H. E. Belkin

FLUID INCLUSION RESEARCH

Proceedings of COFFI

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

Volume 11

1978

Fluid Inclusion Research

Volume 11

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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. We are acutely aware of the inadequate coverage in "COFFI" of the French literature, and would particularly welcome volunteers to make these items available to inclusion workers. 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 entrée 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, I publish English translations of inclusion papers from foreign languages, where available and not otherwise published in English, and notices of meetings and symposia.

Most of the 436 items from Russian sources in this volume were translated or abstracted by the associate editor. A major part of these are the abstracts from several meetings in the Soviet Union, for which proceedings volumes have yet to be published. There are 52 items from other foreign language sources and 323 items from the English language literature for a total of 911 abstracts, citations, or annotated citations, plus subject and locality indices. (As all 6 items in the Translations section are also listed in the Abstract section, no author index is needed.) A few non-pertinent items are cited, by title only, when they were presented as part of a symposium dealing with fluid inclusions.

Although each abstract is duly credited, I wish to acknowledge, in particular, the help of Dr. M. Fleischer, of the U.S. Geological Survey, who provided translations of 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 particularly from Drs. H.A. Stalder (Bern, Switz.); P. Lattanzi (Firenze, Italy); and A.P. Berzina (Novosibirsk, USSR). Many other individuals, too numerous to list here, have helped by sending books, reprints, references, individual translated abstracts, and copies of abstracts. I am also indebted to Professor Ermakov, Chairman Emeritus of COFFI, for copies of Russian books; and to Prof. J. Guha (Chicoutimi, Québec), and to H.E. Belkin (U.S.G.S.), for literature searches.

In the Preface to the previous volume, some striking trends in fluid inclusion research were noted. Thus there had been dramatic increases in research 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 were also noted in studies of carbonatites, tin and tungsten in skarns and greisens, and porphyry copper-molybdenum deposits. The largest increase is in studies of gold deposits, mainly in the USSR. These same trends continue in the present volume.

To authors of pertinent articles that have been omitted or are misquoted here through haste, or through language difficulties, I extend my apologies and my request to have these things called to my attention; to authors whose original abstracts have been drastically shortened, edited, or revised, I 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; I still hope to make future volumes much more current than this one. I 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.

February 5, 1982 Edwin Roedder, Editor*

*Associate Editor Kozlowski could not participate in writing this Preface since his whereabouts is still unknown at the time of writing.

Contents

Translations

Indices

Notices of Meetings and Symposia

The Sixth International COFFI Symposium on Fluid Inclusion Research, was held August 17, 1978, at Salt Lake City, Utah, as part of the Fifth Quadrennial Meeting of the International Association on the Genesis of Ore Deposits (IAGOD). Abstracts of the 26 inclusion papers presented at this symposium will be found in this issue.

At the spring meeting of the Soc. Italiana di Mineralogia e. Petrologia held in S.Margherita Ligure, May 30-31, 1978, a section was devoted to crystal formation and growth. Seven papers were presented, but none was particularly pertinent to fluid inclusion studies.

The Eleventh General Meeting of the International Mineralogical Association was held in Novosibirsk, USSR, on Sept. 4-10, 1978. Pertinent abstracts from this meeting will be found in this issue.

The Sixth All-Union Conference on Thermobarochemistry was held 15-18 September, 1978, in Vladivostok, USSR. There were 410 registered members. Two volumes of abstracts were printed: I - Thermobarogeochemistry in geology, and II - Thermobarogeochemistry and Ore Genesis; most of these abstracts will be found in this issue.

A Workshop on Fluid Inclusions, organized by T.A.P. Kwak and 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. Individual items from the mimeographed notes from this workshop, although not actually published, are cited in this issue (but with an erroneous "1978" date).

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. Abstracts of inclusion papers given at the IMA and IGC were published in Abstracts volumes and will be included in the appropriate (1980) COFFI volume.

A Short Course on Petrologic Applications of Fluid Inclusions was held at the Univ. of Calgary, Alberta, Canada, on May 7-10, 1981, under the auspices of the Mineralogical Association of Canada. A volume of papers covering the individual presentations at this course has been published (Hollister & Crawford, eds., 1981, Mineralogical Association of Canada Short Course Handbook, v. 6, 304 pp. Available from the Association c/o Dept. Mineralogy, Royal Ontario Museum, 100 Queen's Park Toronto, Ontario Canada M5S 2C6).

The Sixth Symposium of the International Association on the Genesis of Ore Deposits (IAGOD) will be held in Tbilisi, August 30-September 17, 1982. It will include a meeting of the Commission on Ore-Forming Fluids in Inclusions (COFFI).

The Seventh All-Union Conference on Thermobarogeochemistry is tentatively scheduled for L'vov, in 1983.

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.

Regional Representatives

The following series of Regional Representatives have 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. 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	Td	temperature of decrepitation.*
G	gas	Te	temperature of eutectic melting.*
L	liquid	Th	temperature of homogenization.*
V	vapor	Tm	temperature of melting (usually of ice).*
P	primary	Tn	temperature of nucleation.*
PS	pseudo secondary	Tt	temperature of trapping.*
S	secondary	(...)	part of author's abstract omitted.

*For explanation, please see the following item, reprinted from Volume 10.

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, 1978

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

ABBOTT, R.N., Jr., 1978, Peritectic reactions in the system An-Ab-Or-Qz-H_2O: Canad. Mineral., v. 16, p. 245-256.

ABELSON, P.H., 1978, Organic matter in the Earth's crust: Ann. Rev. Earth Planet. Sci., v. 6, p. 325-351.

An extensive review, dealing most particularly with the changes that occur with burial and time. (ER)

AKHMANOVA, M. V., DEMENT'YEV, B. V. and MARKOV, M. N., 1978, Water in regolith from Mare Crisium ("Luna-24" samples)?: Geokhimiya, No. 2, p. 285-288 (in Russian). First author at Inst. Geochem. and Anal. Chem. of Acad. Sci. USSR, Moscow.

By IR diffusion reflected spectroscopy, water was found (∿0.1 wt.%) in samples of lunar regolith taken from the depth 143 and 184 cm; the authors exclude the possibility of sample contamination with terrestrial water. (A. K.)

ALAIMO, R., CARAPEZZA, M., DONGARRA' G., HAUSER, S., 1978, Geochemistry of thermal springs of Sicily. Rendiconti Soc. Ital. Mineral. Petrol., v. 34, p. 577-590 (in Italian).

ALDERTON, D., 1976, The geology and mineralization at Pendarves, and other Cornish areas: Ph.D. thesis, Univ. of London; Abstract published by Inst. Mining & Metal., Trans. Sect. B, v. 90, p. 134-135, 1981.

Pendarves is a small Cornish tin mine situated on the margins of a granite ridge. The chemical and mineralogical characteristics of the granite and its variants have been studied and compared with those of the main Carnmenellis mass. The two main lodes (Tryphena and Harriet) have a complex ore mineralogy and associated wallrock alteration, and these are described in detail. Contouring by trend surface analysis has delineated the main "ore-shoot" in the Tryphena lode and shows that there has been a marked concentration of ore just within the granite contact.

Other areas in southwest England have been briefly studied, especially for comparison of their wallrock alteration. Tourmalinization, sericitization and potassic alteration seem to be the most common, although deep weathering has often obscured the original hydrothermal characteristics. Studies of the chemistry and mineralogy of these alteration profiles have enabled some suggestions to be put forward concerning the chemistry of the responsible solution and its change with time.

Fluid inclusion work has furthered this by providing the temperature, salinity and relative alkalinity of the fluids during mineralization. A sequence of mineralization can be recognized on these grounds and it is likely that the crosscourse deposits are of a completely different origin.

Oxygen isotope studies have allowed a refinement in the temperature data and reveal that the alteration assemblages are the product of several stages of alteration.

Warm springs still issue in the region and their chemistry suggests that they represent modified meteoric waters of local derivation. Current ideas suggest that a similar process was responsible for the majority of hydrothermal mineralization in the province.

In some areas the ore minerals were available at an "early stage"; at St. Just it can be demonstrated that the metasomation of the volcanosedimentary sequence was effected by tin-rich fluids. (Author's abstract)

ALDERTON, D.H.M., 1978, Fluid inclusion data for lead-zinc ores from southwest England: Inst. Mining and Metallurgy Trans., v. 87, p. B132-135. Author at Dept. of Geology, The University, Keele, Staffordshire, England.

Fluorite and quartz from 15 mines yielded Th 133-345°C and salinity either low (1.8-4%) or high (∿23%) with only one intermediate value. Some sulfate(?) dxls. (ER)

ALDOUS, R.T.H. and RANKIN, A.H., 1978, Inclusion studies in copper-bearing carbonatites, in Société Francaise de Minéralogie et Cristallographie, Colloque "Minéraux et Minérais," Nancy, 26-29 Sept., 1978--Programme et Resumes des Communications: (Nancy), p.19. Authors at Royal School of Mines, Imperial College, London.

Olivines from the earliest carbonatite facies (phoscorite) of the Palabora complex of S. Africa (one of the top ten copper producers in the world) contain a complex assemblage of multisolid melt inclusions composed essentially of calcite, dolomite, phlogopite, magnetite and sulphides of copper, iron and carrying traces of nickel. The presence of significant amounts of copper and sulphur in these inclusions, which represent portions of the earliest carbonatite magmas evolved at Palabora, demonstrates conclusively that the extensive copper mineralization within this complex was an integral part of the carbonatite process. (Continued on next page)

The copper mineralization is closely associated with the youngest carbonatite but has been extensively remobilized by late-stage tectonic and metasomatic/hydrothermal events. Unfortunately, evidence on the nature and composition of the fluids responsible for this remobilization is lacking at Palabora. The ability of late stage, low temperature hydrothermal fluids of carbonatitic origin (carbothermal fluids) to transport and deposit sulphides of copper and iron can, however, be demonstrated in other copper-bearing carbonatites, especially the Sokli carbonatite of N. Finland. In this example, primary fluid inclusions in apatite and phlogopite, co-precipitated with the sulphides are essentially low-temperature (Th < 200°C), alkali-carbonate-bearing brines.

These studies demonstrate that in the continuum that exists between early carbonatite melts and later carbothermal fluids, copper can become progressively concentrated and deposited under hydrothermal conditions. (Authors' abstract)

ALEKHIN, Yu.V., ZOTOV, A.V., KOLPAKOVA, N.N., 1977, Thermodynamic functions of individual ions in hydrothermal solutions from potentiometeric measurements (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. 3, p. 19-20 (in Russian).

ALEKHIN, Yu.V., ZOTOV, A.V., KOLPAKOVA, N.N., MIRONOVA, G.D., 1977, Investigations of ionic equilibria by sulphide-silver electrode (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. 3, p. 21 (in Russian).

ALEKHIN, Yu.V., ZOTOV, A.V., SOROKIN, V.I., 1977, Combined investigations of low temperature ore formation (as examplified by arsenic, mercury and stibite) (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. 3, p. 93-94 (in Russian; abstract courtesy Dr. A.P. Berzina).

Experimental investigations and theoretical analysis have shown that the true form of mercury in solution at 25-200°C is Hg°. The range in which this form is predominant in solution is larger than that for chloride and hydrosulphide ions, and its role grows with increase in temperature and decrease in sulphide sulphur and chlorine contents. In natural solutions Hg° predominates.

Arsenic in hydrothermal solutions is largely transported as $As(OH)_3$. The most important factor which leads to arsenic sulphide formation side by side with temperature decrease and solution acidification is increase of H_2S contents. Antimony is characterized by relatively higher stability of hydrosulphide complexes that can play an important role in its transport.

ALEKSANDROV, S.M., ed., 1973, The zoning of hydrothermal ore deposits, vol. 1: Moscow, Akad. Nauk SSR, 298 pp (in Russian; trans. Geol.

Survey Canada, 1979).

Fluid inclusions are mentioned as follows:

Page (in translation)	Authors	Deposit type
199, 241	Ontoev	Tungsten
344, 373, 375	Chernyshev & Safonov	Skarn
461	Nevskii, et al.	Rare metal-polymetallic

ALEKSEENKO, V. A., 1978, Vacuum-decrepitation analytical studies during the study of stratified lead-zinc deposits: Teor. Prakt. Termobarogeokhim., (Dokl. Vses. Soveshch.) 5th 1976, N. P. Ermakov, ed.: Moscow, Izd. Nauka, p. 163-168 (in Russian).

Study of the steam haloes around stratified Pb-Zn deposits, by vacuum decrepitation of fluid inclusions, showed that this method can be used to distinguish between hydrothermal and sedimentary ore deposits. All of the deposits studied, in Kazakhstan and Siberia, retained traces of background regional heating, evident as inclusions with decrepitation temps. lower than those formed during hydrothermal transformation. Similar patterns of decrepitation and gas release for ore deposits and country rocks indicates a sedimentary origin. Vacuum decrepitation anal. of monomineralic samples from ores allows definition of the general pattern of deposit formation. The vertical distribution of indirect element indicators is related to the thermal history of a deposit, e.g. high Ag and Ga concns. in galena and sphalerite, resp., are caused by increased isomorphous substitution at high temp. (Chem. Abstracts 91: 60438n, 1979)

ALEKSEENKO, V.A., SEDLETSKII, V.I., KHOVANSKII, A.D., and KLEVTSOV, S.F., 1978, Thermobarogeochemistry of stratified lead-zinc deposits. 336 pp. (in Russian).

ALEKSEEV, V. A., ANAN'EVA, L. A. and RAFAL'SKY, R. P., 1977, Equilibria and metastable phase relations in uranium-oxygen system at 150-350°C (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. 3, p. 82-83 (in Russian; abstract courtesy Dr. A. P. Berzina).

