features of these indices. The indexing procedures and entries are evolving and hence are not uniform from one volume of COFFI to the next, and even within a given volume consistency cannot be claimed, so caveat emptor. Where several different items in the given category occur on the same page, the number of such items is put in parentheses after the page reference. Some items may continue on to following pages. Transliteration of Cyrillic has not been uniform in the various sources used, and hence the user must look under both possible spellings, e.g., Ye and E, ...iy and ...ii, etc. As all entries in the Translation section are also entered in the Abstracts section in alphabetical order, no Author index is needed. The editors want to know about errors and omissions in these indices, and would particularly welcome comments on entries that are specially useful or useless to users.

SUBJECT INDEX

See general notes above. I have tried to make this a user-oriented index rather than a documentalist's type index. Only data in the title and abstract are indexed, and then only if they appear to be of more than incidental mention. Misleading or erroneous translations may have resulted in occasional incorrect or omitted entries. Some entries are included under a given subject heading even though the index word does not occur in the abstract. The deposit type is indexed only where it is evident without research. The aim has been to err on the side of completeness and convenience to the user. Thus I have attempted to index some related or possible pertinent items, and even ones involving negative data or evidence, under each category. The ore type terms such as porphyry copper and Mississippi Valley are used loosely. Analyses for specific elements are indexed only when they are particularly unusual or significant; thus semiquantitative spectrographic analyses are generally ignored. The mineral host for the inclusions studied is indexed except for decrepitation studies. Entries that would include too many page references are listed without page numbers. Some entries with broad and diffuse applicability (e.g., "Geobarometry, methods and comparisons") have only a few of the most pertinent page references.

LOCALITY INDEX

Notes: See page 343. Individual deposit place names are indexed only when significant data are presented. Inexact place names (e.g., "Soviet Far East") are not entered, nor are individual mines in districts known by a district name. Soviet place names may be listed under various transliterations and in particular, with different endings; thus Began and Began'skii, Blyava and Blyavinsk, Kochkar and Kochkarskoje.



Errata

Note: This listing includes corrections to all published volumes, but does not reproduce errata published earlier (vol. 9, p. 262). The editors would appreciate notice of any other errors or omissions.

TEXT

Volume	Page	Item†	Line*	
2	60	6	8	Change Klertsov to Klevtsov
2	60	6	11	Change to read "very high early pressures"
6	105	3	-1	Add (See also Lofgren & Donaldson, p. 94)
7	37	2	1	Change name to KENG, Chien-Min and insert on p. 97
8	81	5	2	Add: "in Carbon and its compounds in endogenic processes of mineral formation (data on studies of fluid inclusions in minerals) - Abstracts of Regional Meeting, L'vov, Sept., 1975: L'vov, Acad. Sci. Ukrainian SSR"
8	179	4	-1	Add: "Includes electron microprobe analyses of 12 melt inclusions and some analyses by laser microprobe for Cu and Zn."
9	16	2	-8	Change cloe to close
9	78	3	1	Change to 1976b
9	78	2	1	Change to 1976a
9	85	3	1	Change to MAKAGON
9	111	3	12	Change to alkalies
9	132	1	6	Change to equivalent
9	172	1	-12	Change to Arbor
9	174	1	16	Change to microthermometer
9	187	1	-1	Change to Mikhailov
9	195	-	-4	Change to tektites

INDEX

Volume	Page	Item
8	222	Electron microprobe - add p. 179
8	222	Heavy metals - add p. 179
8	223	Laser microprobe - add p. 179
8	223	Mass spectrometry - add p. 47
9	258	Olivine - change p. 54 to 55
9	259	Origin of inclusions - out of alphabetical order

†Partial items are also counted

*Minus sign refers to lines up from bottom of item

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FLUID INCLUSION RESEARCH

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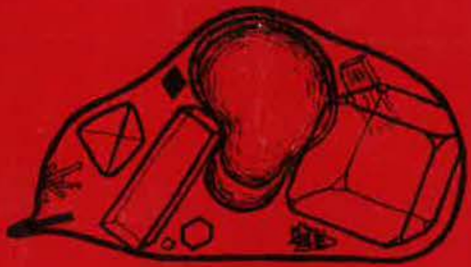

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