Experimental data confirm the supposition of mestastability of natural uranium oxides which can be caused by dispersion of forming particles and by presence of admixtures which produce a stabilizing influence on the crystalline lattice of UO_2.

ALLEGRE, C.J., and HART, S.R., eds., 1978, Trace elements in igneous petrology: Amsterdam, Elsevier Sci. Pub. Co., 272 pp.

Various chapters include much discussion of trace element partitioning, magmatic differentiation processes, ultramafic inclusions, H and O isotopes, etc. (ER)

ALLEN, J.M., 1978, F-OH distribution among minerals in marbles and implications for the stability of talc-calcite (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 10, no. 7, p. 358.

Sphalerite geobarometry and calcite geothermometry of marbles around the Tudor Gabbro in SE Ontario indicate metamorphism at 5 Kb and 430-530°C. Under these conditions the proportion of fluorine in the OH-site of the following minerals is in the order: K_D (F-OH) phlogopite > tremolite (0.54) > talc (0.28) > **muscovite** (0.09) > chlorite (0.06). Regular partitioning and absence of replacement textures may indicate that F-OH exchange equilibrium was attained. In phlogopite and tremolite F/F+OH is inversely correlated with Fe/Fe+Mg. The relationship between these ratios in phlogopite is consistent with equilibrium with a hypothetical gas phase of constant H_2O/HF fugacity ratio, and HF fugacity of 0.03 bars or less.

Tremolite, as well as having a higher F/F+OH ratio than coexisting talc, is also richer in Fe and Al. Calculations assuming ideal solution show that for the observed mineral compositions, the T-X_{CO_2} stability field of talc-calcite is restricted to a discontinuous, narrow, 10-60 m wide zone near the Tudor Gabbro. In contrast to these observations, tremolite in the Central Alps has lower F/F+OH than coexisting talc. This expands the talc-calcite stability field. Such differences in F-OH partioning may be related to T or other parameters. (Author's abstract)

AM, D.T., TENG, T.T., and SANGSTER, J.M., 1978, Vapor pressures of $CaCl_2$-NaCl-H_2O and $MgCl_2$-NaCl-H_2O at 25°C. Prediction of the water activity of supersaturated NaCl solutions: Canad. Jour. Chem., v. 56, p. 1853.

AMOSSÉ, Jean, 1978a, Variation in wolframite composition according to temperature, at Borralha, Portugal, and Enguyales, France: Econ. Geol., v. 73, p. 1170-1175.

Th on fluid inclusions in quartz (192-320°C) associated with wolframite were corrected for pressure using the method of Amossé, 1976 (Fluid Inclusion Research -- Proc. of COFFI, v. 9, 1976, p. 3), based on permanent strain and the compressibility coefficient for wolframite, to determine the conditions of deposition, and their variation with position in vein. Tm ice(?) values are given of -5.5 to -8 for Borralha and -4.7 for Enguyales. (E.R.)

AMOSSÉ, Jean, 1978b, Thermodynamical study of the zonal distribution of the hübnerite-ferberite series in the wolframite deposits: Metallization Associated with Acid Magmatism, v. 3, p. 315-323.

Four Th values determined (195-275°C) for inclusions from unspecified mineral in the San Antonio vein. Upon correction for pressure (based on lattice parameters of wolframite) these yielded Tt of 325-430°C. (ER)

ANDERSON, A.T., Jr., 1978, Parental magmas of some andesitic magma series (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 10, no. 7, p. 358-359.

As first documented by Kuno, andesites, particularly those of the hypersthenic rock series, commonly contain xenocrysts of magnesian olivine and calcic plagioclase. That such crystals are derived from basaltic melts as surmised by Kuno is demonstrated by the occurrence within them of inclusions of basaltic glass. The compositions of such inclusions of glass reveal that compositionally similar, volatile-rich, high-alumina basaltic melts exist beneath widely separated volcanoes of subduction zones. The widespread occurrence of high-alumina basalt magmas with similar concentrations of H_2O and with similar weight ratios of Cl to K_2O (0.07 to 0.22) and of H_2O to Cl (20 to 50) is consistent with negligible loss or gain of water from local, upper crustal sources. The source of water in the magmas of the hypersthenic series probably is intrinsic to the parental basalt and not derived by contamination within the upper crust. Below I give some representative compositions of inclusions of glass (calculated anhydrous):

Volcano	SiO_2	Al_2O_3	FeO	MgO	CaO	Na_2O	K_2O	TiO_2	Cl	H_2O	Host
Asama, 1783	53.6	21.5	5.2	3.4	11.6	3.0	0.7	0.9	0.08	4	Fo84
Fuego, 1974	51.0	19.1	10.0	5.4	9.3	3.0	0.6	1.1	0.09	5	Fo79
Pavlof	50.0	20.4	7.3	3.8	13.7	2.8	0.9	1.0	0.15	4	Fo83
Paricutin	53.6	18.8	8.2	4.7	7.5	4.4	1.2	1.2	0.08	3	Fo81
Shasta	53.7	19.1	5.5	5.7	11.4	3.4	0.4	0.7	0.06	3	Fo88

(Author's abstract)

ANDERSON, D.E. and GRAF, D.L., 1978, Ionic diffusion in naturally-occurring aqueous solutions; use of activity coefficients in transition-state models: Geochim. et Cosmo. Acta, v. 42, p. 251-262.

ANDERSON, G.M., 1978, Basinal brines and Mississippi Valley-type ore deposits: Episodes, Geological Newsletter IUGS, v. 1978, no. 2, p. 15-19.

A review of the evidence as to the conditions of precipitation of these ore deposits. (ER)

ANDREEV, B.S. and SAVVA, N. Ye., 1978, Native arsenic from the gold-ore deposit of Chukotka: Acad. Sci. USSR Doklady, v. 238, no. 5, p. 1207-1209 (in Russian).

Native arsenic constitutes 1-3% of total ore, arsenic grains are up to 1 mm in size, grain aggregates - 3-4 mm, quartz-arsenic parageneses are almost sulfide-free. In the deposit polysulfide Au ores formed at Th 100-370°C, P 765-800 atm, antimonite ore - 90-270°C, up to 170 atm, Au-sulfoantimonite-arsenic ore at 140-320°C, 80-615 atm, but arsenic itself - at 140-220°C. (Abst. by A.K.)

ANDREEV, G.V. and SHVADUS, M.I., 1978, Melt inclusions in alkaline rocks of N. Pribaikal'ye, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 56-57 (in Russian). Authors at GIN BF SO of Acad. Sci. of the USSR, Ulan Ude.

Melt inclusions and inclusions rich in salts were found in the rocks of the Synnyr complex. At room T melt inclusions often have nebulous outline, length from 2 to 35μm. Vacuoles are filled either with 3-6 dms plus G bubble in pyroxene, nepheline, quartz, K-spar or are weakly anisotropic, finely crystalline (in peudoleucite). Inclusions are clearly P. Massifs formed at 900-1300 atm. In Goudzhekit massif in nepheline syenites, in nepheline Th was 990-1060°C; Burpala massif, trachytoid quartz syenites, quartz 1030-1070°C, pulaskites, pyroxene 1050-1130°C; Synnyr massif, porphyroid pseudoleucite syenite, pseudoleucite phenocrysts 1050-1100°C, matrix nepheline 1020-1080°C, nepheline syenites, nepheline 990-1100°C, K-spar 840-890°C (incs. of melt-solution), pulaskites, pyroxene 1050-1110°C. Data on inclusions of G+L+NaCl are listed in the table. (From the authors' abst, by A.K.)

Massif	Synnyr	Burpala	Goudzhekit
T of gas dissolving,°C	90-110	100-110	80-105
T of salt dissolving,°C	190-210	195-215	180-205
P, atm	900-1300	1000-1300	900-1500

ANDREEVA, T. A. and MOLCHANOV, V. I., 1978, Hydrogen and hydrocarbon gases in the composition of gaseous inclusions in rocks: Izv. Geol. Geofiz. no. 10, p. 32-39 (in Russian).

The concn. was detd. of CO_2, H, and CH_4 in the gas-liq. inclusions from Fe ore rocks from Eya, Sheregesh, Abakan, Krasnogarask, etc., from granitic rocks of Kuznetsk Alatau, and from dolostones and limestones. The concn. detd. for these gases depends on the method of detn. used. The hydrocarbon gases in the basic-ultrabasic rocks are of metasomatic origin; hydrothermal activity and lithogenesis were also important. (Chem. Abstracts 90: 90340w)

ANDRIANOVA, S.I., VALYASHKO, L.M., AMINEV, V.B. 1978, Role of carbon dioxide in formation of a gold ore deposit in the Lensk Region (USSR), in Carbon and its compounds in endogene processes of mineral formation, G.N. Dolenko, ed.: Kiev, "Naukova Dumka" Pub. House, p. 118-121 (in Russian).

The presence of a large no. of fluid inclusions with CO_2, in quartz of all mineral-forming stages of Au deposits in the Lensk region (Siberia), and also the high CO_2 concn. in the gas component of the inclusions indicates that CO_2 was a major component of the hydrothermal solns. involved in ore formation. An increase in the CO_2 content for stages of early sulfides with dispersed Au is related to metasomatic processes resulting from the boiling of hydrothermal solns. enclosed in carbonaceous shales with high porosity (2.5-11%). (Chem. Abstracts 89: 200633h)

ANDRIYANOVA, N. A., BELIKOVA, G. I. and KHAIRETDINOV, I. A., 1978, Thermobarogeochemical data and genesis of chalcopyrite deposits in the Southern Urals, in Thermobarogeochemistry of the earth's crust and ore formation, N. P. Ermakov, ed.: Moscow, "Nauka" Press, p. 40-54 (in Russian).

Fluid inclusions in minerals of early mineral assocns. in southern Urals chalcopyrite deposits had Th 55-760° and Td 340-70° and pressures estd. from that of 550-760 atm. Imposed, later-formed Th and Td mineral assocns. of the deposits have fluid inclusions with Th 65-390 and Td 95-440°, and formational pressures are estd. as 95-685 atm. Comparison of data on the pH of pyrite-quartz formation in the ore deposits with Eh-pH diagrams calcd. for the Fe-As-Sb-S system indicates Eh values of 210-230 mV. The earliest formations of the chalcopyrite ores formed under subaerial or submarine conditions at shallow depth (100-300 m from the ground surface). Acidic conditions of mineral formation were detd. from chem. anal. of the fluid inclusions (aq. ests.) and thermodn. anal. of paragenetic assocns. (Chem. Abstracts 89: 166304q, 1978)

ANDRUSENKO, N. N. and ADRIANOVA, S. I., 1978, Characteristics of the formation of gold deposits at different depths and ore formations: Teor. Prakt. Termobarogeokhim., (Dokl. Vses. Soveshch.) 5th 1976, N. P. Ermakov, ed.: Moscow, Izd. Nauka, p. 143-151 (in Russian).

Anal. of literature data on the thermobarogeochem. (fluid inclusion characteristics) of USSR Au ore deposits of various depths and formations shows that the Au-bearing minerals formed at similar temps., generally in the 100-430° range. For medium-depth deposits, the ore-forming hydrothermal solns. were typically SO_4^{2-}-Cl- or HCO_3^- -Cl- types. CO_2 acted as a catalyst in ore pptn. For near-surface deposits of Au-chalcedony-adularia-quartz formation-type, the solns. contained CO_2 in their volatile portion and had HCO_3 concns. several times lower than in the solns. from which deeper deposits formed. In general in the Au ore formation, high-temp. solns. were predominantly halide-alk. with more Cl- than F- and more Na+ than K+; at medium temp. HCO_3^-, Ca^{2+} and CO_2 gained importance; and at low temp. K^+ became predominant over Na^+ and Ca^{2+}. (Chem. Abstracts 91: 60436k, 1979)

ANDRUSENKO, N. I., KOSOVETS, T. N., USHAKOVA, L. K., SHUGURUOVA, N. A., and BOCHEK, L. I., 1977, Conditions of formation of gold mineralization in a complex field: Sovet. Geologiya, 1977, no. 8, p. 65-76 (in Russian; translated in Inter. Geol. Review, 1978, v. 29, no. 8, p. 916-926).

A W-Mo deposit (unspecified) was studied. Th of stage, of productive (Au) stage, of boiling solutions, and of solid phases are given for stages: W-Mo skarn, post skarn metasomatism, and hydrothermal Mo-Au ore, As-Au-Pb-Zn ore, and Au-Ag-Sb ore. Very wide ranges are shown (e.g., "710-200" for Mo-Au ore). Boiling occurred in range 460-290°C; dms (mainly NaCl?) homogenized at 425-215°C. Some Td were also determined. Pressures (method not stated) ranged from 75 to 1250 bars (even in a single stage, they ranged from 75 to 1150 bars). Up to 36 vol.% of sum of H_2S, SO_2, and SO_3 was found in gas phase of some inclusions; up to 10% O_2 or up to 45% N_2 in others; CO_2 was major constituent in all. (ER)

ANUFRIYEV, Yu. N., PETRUKHA, L. M., KHOKHLACHEV, A. P. and MOSKALYUK, A. A., 1978, Quartz-forming solutions at one of the pegmatite and hydrothermal vein deposits of the Urals: Geokhimiya, No. 3, p. 375-383 (in Russian, English abst.). Author's institution not specified.

The deposits occur in the exocontact of the Variscan granitoid massif in schists metamorphosed under amphibolite facies conditions. Quartz in pegmatites is smoky and morion, in veins - rock crystal, and more rarely smoky, amethyst or citrine. Water leachates yielded following ion concentrations in fluid inclusions (in mg/100 g of sample): Li 0-0.06, Na 0.36-1.14, K 0.09-0.44, NH_4 0-0.05, Mg 0-06, Ca 0.16-1.11, F 0-0.10, Cl 0.38-2.38, SO_4 0.15-1.55, HCO_3 1.07-3.05 (41 samples). Fluid inclusion solutions are compared with other pegmatites and veins. (Abst. by A. K.)

APLONOV, V. S. and MOSKALYUK, A. A., 1978, Evolution of the chemical properties of mineral-forming solutions forming Norilsk copper-nickel ores: Teor. Prakt. Termobarogeokhim., (Dokl. Vses. Soveshch.) 5th 1976 N. P. Ermakov, ed.: Moscow, Izd. Nauka, p. 119-122 (in Russian).

The quantity of fluid inclusions in minerals of the Norilsk differentiated trap intrusions depends directly on the degree of differentiation. The inclusions contain 5-10% gas. Aq. exts. from the inclusions have mineralization 3.66-33.9 mg/100 g of sample with pH 7.45-8.0. The solns. contain mainly Cl- and HCO_3^-, SO_4^{2-} is subordinate. The exts. from taxitic gabbro-dolerites are enriched in K+ and Na+, do not contain Mg^{2+}, and, in comparison with the exts. from picritic gabbro-dolerites, are deficient in Ca^{2+}. The chlorinity of the hydrothermal solns. increased with increasing ore-bearing capacity of the intrusions. (Chem. Abstracts 91: 77039f, 1979)

APOLLONOV, V.N., 1976, Ammonium ions in sylvine of the Upper Kama: Akad. Nauk SSSR, Doklady, v. 231, p. 709-710 (in Russian; trans. in Doklady Acad. Sci., Earth Sci. Sect., v. 231, p. 101-102). Translation of article abstracted in Fluid Inclusion Research -- Proc. of COFFI, v. 9, p. 6, 1976.

AREVADZE, D.V., GOGISHVILI, V.G., KAVILADZE, M.Sh. and YAROSHEVICH, V.Z., 1978, Stable isotopes in gaseous-liquid inclusions in minerals, (Abst): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, pp. 33-34 (in Russian). First author at Caucasian Inst. Mineral Raw Materials, Tbilisi.

Studied specimens came from vertically zoned pyrite-polymetallic deposits of SE Georgia. Pyrite ores gave Th and Td 370-320°C, chalcopyrite ores - 290-250°C, barite-polymetallic ores - 280-180°C, monomineralic barites of the upper levels - Th 120-60°C. Water leachates and cryometry showed low salinity 2 to 4 equiv. NaCl (sic; % of NaCl equiv.? - A.K.). Water from P inclusions was released by heating and decrepitation at T determined by homogenization. Value δD for recent meteoric water of the region ranges from -5 to -10%*. Increase of heavy isotope content is reported for P inclusions in sulfides (-95%*) and for S inclusions in sulfides and P inclusions in late barites (-31%*). This may be explained by mixing of meteoric and magmatic waters. (From the authors' abst., by A.K.) (*-Probably misprints for %; Eds.)

AREVADZE, D.V., GOGISHVILI, V.G., KAVILADZE, M.Sh., YAROSHEVICH, V.Z., 1978, Fluid inclusion and stable isotope studies of sulfur and hydrogen of pyrite-polymetallic deposits, South-Georgia (abst.) in International Assoc. Genesis Ore Deposits, 5th Symp., Snowbird, Alta, Utah, 1978, Program and Abstracts: Alta, Utah, p. 40.

Pyrite-polymetallic deposits of South-East Georgia, occurring in Upper Cretaceous volcanic sequences of Minor Caucasus, are characterized by clearly defined vertical zoning of ores and host rocks. In lower horizons in connection with copper-pyritic ores quartz-sericite-chloritic metasomatics are developed, which in according section are changed by secondary quartzites or hydrothermal argillites - the altered rocks of baryte-lead-zinc ores (sic.) (Continued on next page)

Temperature, salinity and hydrogen isotope studies are made on fluid inclusions of ore and gangue minerals together with sulfur isotope investigations in sulfides and sulfates.

1. The homogenization and decrepitation of primary inclusions in pyritic ores (pyrite, quartz, anhydrite) range at temperatures from 370 to 320°C; in copper-pyritic ores (pyrite, chalcopyrite, quartz, anhydrite) from 330 to 260°C; in copper-polymetallic ores (chalcopyrite, sphalerite, galenite, baryte, quartz) from 290 to 250°C, in the same minerals of barite-polymetallic ores the temperature range is 280-180°C and in monomineral barytes 120-60°C.

2. Aqueous extracts, gas analysis and freezing temperature studies indicate the low salinity of original hydrothermal fluid at all stages of formation of deposits (from 2 to 4 equivalents of NaCl).

3. The isotope composition of sulfur in sulfides is near to meteroritic standard (±4‰) and in sulfates it is much heavier (+15‰). The isotope equilibrium in paragenetic minerals doesn't occur. The experimental data of distribution of ^{34}S values in sulfide - sulfate paragenesis are obtained with synthesis of hydrothermal system at 250°C, in addition to this theoretical calculations indicate the juvenile source of sulfur in solutions, which have formed the considered ores.

4. The water from primary fluid inclusions for the determination of hydrogen isotopes was extracted by heating under the temperature interval determined by homogenization and decrepitation. H/D values of modern metheoric waters of the region is - 5 - 10‰(SMOW). The rise of content of heavy hydrogen isotopes in inclusions from - 95‰in pyrite of pyritic ores to - 31‰in monomineral barytes can be explained by mixing in upper horizons of deposits of originally magmatic waters with metheoric.

The obtained data and their thermodynamic analysis indicates the monoascendent nature of vertical zoning. (Authors' abstract)

AREVADZE, D.V., KAVILADZE, M.Sh., GOGISHVILI, V.G. and YAROSHEVICH, V.Z., 1976, Studies of gas-liquid inclusions, isotopes of hydrogen and sulfur of sulfide-polymetal deposit Madneuli (South-East Georgia): Abstracts of the 6th All-Union Symposium on Stable Isotopes in Geochemistry, September 20-23, Moscow, p. 64-65 (in Russian). First author at Caucasian Inst. of Raw Materials, Tbilisi, Georgian SSR.

The deposit Madneuli occurs in Upper Cretaceous volcanogenic-sedimentary beds of the Somkhito-Karabakh zone of the Little Caucasus. The deposit has distinct geological and mineralogical zoning, from bottom to roof beds: pyrite ore-chalcopyrite ore-polymetallic ore-barite-polymetallic ore-barite with galena.

The δS of sulfides varies from +3.1 to -3.8 ‰. Sulfur isotope distributions between galena and sphalerite (barite-polymetallic zone) and between pyrite and chalcopyrite (chalcopyrite zone) are close to equilibrium pattern.Td of sulfides and Th of gangue minerals correlate well with isotope temperatures. Isotope composition of sulfur from barite ranges from +12.1 to 15.5 ‰. Sulfide/sulfate isotope sulfur ratio does not achieve theoretical equilibrium value. Regular change of sulfur isotope composition correlating with vertical zoning suggests one deep-seated sulfur source.

Samples for hydrogen isotope studies were dried at 110°C, 10^{-6} mm Hg, then water from G/L inclusions was extracted at T of abundant decrepitation and frozen at T of LN_2 in vessels with metallic Zn. To separate G, vessel was held at -4 to -6°C for several minutes; following analytical technique was of routine type.

The δD value of water in G/L inclusions in sulfides (pyrite, chalcopyrite, sphalerite and galena) varies from -96 to -107 ‰; in barite and quartz - -31 to -57 ‰; recent waters of this region are close to SMOW (δD -5 to -12 ‰). The difference in δD suggests a deep source of the water in ore-forming solutions. (Authors' abst.)

ARMAN, O.P., 1978, Chromatographic quantitative determination of main components of gas phase in inclusions, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 159-160 (in Russian). Author at All-Union Inst. of Mineral Raw Materials, Moscow.

A special chromatographic method, using two chromatographs L KhM-8MD type joined in sequence was applied. Column of the first chromatograph was filled by Polysorb-A, column of the second by molecular sieves, column length 2 m, eluent gas-helium with flow rate 30 ml/min. Washed and dried mineral sample was placed in glass vacuum vessel and sealed. During the following decrepitation, G from inclusions are released to the vessel. Next the vessel is crushed and gases go to the first chromatograph, where (N_2+CO+O_2), CH_4, CO_2 and H_2O are separated at 70°. Next gases go to the second chromatograph column to separate N_2, O_2 and CO at 35°C; the detector is of catharometer type. (From the author's abstract).

ASHIKHMINA, N.A., GORSHVOV, A.I. MOKHOV, A.V. and OBRONOV, V.G., 1978, Sylvite and halite in lunar soil: Akad. Nauk SSSR Doklady, v. 243 no. 5, p. 1258-1260 (in Russian ; see translations.)

ATKINSON, P., CELATI, R., CORSI, R., KUCUK, F., and RAMEY, H.J., 1978, Thermodynamic behaviour of the Bagnore geothermal field: Geothermics, v. 7, p. 185-208. First author with Union Oil Co. of California, Santa Rosa, CA, USA.

In 1959 production began from the Bagnore reservoir near the Mt. Amiata Volcano. The reservoir gas was initially at a pressure of approximately 23 ata. Its noncondensable gas content was more than 80% by weight, most of which was CO_2. A mathematical model which accounts for thermodynamic and chemical equilibria between the vapor, liquid and solid carbonate phases in the reservoir was developed and applied to a study of the initial conditions in the reservoir. A lumped-parameter model of a 2-phase, 2-component system was then developed. This CO_2-H_2O, liquid-vapor model was used to calculate history of pressure and composition for the reservoir. These calculated histories compared favourably with those observed in the field. (From the authors' abstract)

BABANSKY, M. D. and STROITELEV, A. D., 1977, Sphalerite solubility under hydrothermal conditions, (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. 3, p. 39-41 (in Russian; abstract courtesy Dr. A. P. Berzina).

In aqueous solutions of NH_4Cl, K_2CO_3, Na_2SiO_3, and $ZnCl_2$, at 350-500°C and 500-750 atm, sphalerite solubility increases with increase in temperature and concentration of solutions and reaches 0.58, 0.4, 0.28, 0.48 weight % in NH_4Cl, Na_2SiO_3, K_2CO_3, $ZnCl_2$ solutions respectively. The temperature dependence of sphalerite solubility and its thermodynamical parameters are controlled by peculiarities of the aqueous medium (hydrolysis, complex formation, etc.).

BAKHANOVA, E.V., BOGOLEPOV, V.G., NARSEEV, V.A., POLYVYANNYI, E. Ya, 1978, Criteria of the "juvenility"of relics of hydrotherms and nature of carbon compounds in inclusions, in Carbon and its compounds in endogene processes of mineral formation, G.N. Dolenko, ed.: Kiev, "Naukova Dumka" Pub. House, p. 16-25 (In Russian).

This is full paper corresponding to abstract given in COFFI v. 8, p. 12, 1975 (ER)

BAKHANOVA, E. V., LEVIN, G. B., POLYVYANYI, E. Ya. and NAIDENOV, V. M., 1978, Certain features of mineral formation in a gold ore deposit determined from data on the isotopic composition of argon in gas-liquid inclusions, in Thermobarogeochemistry of the earth's crust and ore formation, N. P. Ermakov, ed.: Moscow, "Nauka" Press, p. 201-202 (in Russian).

In the Au deposit studied the regime of mineral formation, detd. by homogenization and decrepitation of gas-liq. inclusions (GLI) in the principal vein mineral (quartz), was characterized by gradual decrease in temp. (from 420 to 95°) and pressure (980 to 260 atm). The GLI for the most productive and richest ore veins have the max. radiogenic Ar, i.e. the productive stages involved min. participation of vadose water. The content of hydrocarbons in the GLI decreases with increase in the content of atm. Ar. The content of atm. Ar is related to the degree of openness in the paleohydrothermal system and its increase is also accompanied by increase in the degree of oxidn. of hydrocarbons. The GLI in subvolcanic and near-surface deposits contain Ar which has a very high proportion of atm. Ar. (Chem. Abstracts 89: 149714f, 1978)

BAKUMENKO, I.T., BAZAROVA, T.Yu., KOSUKHIN, O.N., KRASOV, N.F., PODGORNYKH, N.M. and CHUPIN, V.D., 1978, Conditions of crystallization of magmatic rocks as indicated by melt inclusion studies, (Abst): Abstracts of the Sixth All-Union Meeting, Vladivostok, Acad. Sci. USSR, pp. 31-33 (in Russian). Authors at Inst. Geol. Geophys. of Siberian Branch of Acad. Sci. of the USSR, Novosibirsk.

1. The necessity of separate methods of study of inclusions that are poor and rich in water and possibility of P determinations on fluid (G/L) inclusions coeval with melt ones, is confirmed.

2. Conditions of crystallization of plutonic rocks (gabbroids, alkaline rocks, granitoids) and their volcanic analogues are compared. Only water-poor high-T magmas intrude into upper levels of the Earth's crust. Low-T melts appear only due to water saturation and differentiation of "dry" magmas; this is especially typical of acid melts. Alkali ratio also often strongly influences T of melt, e.g. K basaltoids crystallized in narrow T ranges 1280-1200°C from "dry" melts. Na basaltoids in the final stages of crystallization become rich in water (and salts), hence the lower limit of nepheline crystallization is 900-

800°C, whereas femic minerals crystallized at high T, 1250-1200°C. Phonolites of Armenia (Na-type) crystallized from melts rich in water at T 1150-750°C. For basic and medium rocks of andesite formation of Kamchatka T 1360-1300°C are characteristic, close to the beginning of crystallization; minimum T for phenocrysts are 1270-920°C due to variable gas saturation of magmas.

3. Magmatic origin was proved for individual zones or fragments of polygenic bodies like pegmatites, carbonatites and migmatites.
a.) Th of inclusions in anorthite from veins and schlieren of Iranian eucrite-type ophiolitic gabbro-pegmatites are 1425-1260°C. The lowest T are chamber granitic pegmatites from Kazakhstan and Transbaikalia - 630-540°C; trigonal low quartz crystallized from remnant pegmatitic melt (H_2O + other volatiles ≥ 7 wt.%). At the point of saturation and boiling of melt P fluid was 3.6-3.8 kbar, significantly exceeding lithostatic overload.
b.) Magmatic nature of silicate rock-forming minerals in the Karelia-Kola and E. Sayan carbonatites was confirmed by Th 1260-760°C. Apatite and calcite bear inclusions of silicate melts; ankerite and calcite bear inclusions of silicate-salt melts-brines. Similarity of those inclusions to inclusions in alkaline rocks suggests the possibility of carbonatite formation during differentiation of alkaline-ultrabasic magmas.
c.) Crystallized inclusions in quartz with Th $\sim$700°C revealed the conditions of origin of leucosomes in migmatites of amphibolite and granulite facies. (Authors' abst., translated by A.K.)

BAKUMENKO, I. T., BAZAROVA, T. Yu., PANINA, L. I., KOSUKHIN, O. N., MOTORINA, I. V., CHUPIN, V. P. and SHATSKII, V. S., 1978, Inclusions of silicate and nonsilicate melts in minerals: Teor. Prakt. Termobarogeokhim., (Dokl. Vses. Soveshch.) 5th 1976, N. P. Ermakov, ed.: Moscow, Izd. Nauka, p. 29-33 (in Russian).

A classification of melt inclusions is presented. The different types of melt inclusions are characterized; these include silicate, silicate-salt and salt melts, salt and silicate-salt melt-brines, and silicate-melt-solns. Evidence is cited, drawing from results of expts. reported in the literature, that the homogenization temps. of melt inclusions are valid for use in thermobarogeochem. (Chem. Abstracts 91: 60361g, 1979)

BAKUMENKO, I. T. and DOLGOV, Yu. A., 1977, Thermobarogeochemical Researches: Geologiya i Geofizika, v. 18, no. 11, p. 127-135, (in Russian; translated in Soviet Geol. & Geophys., v. 18, no. 11, p. 98-104, (1978).

Summarizes the most important results of thermobarogeochemical studies in Siberia and the adjoining neighboring territories of the USSR. The special parts played by the Moscow, Novosibirsk, and L'vov schools of researchers in this field are noted, with particular emphasis on the achievements in the study of inclusions in the minerals of igneous and metamorphic rocks and objects from space. (A good review of the major contributions of many individuals-E.R.)

BAKUMENKO, I. T., DOLGOV, Y. A., KOSUKHIN, O. N. and TCHUPIN, V. P., 1978, Acid magmatism and mineral formation (abst.): XI General Meeting of International Mineralogical Association, Novosibirsk, Abstracts, v. 1,

p. 165 (in English).

Conditions of crystallization and localization of both metallic and nonmetallic minerals have been established from studying inclusions in minerals of acid igneous rocks, granitic pegmatites and postmagmatic rocks. The temperature and fluid regimes of crystallization of high- and low-temperature granitoids and pegmatites from facies of different depth of occurrence have been fixed; temperature decreases (sometimes to 580°C) in the apical parts of some intrusives and their later phases are shown (owing to increase of water, fluorine and other volatiles in the crystallizing melts). Conditions of fluid separation are evaluated with their composition fixed.

The granitic pegmatites of low depth (chambered pegmatites) begin their crystallization from melts (early zones, at 660 - 550°C), while the minerals from the inner zones and the crystals of their cavities are formed with participation of the melt solutions, melt-brines, gaseous and fluid solutions. Formation of intermediate depth pegmatites (rare metallic) involves the magmatic stage usually followed directly by hydrothermal one. Pneumatolitic (gaseous) states of solutions arise sporadically with a sudden increase in the volume of pegmatite chamber. Deep pegmatites (ceramic and rare earth) are distinguished frôm the above in having higher temperatures during the magmatic stage of crystallization and in high density of the postmagmatic fluids.

The model of mobilization of solutions and localization of the ore matter owing to adiabatic processes is discussed in the light of fracturing in the Earth's crust; increase in the volume occupied by solutions at fracturing results in the decrease of temperature, pressure, and solution density in cavities and to separation of the interporous fluids as based on their volatility. Intrusion activates the porous solutions of the host rocks and intrusive crust, while fracturing mobilizes the porous solutions leading to a deposition and localization of ores. (Authors' abstract)

BAKUMENKO, I.T., KOSUKHIN, O.N. and CHUPIN, V.P., 1978, Conditions of various types of magmatic quartz-feldspar granophyric intergrowths, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in Geology: Vladivostok, Acad. Sci. USSR, p. 47-48 (in Russian). Authors at Inst. Geol. Geophys. of Siberian Branch of Acad. Sci. of the USSR, Novosibirsk-90.

Magmatic quartz-feldspar granophyric intergrowths may be divided into two types:

1. Intergrowths forming mesostasis of rocks connected with magmas formerly undersaturated with SiO_2, e.g., from trap rocks of Siberia. Quartz from granophyric intergrowths of granite-diorite composition bears glass and crystallized inclusions with Th 940-1130°C. Quartz-sanidine graphic intergrowths in pegmatitic bodies of the trachyandesite, syenite-diorite and syenite Gusinoozerskaya dike bear in quartz very high-T melt inclusions with Th 1250-1280°C, trapped under high P. Also sanidine bears inclusions, but they cannot be homogenized due to earlier melting of host mineral (at 1150-1190°C) and leakage of inclusions.

2. Intergrowths appearing in matrix of porphyroid granites, certain granite-porphyries and quartz porphyries. Portions of remnant granitoid melts, from which the micrographic aggregates formed, often became enriched in water and hence the aggregates crystallized at low T. Micrographic intergrowths surrounding miarolytic cavities in quartz porphyries from Altyn-Topkana (S. Tadzhikistan) crystallized at 650-

660°C, and micrographic intergrowths of matrix in quartz prophyries from Dzhel'tau (Golodnaya Step', Kazakhstan) even at 640-620°C.

3. Graphic aggregates from granite pegmatites:

a) Pegmatites crystallizing from remnant melts. P inclusions in quartz permitted detailed studies of the peculiarities of the magmatic stage of crystallization of shallow (near-surface) (sic.) zoned chamber pegmatites of Kazakhstan and E. Transbaikalia, where graphic aggregates crystallized at 620-550°C. In bodies found in various other regions those intervals vary slightly. Low-T (560°C, rarely up to 610°C) dikes of graphic pegmatites bearing cordierite (Pamirs) seemingly also are connected with granites.

b) Pegmatitic bodies crystallizing from anatectic melts have Th of melt inclusions in quartz varying over a wide range. Orthotectites with nebulous structure formed due to anatexis under conditions of granulite facies (Upper Aldanian complex) crystallized at 850-820°C, but in amphibolite facies T was only 790°C or 710°C.

4. Graphic aggregates crystallizing from regenerated eutectoid melts, which were formed during contact melting, etc. Melt inclusions in quartz from micrographic veinlets at the contacts of gabbro-diabase dikes intruding into granite-gneisses of Dedovets Island in Onega Lake have Th 640±20°C. (Authors' abst., translated by A.K.)

BALITSKII, V.S., 1978, Experimental studies of processes of crystal formation: Moscow, "Nedra" Press, 144 pp. (in Russian).

BALITSKY, V. S. and SAMOILOVITCH, L. A., 1977, Hydrothermal method of temperature change and its significance for investigation of mineral-forming systems (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. 3, p. 60-61 (in Russian).

BANSHCHIKOVA, I. V. and VASIL'YEV, Ye. V., 1978, Spectral microanalysis of inclusions using the hot hollow cathode, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladiovostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 165 (in Russian). Authors at the Inst. of Mineral. and Geochem. of Rare Elements, Moscow, USSR.

Analysis using hot hollow cathode may determine almost all elements in G, L or solid microinclusions with a sensitivity of 10^{-10} to 10^{-11} g. Sample weight is $5\cdot10^{-3}$ to $5\cdot10^{-4}$ g. Melt inclusions from the rocks from Kunashia Island were analyzed to determine Zn, Pb, Cu, Sb, etc. (From the authors' abst.)

BARANOVA, N. N., 1977, On possibilities of gold transport by hydroxy complexes (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. 3, p. 42 (in Russian; abstract courtesy Dr. A. P. Berzina).

Gold solubility is constant in a wide pH range and increases at pH>12 from $(2\pm0.4)\cdot10^{-9}$mol/l at 25°C to $(1.2\pm0.8)\cdot10^{-7}$mol/l at 250°C. Equilibrium gold concentrations correspond to existence of hydroxy complexes of $AuOH^o+Au^o$ composition in the range where gold solubility is independent of pH, and of $Au(OH)_2^-+Au^o$ composition in solutions with pH>12.

BARANOVA, N.N., 1978, Ore components in inclusion solutions from some gold deposits, (abst.), in International Assoc. Genesis Ore Deposits, 5th Symp., Snowbird, Alta, Utah, 1978, Program and Abstracts: (Alta, Utah), p. 45.

1. Extracts from inclusions in quartz of different stages from several Soviet deposits have been analyzed for gold and silver. Au ranged from $0.05 \cdot 10^{-4}$ to $1.7 \cdot 10^{-4}$ and Ag from $0.5 \cdot 10^{-5}$ to $2.0 \cdot 10^{-5}$ g.ion/l in the inclusion solutions, using an inverse amperometric method with a carbon paste electrode. Extracts for the determination have been prepared using 0.5 N HCl solutions in which no processes of hydrolysis and absorption on quartz surfaces occur; up to 40 or more percent of the gold was shown to be present as Au°.

2. Anion composition of the liquid phase of the inclusion, its relatively low mineralization, and near neutral pH values, lead to the conclusion that Au and Ag are present in hydrothermal solutions mainly in the form of various simple and complicated hydrolyzed complexes.

3. Data available for dissociation constants of Au(I), Au(III) and Ag(I) complexes were used in computer calculations. Competition between various complexing reactions in solution have been considered for the temperature interval 25-200°C and pH 1-12 in equilibrium with metallic Au and Ag_2S. Overall contents of Cl and S were chosen to be 1 mole/l and 0.01 mole/l respectively, and P_{H_2} and P_{H_2S} ranged from 10^{-10} to 1 bar. Both metals have been shown to be transported in the form of $Me(HS)_2^-$, MeOH°, and $MeOHCl^-$ complexes. Gold can be transported as Au° as well. Concentrations of these species is sufficient for ore deposition. (Author's abstract with revisions received after publication (ER.))

BARBIERI, M., FERRINI, V., LOMBARDI, G., and PENTA, A., 1978, Use of strontium in carbonates for the interpretation of the deep minerogenetic fluid circulation in the Tolfa Mts. (Rome): Chem. Erde, v. 37, p. 143-153.

BARKHUDARYAN, N. B., 1978, IR spectrometric methods for the determination of the carbon dioxide, hydrocarbon, and water contents in quartz: Teor. Prakt. Termobarogeokhim., (Dokl. Vses. Soveshch.) 5th 1976, N. P. Ermakov, ed.: Moscow, Izd. Nauka, p. 218-221 (in Russian).

Absorption in the 3460 (H_2O) and 2350 cm^{-1} (CO_2) regions are estd. from the optical densities in relation to the calcd. optical d. of bands for the internal std., in the 2200 cm^{-1} region. Quartz (Q) from Au ore deposits, shows increase in the intensity of the 3460 cm^{-1} band, in the transition from early to late ore-forming stages. Absorption in the 2850-2900 cm^{-1} region is caused by the presence in Q of hydrocarbons. Au-contg. Q has the highest CO_2 content. The lowest H_2O content is in the Q from Precambrian rocks. The IR spectroscopy permits assessment of Q in ore deposits close to the surface and at medium or greater depth. (Chem. Abstracts 91: 60364k, 1979)

BARNES, H.L., POTTORF, R.J., and MUROWCHICK, J.B., 1977, Fluid inclusion analyses for Stone and Webster Eng. Corp., Fitzpatrick Nuclear Power Plant Site: submitted during plant operation licensing stage, Fitzpartick Docket 50333-550/570, Job E-19214, Nuclear Regulatory Commission Library, 6 pp.

Fluid inclusion studies were used to prove that the latest significant deformation of the area occurred during a mid-Paleozoic thermal event. (E.R.)

BARNES, Ivan, IRWIN, W.P., and WHITE, D.E., 1978, Global distribution of carbon dioxide discharges, and major zones of seismicity: U.S. Geological Survey Water-Resources Invest. 78-39, Open-File Report, 12 pp.

Carbon dioxide discharges of the circum-Pacific belt are in a seismically active zone and in part stem from contact metamorphism. Carbon dioxide discharges in Europe and Asia Minor, also in an area of high seismic activity, are in part from regional metamorphism and are in areas of very high heat flow. (Authors' abstract)

BARSUKOV, V.L., KOGARKO, L.N., POLYAKOV, A.I. and ROMANCHEV, B.P., 1978, Physico-chemical conditions of crystallization of ankaramites of the South Atlantic islands: Akad. Nauk SSSR Doklady, v. 241 no. 4, pp. 937-939 (in Russian). Authors at Inst. Geochem. Anal. Chem. of Acad. Sci. USSR, Moscow.

Specimens were collected in Gran Canaria (ankaramite) and St. Helen and Tristan da Cunha (ankaramite-basalt). Olivines from the Gran Canaria ankaramite bear partly crystallized inclusions (glass+spinel+apatite+clinopyroxene+kaersutite+L CO_2 + G CO_2, volume of CO_2 is 3-5%, but sometimes it occupies as much as 30 vol.%). Inclusions from inner zone of olivine homogenize at 1330-1310°C, and from outer zone - at 1310-1270°C. P inclusions in olivines from ankaramite-basalts (St. Helen) are filled with glass (10-30 vol.%), dms (clinopyroxene, plagioclase, kaersutite, spinels: magnetite and chrome-hercynite, & augite) and CO_2; inclusions in Ti-augites bear significantly more glass (up to 40 vol.%). Th of inclusions in olivines 1280-1250°C, in pyroxenes 128-1240°C. Olivines in the same rock from Tristan da Cunha bear similar inclusions but are richer in glass (30-50 vol.%), Th 1260±20°C; Th of inclusions in clinopyroxene 1250±10°C. CO_2 has density 0.6-0.725 g/cm^3, displaying at Th pressure 3.3kb (Tristan da Cunha), 3.6kb (St. Helen) and 5kb (Gran Canaria), and corresponding to crystallization of phenocrysts at the depth 10-18km. (Abst by A.K.)

BARSUKOV, V.L., VOLOSOV, A.G., KNYAZEVA, S.N. and SUSHCHEVSKAYA, T.M., 1978, Genesis of cassiterite ore mineralization: (abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostk, Acad. Sci. USSR, p. 16-17 (in Russian). Authors at GEOKHI of Acad. Sci. of the USSR, Moscow.

1. Concentrations of K, Na, Ca, Cl and HCO_3 in inclusions in quartz of the commercial cassiterite-sulfide stage are distributed according to a log-normal pattern (Komsomol'sk region, Khabarovsk province). Pattern of distribution of dissolved non-dissociated CO_2 is more complicated.

2. Alkali, HCO_3 and CO_2 contents decrease from early to late mineralization stages.

3. Correlation was found between solution compounds, and a special role of CO_2 is apparent; initially CO_2 correlates with almost all solution components, but after precipitation of the main mass of cassiterite these correlations disappear. However, HCO_3/CO_2* ratio is such that the main control of the pH value belongs to CO_2* (Authors' abst., translated by A.K.; CO_2* = dissolved but undissociated CO_2).

BATCHELDER, J.N., and O'NEIL, J.R., 1978, Hydrothermal system of the East Tintic district in Utah (abst.): Geological Research 1978, U.S. Geol. Survey Prof. Paper 1100, p. 190.

See next item. (E.R.)

BATCHELDER, J.N., O'NEIL, J.R., MORRIS, H.T., MOGENSEN, A.P., 1978, Geochemistry of fluid inclusions in selected ores from the East Tintic Mining District, Utah County, Utah, (abst.), in International Assoc. Genesis Ore Deposits, 5th Symp., Snowbird, Alta, Utah, 1978, Program and Abstracts: [Alta, Utah], p. 47.

The East Tintic mining district, a part of the Tintic mining district approximately 95 km south-southwest of Salt Lake City, Utah, has yielded complex Au-Ag-Pb-Zn-Cu-Cd-Mn ores with an estimated gross value of $300 million. More than three-fourths of this total value is from ores produced from large replacement deposits in Cambrian carbonate rocks, and most of the remainder is from fissure and breccia deposits in Cambrian quartzite. Minor quantities of related ores also occur in Oligocene volcanic and plutonic rocks that overlie and cut the folded and faulted Paleozoic rocks.

A fluid-inclusion and light-stable-isotope study was undertaken on selected samples of quartz, barite, sphalerite, and galena from the fissure and replacement ore bodies. Filling temperatures of fluid inclusions in quartz and barite range from 150°C to 300°C, and salinities range from 0.1 to 3.1 equivalent weight percent NaCl. Present-day spring waters in the West Tintic district have δD values and $\delta^{18}O$ values of approximately -120 and -15, respectively. Waters liberated from fluid inclusions in quartz have δD values ranging from -121 to -118. Calculated $\delta^{18}O$ values for water in equilibirum with quartz range from -5.1 to 0.0. In sulfide samples, waters liberated from fluid inclusions have δD values generally ranging from -118 to -101 and from -89 to -84. Scanning electron photomicrographs show fluid inclusions in galena, whose waters have δD in the latter range, contain a NaCl-KCl brine and tetrahedrite, chalcopyrite, chalcocite, and other antimonide daughter minerals. These data suggest that the quartz formed from a hydrothermal system that was dominated by meteoric waters in which the waters exchanged oxygen isotopes with the altered sedimentary rocks. In contrast, the data from the sulfides indicate that substantial amounts of magmatic water may have been present during ore deposition. (Authors' abstract)

BAUM, W., 1975, Mineralogische Untersuchungen an Flüssigkeitseinschlüssen aus Baryten hydrothermaler Ganglagerstätten (Mineralogical investigations on fluid inclusions from barite of hydrothermal vein deposits): Dipl. Arb., Giessen, 1975, 86 pp. (in German).

Only Th values are given. (E. Horn)

BAUMER, Alain and ARGIOLAS, Robert, 1978, Descriptive study of fluid inclusions in chloroapatites synthesized by hydrothermal methods. Correlations with experimental conditions: Schweiz. Mineral. Petrogr. Mitt., v. 58(1-2), p. 101-110 (in French).

Coarse chlorapatite crystals were hydrothermally synthesized and the trapped fluid inclusions were studied. The degree of filling is intimately related with formation conditions. The 2-phase primary and secondary inclusions are described (C.A., v. 91, 1979, 42088u)

BAZAROVA, T. Yu., 1978, Inherited melt inclusions in secondary minerals: Geologiya i Geofizika, v. 19, no. 5, p. 136-139, (in Russian; translated in Soviet Geology and Geophysics, v. 19, no. 5, p. 120-122).

The existence of inherited melt inclusions in secondary minerals is reported. Attention is called to possible errors in petrologic conclusions when the possibility of inheritance of inclusions is not taken into account. Examples include melt inclusions in zeolites formed by alteration of nosean. (E. R.)

BAZAROVA, T. Yu. and KAZARYAN, G.A., 1977, Crystallization of leucite phonolite of the Azat-Vedi interfluve, Armenian SSR: Akad. Nauk SSSR, Doklady, v. 232, p. 1418-1420 (in Russian, translated in Doklady Acad. Sci. USSR, Earth Sci. Sects., v. 232, p. 217-220 (1978). First author at Inst. Geol. and Geophy., Sib. Div., USSR Acad. Sci., Novosibirsk.

See Fluid Inclusion Research -- Proceedings of COFFI, v. 10, 1977, p. 22 for abstract. (E.R.)

BELEVANTSEV, V. I., KOLONIN, G. R. and PESHCHEVITSKY, B. I., 1977, On estimation of stability constants and possible role of combined complexes with mixed ligands in mineral formation, exemplified by hydroxyhalide complexes (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. 3, p. 62-63 (in Russian).

BELEVANTSEV, V.I., PESHCHEVITSKY, B.I., 1977, On methods of studying systems with mixed ligand complexes (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. 3, p. 5-6 (in Russian).

BELEVTSEV, Ya. N., DROZDOVSKAYA, A. A., KUZNETSOVA, S. V. and SHCHERBAN', I. P., 1978, Conditions of formation of albitites on the basis of thermodynamic calculations and thermobarometric data, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 136-137 (in Russian). Authors at Inst. of Geochem. and Physics of Minerals of Acad. Sci. of Ukrainian SSR, Kiev.

Carbonate-bearing and carbonate-free albitites occur in nature. From fluid inclusions data, carbonate-bearing albitites form when Na/K ratio in fluid is high (at 100°C, 125; at 200°C, 30; and at 300°C, 10); pH 6-9; T under relatively low P_{CO_2} does not exceed 300-400°C. If the first condition does not exist, K-spar forms instead of albite, if the second one does not - kaolinite, paragonite or kalsilite form, if the third one does not - carbonate cannot crystalize. Carbonate-bearing albitites form at 300-160°C, ~600 atm from solutions rich in HCO_3, Cl, Na and CO_3. Carbonate-free albitites form at similar pH values as above, but at 400-350°C and Na/K <10, P~1000 atm from Cl-HCO_3-Na-K-type solution. (From the authors' abst.)

BELEVTSEV, Ya.N. and TERESHCHENKO, S.I., 1978, Conditions of metamorphism of the ferruginous-silica formations of the Ukraine from thermobarometric data: Vladivostok abs., v. I p. 125-126 (in Russian). Authors at the Inst. of Geochemistry and Physics of Minerals of Acad. Sci. of the USSR, Kiev.

Minerals: quartz, carbonate, garnet, pyroxene, etc. bear inclusions:

G>L, G<L, $LCO_2 + GCO_2$, $LCO_2 + LH_2O + GCO_2$, dms + L + G, essentially L (G<5%), $LCO_2 + GCO_2 + LH_2O$ + dms. Metamorphic processes developed under following PT conditions: greenschist facies 320-400° C, 1-1.5 kbar, low-CO_2 solutions; epidote-amphibolite and amphibolite facies 400-470° C, 1.5-2.5 kbar, H_2O-CO_2 solutions; granulite facies $\leq$ 750° C, $\leq$ 5 kbar. (From the authors' abst.)

BELEVTSEV, Ya. N., VETSHTEYN, Y. Ye., VOINOVA, T. N., KUZNETSOVA, S. V. and SHCHERBAK, N. P., 1978, Isotopic composition of liquid inclusions in vein quartz from various metamorphic complexes of Ukrainian shield, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 127-129 (in Russian). Authors at Inst. Geochem. and Physics of Minerals of Acad. Sci. of the Ukrainian SSR, Kiev.

Samples of quartz from various veins from Archean and Proterozoic were studied for determination D/H and $^{18}O/^{16}O$ ratios in fluid inclusions. D content ranges from -116 to -9‰ and ^{18}O - from -11.5 to +1.3‰ (SMOW). Chemical composition is variable, but mostly rich in CO_2. Th is 540-100°C, P 1.5-0.6 kbar. By isotopic studies the mixing of parent fluids (magmatic and vadose waters) is suggested. Some veins formed from almost exclusively vadose water δD -73 to -65‰ , $\delta^{18}O$ -11.5‰. Alpine-type veins in migmatites have high δD values (-9‰) that prove multiple generation of metamorphic fluids. Only chamber pegmatites of Volhynia formed in closed magmatic system. (From the authors' abst.)

BELIKOVA, G. I., ALIBAEVA, G. S., FILIPPOV, V. A. and KHAIRETDINOV, I. A., 1978, Physicochemical conditions for barite formation in the Bashkir ASSR, in Thermobarogeochemistry of the earth's crust and ore formation, N. P. Ermakov, ed.: Moscow, "Nauka" Press, p. 122-127 (in Russian).

The formation conditions of barite are evaluated from study of fluid inclusions and thermodn. calcns. within the frameworks of the HCO_3^-, SO_4^{2-}, and CO_3^{2-} activities; activity -pH, and Eh-pH. Th and Td of inclusions are in the ∿150-400° range and the pressures calcd. are 80-120 atm., equiv. to 300-500 m depth. The barite could be replaced by witherite in the presence of high total activity of dissolved carbonates. The existence of Ba $(HCO_3)_2$, suggested by some investigators as the form of occurrence of Ba in soln., is doubtful, at atm. temp. and pressure. Supergene leaching of Ba from rocks, with involvement of the bicarbonate; transport of the Ba a large distance: and its introduction into a marine basin comprise an unlikely hypothesis. (Chem. Abstracts 89:166306S, 1978)

BELOGOLOV, A.A. and KONOVALOV, I.V., 1978, Mineralogical, geochemical and temperature zonality of the tin deposit Bukuka: Geol. Rudn. Mest., v. 20, no. 4, p. 102-106 (in Russian). Authors at the Inst. of the Earth's Crust of Siberian Branch of Acad. Sci. of the USSR, Irkutsk.

The deposit Bukuka occurs in the SW part of the tin-tungsten ore belt, as veins and ore zones in phyllites, schists, sandstones, porphyroid amphibole-biotite granites and stocks and dikes of fine-grained biotite granites. Most G/L inclusions in quartz from quartz-cassiterite veins have Th 290-390°C, but maximum Th is 500°C; G/L inclusions in quartz from quartz-tourmaline veins homogenize at 270-330°C, maximum Th 370°C. Total number of Th determination was 157. (Abst. by A.K.)

BENDER J.P. and BENCE A.E., 1978, Effect of temperature and pressure on K_D' (FeO/MgO) for experimental olivine-melt pairs (abst): Eos, Trans. Amer. Geophy. Union, v. 59, p. 401.

BERGER, V. I., GOLUBCHINA, M. N., LEVITSKIY, Yu. F., MIRKINA, S. L., MOSKALYUK, A. A. and PRILUTSKIY, R. Ye., 1977, Structure and genetic features of the Kelyansk antimony - mercury deposit: Sovetskaya Geologiya, 1977, no. 4, p. 102-116 (in Russian; translated in Intern. Geol. Review, 1978, v. 20, no. 3, p. 295-307).

Th and Td are given for quartz (jasperoid), calcite (Iceland spar), fluorite, and cinnabar. Early quartz shows Th of 300-320°C; cinnabar Th 80-100°C. Fourteen analyses of aqueous extracts from quartz, calcite, fluorite, antimonite, and cinnabar were made, for Na, K, Ca, Mg, NH_4, SiO_2, Cl, F, SO_4, HCO_3, and pH. Isotopic values for S and Pb in several ore minerals and rocks are given. (ER)

BETTENCOURT, J., 1976, Mineralogy, fluid inclusions and stable isotopes of oxygen and sulfur from Camaquã copper mine - RS (A preliminary study): Anais XXIX Congresso Brasileiro de Geologia, v. 2, p. 409-423 (in French with Portuguese and English abstracts).

Preliminary results on mineralogy, fluid inclusions and isotope studies of sulfur and oxygen were carried out on 52 samples of sulfides, sulfates and hematites from the Camaquã copper mine vein system.

Paragenetic data suggest at least five stages of mineralization: (1) pyrite, (2) chalcopyrite, (3) hematite, (4) late sulfide and (5) final stage. Fluid inclusions in barite (6) from the final stage show Th L-V(L) of 20 to 80°C and about 8 to 10 wt.% NaCl equiv. The $\delta^{18}O$ of the same barite ranges from + 5.87 to + 8.50 permil and the $\delta^{18}O$ of hematites from stage 3, around + 2.72 to +3.00 (SMOW).

The $\delta^{34}S$ of sulfides (pyrite, chalcopyrite, bornite and chalcocite) of stages 1, 2, 3 and 4 range from -2.03 to + 1.5 permil, a very narrow range, close to the meteoritic average isotopic ratio $^{34}S/^{32}S$ (CDT).

The preliminary results based on fluid inclusions and isotopes suggest the following: 1.) The aqueous nature, the very low density of the fluid inclusions (sic.), the low filling temperatures and the $\delta^{18}O$ values given by barites, precludes the possibility of a deep origin. The participation of meteoric waters or even mixtures of hydrothermal fluids during the last mineralization stage seems certain. 2.) The observed trend of the $\delta^{34}S$ values of the barites seems clearly to indicate sulfur isotopic disequilibrium during deposition. The occurrence of barite in the distal vein zones can best be explained if we admit an increase of pH and oxidation state of the fluids through interactions and reactions with host rocks. Due to the hydrothermal fluid movements toward the peripheral vein areas, oxidized sulfur species became more abundant and the $\delta^{34}S/^{32}S$ ratio more positive at the final deposition stage.

Although it was not possible to determine the ($\delta^{34}S_{\Sigma S}$) of the hydrothermal fluids, the $\delta^{34}S$ values obtained from the hypogene sulfides provide compelling evidence in support of a deep source for the sulfur. The sulfur is probably related to an upper mantle or deep crustal igneous source (silicate melt or extraction from igneous rock sulfides); this does not mean that the metallic elements have the same origin. (From the author's abstract).

BISCHOFF, J.L. and SEYFRIED, W.E., 1978, Hydrothermal chemistry of seawater from 25° to 350°C: Amer. J. Sci., v. 278, p. 838-860.

BLENCOE, J. G., and MERKEL, G. A., 1978, Theoretical analysis of $NaAlSi_3O_8$-$KAlSi_3O_6$-NaCl-KCl-H_2O ion-exchange experimental data (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 10, p. 368.

BOBOKHOV, A. S. and MANSVETOVA, A. N., 1978, Gas-liquid inclusions and metamorphism of acid volcanites in the Ozernoe deposit (S. Urals), (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 140 (in Russian). Authors at Geol. Inst. of Bashkir Division of Acad. Sci. of USSR, Ufa.

Fluid inclusions in quartz, plagioclase and matrix (sic.) of acid volcanites from depths to 1-1.5 km yielded Th 130-195, 230-260, 340-360°C, Td 130-195, 200-260, 260-340, 350-600°C. Following processes were distinguished: background impregnation Td 270-370°C (note by A.K.: here and next Td ranges do not agree with the above values), ore-surrounding impregnation 380-410°C, impregnation of plagiogranite-porphyries 400-440°C, impregnation connected with basic dikes 390-415°C. (From the authors' abst.)

BOCHAROV, V. Ye. and SEREBRYAKOV, G. V., 1978, Determination of water in gas-liquid inclusions by gas-bolometric method, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 171 (in Russian). Authors at the Karakh Inst. of Mineral Raw Material, Alma-Ata.

Water was determined by measuring of gas equivalent released from calcium hydride under action of water steam, when 1 volume unit of water causes appearance of 1244 volume units of hydrogen. Sensitivity of method is ∿0.01%, relative error at the lower detection limit - 10%. (From the author's abst.)

BODNAR, R.J., BEANE, R.E., 1978, Temperature variations in pre-intrusive cover over a buried pluton, (abst.), in International Assoc. Genesis Ore Deposits, 5th Symp., Snowbird, Alta, Utah, 1978, Program and Abstracts: (Alta, Utah), p. 54.

Geologic observations and fluid flow models suggest that the mineralized plutons of the southwestern 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 of pre-ore cover is typically absent from porphyry copper deposits now in production owning to erosion resulting in surface exposure of the mineralized plutons. Recently discovered buried mineralization at Red Mountain, Arizona, however, has provided an opportunity to study alteration characteristics of pre-mineral cover overlying a deep deposit using material from drill cores. Alteration mineralogy consists of quartz+kaolinite+alunite in the near surface environment, grading downward through quartz+sericite+chlorite to quartz+K-feldspar+chlorite+biotite with minor amounts of calcite, anhydrite, illite and sericite. Homogenization studies of fluid inclusions in quartz veins from these various alteration zones indicate temperatures in the range 250-425°C extended through a vertical range of about 1½km in pre-ore volcanics covering the buried intrusive. Simultaneous homogenization of liquid-rich and vapor-rich inclusions indicates boiling occurred to a depth of 1km below the present surface, and provides a geothermal gradient of about 70°C/km during the early stages of vein filling. Detailed analysis of a single vein sample was carried out to establish temperature variations with time at a given position in the geothermal system. Paragenetic relationships indicate vein filling began with deposition of milky comb quartz and was followed by clear quartz with associated sulfides. This early quartz crystallized from boiling, moderately saline solutions ($\sim$10-20wt% NaCl equivalent) in the temperature range 300-450°C. Later hypersaline solutions, from which sulfides were deposited, contained on the order of 35-40wt% NaCl equivalent and appear to have been approximately 25° cooler, on the average, than the earlier solutions of lower salinity. The information obtained from this fluid inclusion study suggest pressures of 200-350 bars during early vein filling indicating that the pluton presumed to exist below Red Mountain was originally emplaced to a depth of 2-3½km. This depth requires removal of ½-2km of overburden to obtain the present topographic surface. (Authors' abstract).

BOGDANOV, A.P. and SALDADZE, K.M., 1978, On the mechanism of solution separation by semipermeable membranes: Akad. Nauk SSSR Doklady, v. 242, no. 4, p. 860-863 (in Russian). Authors at the Sci.-Research Inst. of Plastic Masses, Moscow.

Pertinent to formation and evolution of natural hydrothermal fluids. (A.K.)

BOGOYAVLENSKAYA, I.V., 1978a,Studies of inclusions of mineral-forming media abroad in 1976-1977, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in Geology: Vladivostok, Acad. Sci. USSR, p. 40-41 (in Russian). Author at the Moscow State Univ., Moscow.

A review. (A.K.)

BOGOYAVLENSKAYA, I. V., 1978b,Studies of the inclusions of mineral-forming media abroad: Teor. Prakt. Termobarogeokhim., (Dokl. Vses. Soveshch.) 5th 1976, N. P. Ermakov, ed.: Moscow, Izd. Nauka, p. 61-65 (in Russian).

A review, with 6 refs., of work done outside of the USSR on fluid inclusions. (Chem. Abstracts 91: 60302p, 1979)

BOHLEN, S.R. and ESSENE, E.J., 1978, The significance of metamorphic fluorite in the Adirondacks: Geochim. et Cosmo. Acta, v. 42, p. 1669-

1678.

Thermody. data indicate that relative to H_2O, O_2, H_2, F_2 and HF are not major species in the fluid equilibrated with Adirondack orthogneisses. (From the authors' abstract)

BOIKO, S.M. and TROSHIN, Yu. P., 1978, Composition of ore-forming solutions and rare-element composition of minerals as a criteria for the genetic type of deposits: Geokhim. Osn. Poiskov Prognozirovaniya Rudn. Mestorozhd, L.V. Tauson, ed.: Novosibirsk, USSR, Izd. Nauka, Sib. Otd., p. 104-107, 195-206 (in Russian).

The concns. were detd. of Na^+, K^+, $(Li^+ + Rb^+)$, Fe-, Cl-, and HCO_3- in the fluid inclusions in quartz from the Au, Mo, W, Sn, Zn, and Pb ore deposits of Transbaikalia. The compn. of ore-forming solns., derived from these data, is distinct for each type of ore deposit. The contents were detd. of Sb, Bi, Ni, Co, Mn, As, In, Ga, Cd, Ba, Be, Tl, Sn, Pb, Zn, As, and W in sulfide ores of these deposits. The sulfides differ in the content of rare elements, reflecting evolution of hydrothermal solns. (Chem. Abstracts 92: 218169h)

BORISENKO, A. S., 1977, Physicochemical conditions of the formation of listwanites based on data from a gas-liquid inclusion study: Izv. Tr. Inst. Geol. Geofiz., Akad. Nauk SSSR, Sib. Otd., v. 364, p. 144-157 (in Russian).

The listwanites formed at 50-350° and 0-1000 atm pressure by the action of hydrothermal solns. contg. CO_2 on ultrabasic rocks. In addn. to CO_2 the solns. have Na_2CO_3, $NaHCO_3$, NaCl, KCl, and H_2S as major components. The concn. of these compds. is $\leq$40% (av. 5-10 wt.%) in the hydrothermal solns. and the pH is 4-10.5. Formation of metasomatic columns during listwanitization is the result of filtration of the hydrothermal soln. in a background of decrease in the temp. and total concn. of the soln. and increase in its pH. (Chem. Abstracts 88: 194856u)

BOTH, R.A. and SMITH, J.W., 1975, A sulfur isotope study of base-metal mineralization in the Willyama Complex, Western New South Wales, Australia: Econ. Geol., v. 70, p. 308-318.

Report fluid inclusion measurements on quartz and sphalerite from one Thackaringa-type vein (the Pioneer deposit), Broken Hill area. (ER)

BOYARSKAYA, R. V., DOLOMANOVA, Ye. I. and NASEDKIN, V. V., 1978, Electron microscope methods of study of gas-liquid inclusions in minerals, (Abst.): Abstracts of the Sixth all-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 166-167 (in Russian). Authors at IGEM AN SSSR, Moscow.

Electron microscope studies were made of inclusions in cassiterite, quartz, sphalerite, topaz, beryl, ferberite and obsidian. For transmission electron microscopy the replica techniques of fresh cleavage surfaces (with or without extraction) are most effective, especially for studies of dms or trapped minerals. L phase presence is detected by presence of precipitates around vacuole. This method joined with microdiffraction makes possible the study of dms and precipitates. Authors studied even tiny

(0.n μm) inclusions by this method. Sylvite, sulfohalite, jacobsite, topaz, muscovite and other silicates were determined in inclusions. By electron microprobe analysis iron sulfides, iron, potassium and calcium chlorides, and various aluminosilicates were identified. It was found that precipitates of solutions in inclusions in ferberite bear Al, Sr, Ca, Li, Mn, Fe, Ni, As, S. Vacuole morphology and dm habits are studied by scanning electron microscopy. (From the authors' abst.)

BRATUS', M.D., 1978, Physico-chemical state of mineral-forming solutions during quartz crystal formation in vein pegmatites of the Korsun'-Novomirgorod pluton: Mineral. Sborn. v. 32, No. 2, p. 52-58 (in Russian). Author at the Inst. Geol. Geochem. of Mineral Fuels of Acad. Sci. of the Ukrainian SSR, L'vov.

Pegmatites from miaroles 2-5cm wide to veins 7-10m long occur in rapakivi granite. The structure of pegmatites is typical, as well as quartz sequence: reticulate (honeycomb) → smoky (morion) → transparent (rock crystal). Reticulate fractures were healed by G solutions (15-20%L), Th 420-360°C, sometimes with LCO_2(50-60%) and Th $LCO_2 + GCO_2 \rightarrow LCO_2$ at 22.5-23.0°C; P= 890×10^5Pa. Probably before quartz inversion P > 1000×10^5Pa. Between reticulate and smoky quartz inclusions filled with L 45% + G 50% + dms (cubic salts) 5%, microreactions detected (sic.) in individual inclusions (in g/l) K 1, Ca 70, Mg 6, Cl 174, SO_4 and CO_3 not found, Na (as balance) 23, total salts 275. At +14°C LCO_2 appears; inclusions decrepitated before homogenization. Smoky quartz bears G inclusions (L10-15%, Th 420-405°C, pH by microcolorimetric method in individual inclusions 8.5-9.0), and early-secondary G inclusions (L10-30%, Th 380-320°C, pH 7.5-8.5 and most common L20-30%, at +19 to +22°C 10-15% LCO_2 appears, Th 320-340°C, in G, P $285\text{-}305 \times 10^5$Pa to 270×10^5 Pa without correction for salt concentration, which is 5-7 wt.%). Large S inclusions have parameters: L 30%, LCO_2 appears at +9.8°C, Th 320-315°C, P 205×10^5Pa, salt conc. 5 wt.%, pH of L phase 9.0. P inclusions in quartz of pegmatite veins are as follows: L 25-30%, Th in G 420-410°C, if LCO_2 appears at +10 to +11°C, Td is 380-400°C, thus P is $850 \pm 50 \times 10^5$Pa.

G composition in fluid inclusions in vein pegmatites (by mass spectrometry) may be characterized by the numbers: CO_2 10-74%, N_2O - 80%, CH_4 2-32%, H_2 1-86% (by vol.). (Abst. by A.K.)

BRATUS', M.D., GIGASHVILI, G.M. and BESKROVNYI, N.S. 1978, Conditions of formation of plagiobasalts, example of products of eruption of volcano Shtyubelya (Kamchatka), (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 97-98 (in Russian). First author at Inst. Geol. and Geochemistry of Natural Fuels of Acad. Sci. of Ukrainian SSR, L'vov.

Anorthite and olivine crystals (1-1.5cm and 0.1-0.3cm., respectively bear P melt inclusions. Plagioclase at early stage of crystallization trapped at 1300°C melt close to critical state, since on homogenization the boundary between G and melt disappears. Most of large (>0.1mm) inclusions in plagioclase decrepitated and they are surrounded with haloes of crystallized melt. The parent inclusions are thus filled mostly with G with remainders of crystallized glass. Also S inclusions of boiling melt occur including essentially G inclusions bearing only 5% of LH_2O.

Inclusions in olivine are filled with weakly crystallized glass with G bubbles. G phase in studied inclusions bears H_2O and other gases, including C_2H_6 and C_3H_8. (From the authors' abst., by A.K.)(Note-same abstract reported on p. 106)

BRATUS', M.D. and KORZHINSKIY, A.F., 1978, Conditions of crystallization of magmatic tridymite in volcanites of Transcarpathians, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 109-110 (in Russian). Authors at Inst. Geol. Geochemistry of Natural Fuels of Acad. Sci. of the Ukrainian SSR, L"vov.

Tridymite from cavities in dacites occurs with hypersthene, amphibole, biotite, K-spar, quartz, hematite, palagonite, chlorophaeite and montmorillonite. Tridymite bears three types of inclusions: 1 - melt, 2 - melt with solid phase: dark-brown amorphous substance (palagonite), 3 - G inclusions. Melting of glass begins at 800-900°C, homogenization of glass inclusions is at 1050-1080°C, dissolution of solid - at 1190-1220°C. Probably tridymite in cavities in dacite crystallized from melt rich in volatiles. (Authors' abst., translated by A.K.)

BROWNE, P.R.L., 1978, Hydrothermal alteration in active geothermal fields: Ann. Rev. Earth Plan. Sci., v. 6, p. 229-250.

A thorough review of the mineralogy, fluids, fluid inclusion data, and alteration phase assemblage at various geothermal fields, including Imperial Valley, Yellowstone, Japan and Iceland. (E.R.)

BRUMBY, G.R. and SHEPHERD, T.J., 1978, Improved sample preparation for fluid inclusion studies: Mineralogical Magazine, v. 42, p. 297-298.

The method involves, among other features, coating the sample with a polyester resin before embedding in epoxy; after sawing and polishing, the polyester is dissolved with chloroform, freeing it from the epoxy, for heating runs. (E.R.)

BUCHANAN, D.L. and NOLAN, J., 1978, Sulphur solubility characteristics of synthetic tholeiitic melts: Natural Envir. Research Council, Pub. Ser. D, No. 11, Progress in Experimental Petrology, p. 261-267.

BUDANOVA, K.T., 1978, Phenomena of the deep contact metamorphism connected with Precambrian basite-hyperbasites (S.W. Pamirs): Akad. Nauk SSSR Doklady, v. 239, no. 1, p. 177-180 (in Russian). Author at Inst. Geol. of Acad. Sci. of the Tadzhik SSR, Dushanbe.

Hyperbasites bear xenoliths of biotite migmatites with melt inclusions in plagioclase filled with eutectoid composition: feldspar, quartz, biotite. (A.K.)

BULAKH, A.G., and BULAKH, K.G., 1978, Physico-chemical properties of minerals and components of hydrothermal solutions: Leningrad, "Nedra" Press, Leningrad Division, 162 pp. (in Russian).

Essentially a tabulation of various properties (specific volume, enthalpy, viscosity, fugacity, etc.) of H_2O, CO_2, CH_4 and salt solutions. (E.R.)

BULAKH, A. G. and ISKOZ-DOLININA, I. P., 1977, Origin of carbonatites in the Central'nyy massif, Turiy peninsula: Acad. Nauk SSSR, Izvest., Sov. Geol., 1977, no. 12, p. 28-36 (in Russian).

Td on calcite fell in range 320-360^{o}C. (ER)

BURKOVSKY, S. I., 1977, Investigation of hydrothermal solutions at elevated temperatures and pressures by light dispersion (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. 3, p. 64-65 (in Russian).

BURNHAM, C. Wayne, and OHMOTO, H., 1978, Late magmatic and hydrothermal processes in ore formation (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 10, p. 375.

The myriad of processes by which late magmatic and hydrothermal mineral deposits are formed, whether in a deep intrusive (pegmatites), a shallow intrusive (porphyry, skarn, replacement, and vein types), or an extrusive volcanic (geothermal types) environment, are linked directly or indirectly to orthomagmatic processes. Orthomagmatic processes of major importance include the generation of metal-, sulfur-, and chlorine-rich hydrous magmas, as well as the emplacement and crystallization of such magmas under conditions that lead to separation of a magmatic aqueous phase and to initiation of the critically important groups of transitional and later hydrothermal processes. Paramount among the transitional processes are those that produce fracturing and explosive volcanism, as well as those that endow magmatic fluids with high metal- and sulfur-transporting capacity. With falling temperatures and pressure, transitional processes give way to hydrothermal processes, in which ore deposition and wallrock alteration are of overriding concern.

Groundwaters convectively circulating around igneous bodies, whether in a sub-aerial or submarine volcanic environment, give rise to a group of other hydrothermal processes (geothermal types) that may be linked to magmas only through the thermal effects of orthomagmatic processes and the mechanical effects of transitional processes. This group of processes is regarded as especially important in the formation of stratabound massive sulfide deposits in volcanigenic sediments near the seafloor, where circulating seawater may evolve into an effective ore-transporting hydrothermal fluid. (Author's abstract)

BURRUSS, R.C., 1978, Thermodynamic framework for analysis of fluid inclusions: binary systems CO_2-CH_4 and H_2O-NaCl (abst.): Amer. Geophy. Union, Trans; v. 59, no. 4 p. 226.

Assuming a fluid inclusion has a constant composition and constant volume (i.e., no leakage), observation of phase equilibria in that inclusion as a function of temperature on a cooling and heating stage allows description of the thermodynamic properties of the entrapped fluid with the Helmholtz free energy (A) for which $dA=-SdT-PdV+\Sigma\mu_i dn_i$. In a fluid inclusion containing a binary fluid, observation of a univariant phase transition defines a tie-line connecting the molar volume ($\bar{V}$) and composition (X) of the coexisting phases at that temperature. Observation of a second transition at a different temperature defines a second tie-line connecting ($\bar{V}$) and (X) of the coexisting phases at that temperature. The projected intersection of these two tie-lines in $\bar{V}$-T-

X space (Helmholtz free energy space) uniquely defines both $\bar{V}$ and X of the bulk, one-phase fluid. Phase diagrams constructed from literature data for the CO_2-CH_4 and H_2O-NaCl systems quantitatively illustrate the method.

To analyze the immiscible CO_2-H_2O system, it is necessary to assume the mixing properties of CO_2-H_2O fluids and make an estimate of the relative volume % occupied by the coexisting phases at constant temperature (40°C). Given this, it is possible to combine the CO_2-CH_4-H_2O-NaCl systems and estimate the ($\bar{V}$) and (X) of fluids in the quaternary CO_2-CH_4-H_2O-NaCl system. (Author's abst.)

BURT, D.M., 1978a, Tin silicate-borate-oxide equilibria in skarns and greisens--The system CaO-SnO_2-SiO_2-H_2O-B_2O_3-CO_2-F_2Q_1: Econ. Geology, v. 73, p. 269-282.

A geochemical association among tin, fluorine, and boron-bearing minerals in skarns and greisens has long been recognized (e.g., cassiterite with fluorite and calcium stanno- and borosilicates in skarns and with fluorite, topaz, and tourmaline in greisens). Diagrams involving the chemical potentials of H_2O, B_2O_3, CO_2, and F_2Q_1 show that in the presence of typical gangue minerals, malayaite and other Sn-bearing calc-silicates are stable only under the relatively low potentials of acid volatiles typical of skarns. At the higher potentials of B_2O_3, CO_2, and F_2O_{-1} typical of greisens, cassiterite becomes stable, except under SiO_2-deficient and B_2O_3-rich conditions, when nordenskioldine may appear. The participation of datolite in the above equilibria is restricted to relatively low-temperature, basic, CO_2- and F_2O_{-1}-depleted environments, and datolite is thus excluded from greisens. (From the author's abstract)

BURT, D.M., 1978b, Multisystems analysis of beryllium mineral stabilities: the system BeO-Al_2O_3-SiO_2-H_2O: Amer. Min., v. 63, p. 664-676.

BURT, D. M. and LONDON, David, 1978, Sodium-lithium ion exchange among pegmatitic silicates and phosphates--A chemical model (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 10, p. 375.

Sodium for lithium ion exchange appears to have been an important late process in some zoned lithium pegmatites, including those at the classic locality of Branchville, CT (Brush and Dana, 1880; 1890). In the presence of quartz, the lithium aluminosilicates (eucryptite, spodumeme, or petalite) can ion exchange to albite, $NaAlSi_3O_8$, amblygonite to lacroixite, $NaAlPO_4$ (F, OH), and lithiophilite to natrophilite, Na(Mn,FE)PO_4. the modeling of natural mineral compatibilities in the quartz-saturated reciprocal quaternary system / Na, Li//AlO_2, $AlPO_4F$, $MnPO_4$/ leads to the conclusion that the assemblage quartz-albite-amblygonite-lithiophilite is stable. This result implies that the lithium aluminosilicates must be incompatible with either lacroixite or natrophilite, and therefore explains the rarity of these sodium phosphates in lithium pegmatites.

In quartz-free systems at low temperatures (i.e., possibly towards the interiors of large crystals), the lithium aluminosilicates eucryptite and spodumene respond differently to Na for Li exchange (as expressed by increasing μNaLi) than they do to the volatiles P and F (as expressed by increasing μPFO_2)^1. Spodumene is the first lithium aluminosilicate to break down with increasing $\mu NaLi_{-1}$, to eucryptite + albite, whereas eucryptite is the first to break down with increasing μPFO_2, to amblygonite + spodumene. With increasing potentials of both $NaLi_{-1}$ and PFO_2, both lithium aluminosilicates break down to amblygonite + albite. The commonly observed late replacement of spodumene by eucryptite + albite therefore indicates a relatively high Na, low P and F environment. (Author's abstract)

BURYAK, V. A., 1978, Physico-chemical peculiarities of metamorphic-hydrothermal ore formation, (Abst.): Abstracts of the Sixth All-Union Meeting; Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 145-146 (in Russian). Author at Far-East Inst. of Mineral Raw Materials, Khabarovsk, USSR.

T of vein quartz crystallization, calculated on the basis of Th and Td, depends strongly on T of metamorphism of wall-rocks: 450-550°C in amphibolite zone, 400-500°C in epidote-amphibolite zone, 300-450°C in biotite chlorite zone and 230-360°C in chlorite-sericite and zeolite zones. In zones of high-temperature metamorphism, T of vein-forming fluids is somewhat lower than T of progressive stage of metamorphism, often being comparable with T of retrograde metamorphism. (From the author's abst.)

BURYAK, V.A., GUMENYUK, V.A., KAYDALOVA, Ye. F., SOROKIN, A.P. and SHIKHANOV, V.V., 1978, New (tourmaline-garnet-quartz-sericite) type of gold-bearing metasomatites: Akad. Nauk SSSR Doklady, SSSR Doklady, v. 241, no. 5, pp. 1143-1146 (in Russian). First author at Far-East Sci.-Research Inst. of Mineral Raw Materials, Khabarovsk.

In gold-bearing metasomatic stockwork in the Upper Priamur'ye, Td of tourmaline was 380-360°C, garnet- 360-340°C, quartz 300-180°C (A.K.)

BUSHMAKIN, A.G. and ISHAN-SHO, G.A., 1977, Temperature conditions for the formation of Kopet-Dag mercury deposits: Izv. Akad. Nauk Turkm. SSR, Ser. Fiz.-Tekh., Khim. Geol. Nauk, no. 5, p. 121-122 (in Russian).

Formation temps. of the Hg deposits are estd. from Th of the fluid inclusions in cinnabar and accompanying barite, quartz, and calcite. The Hg deposit formed from hydrothermal solns. which evolved compositionally during ore formation. The min. temps. of ore formation were 60-340°. In a general background of temp. decrease in time, Hg mineralization was confined to 220 and originated down to 65-80°. (Chem. Abstracts 88: 123928h).

BYCHKOV, A.M., SENDEROV, E.E. and UCHAMEYSHVILI, N.Ye., 1978, Peculiarities of formation of neointrusions of the North Caucasus (inclusion and feldspar structure data), (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 85-86 (in Russian). Authors at GEOKHI of Acad. Sci. of the USSR, Moscow.

"Neointrusions" in Caucasus are small massifs of porphyric acid rocks formed during Alpine orogeny. Neointrusions have very poorly developed post-magmatic phenomena, thus they are suitable for geochemical studies of magmatic processes. The writers studied Tyrnyauz granitoid complex: Eldzhurtin biotite granite, leucocratic granite porphyry, liparites, plus adjacent liparite from the Kyrtyk laccolith. Potassium feldspars are intermediate sanidines $Or_{65-75}(Ab+An)_{25-35}$.

Th of melt inclusions in acicular apatites from all rocks are 1050-1250°C. Th of melt inclusions in quartz and sanadine are almost the same in individual rock types, but they decrease in the sequence: Kyrtyk liparite (900-1220°C), Tyrnyauz liparite (790-970°C), leucocratic granite porphyry (790-880°C), Eldzhurtin granite (730-840°C).

Similar chemical and mineral compositions of the rocks, and almost the same Th of inclusions as in the earliest mineral-apatite suggest that parent magma migrated from one magmatic chamber. (From the authors' abst, by A.K.)

CARPENTER, A.B., 1978, Origin and diagenesis of subsurface brines (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 10, no. 7, p. 377.

A brine may be defined as a solution containing more than 100,000 mg/l dissolved solids. Brines in sedimentary basins are genetically related to evaporites in one of three ways: (1) dissolution of evaporite minerals, generally halite; (2) expulsion of interstitial fluids from evaporites; and (3) alteration of hydrous evaporite minerals such as carnallite. Most Na-Ca-Cl brines originate as interstitial fluids in halite-rich rocks. These fluids initially are rich in magnesium, sulfate, and potassium but evolve to an Na-Ca-Cl brine during migration to their present host rock. The principal reactions involved in the chemical evolution of these brines are dolomitization, sulfate reduction, albitization of plagioclase, and the formation of authigenic potassium aluminosilicates.

Some brines in sedimentary basins have been attributed to shale membrane filtration. Increases in the ratios of Ca/Mg and K/Na in pore water have been cited in support of this hypothesis. However, the equilibrium constants for the interaction of K-spar-albite-solution and calcite-dolomite-solution are such that K^+ and Ca^{2+} increase relative to Na^+ and Mg^{2+} with increasing temperature. Attempts to explain the origin of a brine from sea water within the clastic rocks of a sedimentary basin are difficult since many of the spatial variations in water chemistry can be explained by rock-water interaction without membrane filtration. (Author's abstract)

CASTAING, Raimond, BIZOUARD, Helene, CLOCCHIATTI, Robert, and HAVETTE, Andree, 1978, Some applications of the electron microprobe and of the ion microanalyser in mineralogy: Bull. Mineral., v. 101, p. 245-262 (in French). First author at Lab. de Phys. des Solides associe au C.N.R.S., Bat. 510, Univ. Paris XI, 91405 Orsay.

New possibilities have been opened in the field of earth sciences by the development of modern techniques of point analysis; this paper is concerned with two of them: microprobe analysis, which is now used routinely in most mineralogical laboratories, and ion emission analysis which makes possible isotopic as well as chemical identification.

Both techniques are briefly outlined, with special emphasis on their specific advantages and limitations. A few typical applications: quantitative analysis, identification of unknown phases, mapping of the constituent elements in a mineral, zoning studies, local measurements of isotopic ratios...are presented as illustrations. A study of the so-called "melt inclusions" is discussed in more detail as an example of a joint application of microprobe and ion analysis. (Authors' abstract)

This and the following three articles in this volume discuss a variety of applications of these techniques that are of direct pertinence to various inclusion studies. (E.R.)

CAWTHORN, R.G. and McCARTHY T.S., 1977, Partitioning of nickel between immiscible picritic liquids: Earth and Plan. Sci. Letters., v. 37, p. 339-346. Authors at Geol. Dep., Univ. Witwatersrand, Johannesburg 2001, South Africa.

Proterozoic lavas from the Ventersdorp Supergroup in South Africa display liquid immiscibility textures with ocelli up to 15 cm in diameter. The magmas are of an unusual high-magnesia, but quartz-normative, composition. The high silica and high magnesia content may cause the liquid immiscibility, producing a "pyroxene-type" and "tridymite-type" structured liquid. Nickel contents are high (400-900 ppm), with the matrix containing up to 1.45 times that of the ocelli. A greater proportion of octahedral sites probably exists in the "pyroxene-type" liquid causing this preferential partitioning of Ni. The partition coefficients for Ni between olivine and these two liquid types are significantly different, emphasizing the importance of the structure of these liquids on such parameters. (Authors' abstract).

CHADHURI, S., 1978, Strontium isotopic composition of several oilfield brines from Kansas and Colorado: Geoch. Cosmo. Acta., v. 42, p. 329-331.

CHEKVAIDZE, V.B., KUDRYAVTSEVA, N.G., ISAKOVICH, I.Z., and BAKUEV, N.S., 1978, Conditions of formation of the wall-rock ore metasomatites and ores in the Rubtsovskoe ore deposit in the Rudnyi Altai: Geol. Rudn. Mest., v. 20, no. 2, p. 71-82 (in Russian). Authors at the Central Sci.-Research Geol.-Prosp. Inst., Moscow.

The deposit bears polymetallic ores; the wall-rocks contain zones of albitization, chlorite-carbonate-sericite-quartz, carbonate-sericite-quartz and sericite-quartz metasomatites. The general range of Th in metasomatic minerals is 320-260°C. Ores yielded Th 278-238°C (sphalerite) and 215-210°C (sphalerite and barite). (A.K.)

CHIVAS, A.R., 1977, Geochemistry, geochronology, and fluid inclusion studies of porphyry copper mineralization at the Koloula igneous complex, Guadalcanal, Solomon Islands: PhD dissertation, Univ. Sidney, 414 pp.

See next item. (E.R.)

CHIVAS, A.R., 1978, Porphyry copper mineralization at the Koloula igneous complex, Guadalcanal, Solomon Islands: Econ. Geol., v. 73, p. 645-677.

A more extensive report on the deposit but with less than one page (p. 674) on the inclusions (see Chivas and Wilkins, Fluid Inclusion Research-Proc. of COFFI, v. 10, 1977, p. 42-43, and v. 9, 1976, p. 26. (E.R.).

CHKHARTISHVILI, T.A. and NAUMOV, V.B., 1978, Temperatures of formation of granites from the Kelasur intrusive (Abkhasia, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 86-87 (in Russian). First author at Caucasian Inst. of Mineral Raw

Material, Tbilisi.

Distribution of albite component between coexisting feldspars yielded T of crystallization of biotite granite 700°C, granite-aplite at 600°C, aplite-orthotectite at 500-600°C; Oftedal geothermometer gave for the latter 620-650°C. Quartz of granite-aplite and marginal facies of granite-porphyry bears P melt inclusions with anisotropic dms. At 800-820°C dms begin to melt after 0.5-1 hour runs; Th are 850-870°C, sometimes up to 900°C (run 1 hour long). Values of Th 740-780°C were obtained for block quartz of aplite-orthotektites. T gotten by two-feldspar geothermometer are too low. Biotite granites formed at T 850°C. (Authors' abst., by A.K.)

CHOI, S.W., and PARK, H.I., 1978, Fluid inclusion studies of the Jeie-Mundeung fluorite deposits: Chijil Hakhoe Chi, v. 14(2), p. 13-16 (in Korean).

Deposit is a com.-grade deposit in the Hwacheon ore district, Korea. The fluorite deposits occur in fissure-filled veins traversing the Precambrian granitic gneiss and banded gneiss. Ores are composed of fluorite, chalcedonic quartz, and minor amts. of calcite and pyrite. The temp. of homogenization Th of fluid inclusions representing 22 different sites, is 125°-160°. Differences of Th are not shown along the vein. A comparison of the fluid inclusion and geol. data of the Jeie-Mundeung and the Shinpo deposits indicate that the origin of both deposits is similar. (C.A., v. 91, 1978, 178330z).

CHOJECKA, E., 1978, Geochemistry of fluorite in the barite deposits at Boguszow and Stanislawow (Poland). M.Sc. thesis, Archives of the IGMiP, Geol. Fac., Warsaw Univ. (in Polish).

Average Th of P inclusions in fluorite from Boguszow mine, from an actual depth of 240m (level XII) is 113°C and from 380m (level XIX) - 157°C. Fluorite from the Stanislawow mine at 140m (level VIIA) has Th 144°C, at 240m (level XI) - up to 174°C; Th of inclusions in fluorite from the borehole Stanislawow St18/S, depth 620-640m, 245-160°C. Presumably, fluorite from the Stanislawow area is generally of higher T origin than from Boguszow mine. Differences in Th were also found between color varieties of fluorite - Th 110°C, green - Th 135°C, level XIX, ~130°C and ~170°C, respectively. (Author's abst., modified by A.K.)

CHORLTON, L.B. and MARTIN, R.F., 1978, The effect of boron on the granite solidus: Canad. Mineral., v. 16, p. 239-244. Authors at Dept. Geol. Sci., McGill Univ., 3450 University Street, Montreal, Que. H3A 2A7.

The addition of boron to a water-saturated granitic system lowers the solidus at 1 kbar by 125°C; the liquidus seems similarly affected. This drastic reduction reflects the incorporation of tetrahedrally coordinated boron (B^{IV}) in the place of aluminum in the liquid and the influence of this substitution on the thermal stability of the feldspars. The ratio of B^{IV} to B^{III} in the melt increases with increasing pressure and alkalinity and with decreasing temperature. Reedmergnerite-bearing peralkaline pegmatites in alkaline complexes could have crystallized from melts at temperatures below 600°C. (Authors' abstract).

CHOU, S.-A., 1978, Fluid inclusion and sulfur isotope study of the Chimei copper deposit (Taiwan): K'uang Yeh Chi Shu, v. 16(1), p. 46-53 (in Chinese).

The formation temps. of fluid inclusions in the quartz veins suggest that there are at least 3 stages of hydrothermal activities in the Chimei Cu deposit, Hualien. They are: an early stage of 400-650 , a middle stage of 300-400, and at late stage of 300°. The present-day ore body is intimately related to the hydrothermal activities of the middle stage. The salinity of the polyphase inclusions formed in the early stage is generally $>$50%. The salinity values of other fluid inclusions are 3.3-12.8%. Based on the temp. and salinity data of the fluid inclusions trapped at b.p. the pressures in the early stage, in the middle stage, and in the late stage are $\sim$330-390, $\sim$190, and $\sim$65 bars, resp. The δ^{34}S values of the sulfide minerals in the deposit indicate the ore bodies were probably derived from magmatic hydrothermal soln. (C.A. v. 89, 132675w, 1978)

CHUPIN, V.P. and MATRENITSKIY, A.T., 1978, Temperature conditions of granitoid formation in certain regions of Mongolia, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 81 (in Russian). First author at Inst. Geol. Geophys. of Siberian Branch of Acad. Sci. of the USSR, Novosibirsk-90.

The studied specimens were collected from intrusions of gabbro-syenite and granite-granosyenite associations in the Orkhon-Selenga area. Th of melt inclusions (often with distinct L H_2O phase) in quartz of rocks of the granite-granosyenite association Balāgagol massif are: Leucocratic two-feldspar granite - Ca. 630°C; porphyric two-feldspar biotite granite - 600-650°C in quartz phenocrysts and 620±20°C in matrix quartz; and vein apatite-granite - 580-620°C. Quartz of granosyenite of the Khusumay massif, same association have Th$<$800°C. Gabbro-syenite association, Narintol-Burigol massif: Th in andesine of olivine syenite 720-680°C, in granosyenite - $<$650°C (melt inclusions). (From the authors' abst., by A.K.)

CLARK, G.J., WHITE, C.W., ALLRED, D.D., APPLETON, B.R. and TSONG, I.S.T., 1978, Hydrogen concentration profiles in quartz determined by a nuclear reaction technique: Phys. Chem. Minerals, v. 3, p. 199-211. First author at Solid State Div., Oak Ridge Nat. Lab., Oak Ridge, TN 37830 U.S.A.

The nuclear reaction $^{19}F(^{1}H, \alpha\gamma)^{16}O$ has been used to determine the hydrogen concentration in natural and synthetic quartz samples. The depth-profile of the hydrogen concentration in these samples has been determined in detail for the smoky and X_o quartzes. These profiles exhibit a region of high hydrogen concentration in the near surface region (down to a depth of $\sim$2000A), with a lower concentration in the bulk of the sample. The results provide a plausible explanation for the substantial disagreement between previous hydrogen analysis in these quartzes by other techniques. Evidence for hydrogen mobility in crystalline quartz under ion beam bombardment is presented and discussed. (Author's abstract)

CLAYTON, R.N., JACKSON, M.L., and SRIDHAR, K., 1978, Resistance of quartz silt to isotopic exchange under burial and intense weathering conditions: Geoch. et Cosmo. Acta., v. 42, p. 1517-1522. First author at Enrico Fermi Inst. and Dep. Chem. and the Geophy. Sci., Univ. Chic., Chicago, IL 60637, U.S.A.

Oxygen isotopic compositions of quartz from silty sediments buried to 5400m depth from two wells in the Gulf of Mexico each showed δ^{18}O variations of less than 1.7‰. Clay diagenesis has been reported within this depth. The observed variations in the quartz do not appear to be primarly diagenetic effects, but rather are mainly depositional features reflecting variations in the sources of the sediments. Sources may be influenced by the variation of distance from the shore at different depths in a given sampling location and by sediment production by continental glaciations. Stability of the oxygen isotopic composition of quartz in the 10-20 μm size range under long-time humid, temperate weathering conditions was studied by analysis of saprolites formed from Pennsylvanian to Precambrian crystalline rocks. In four of the five cases, the 10-20 μm fraction was found to have only 0.1-0.5‰ greater $\delta^{18}O$ than the corresponding 20-50 μm fraction. This increase may be attributable either to a slight oxygen isotopic exchange with ambient ground waters or original differences within the rock since the saprolites were sufficiently coherent to make an influx of extraneous detrital silt unlikely. The amount of oxygen isotopic exchange in silt size quartz over periods of many million years of shallow burial or weathering appears to be small enough to permit the use of the oxygen isotopic ratio of quartz in tracing the origin of eolian and fluvial additions of minerals to continental soils and pelagic sediments. (Authors' 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.): Eos, Trans. Amer. Geophy. Union, v. 59, p. 225.

See Fluid Inclusion Research--Proc. of COFFI, v. 10, p. 46, 1977.

CLOCCHIATTI, R. and HAVETTE, A., 1978, Contribution of the ion analysis to the study of magmatic melts trapped into lava phenocrysts (abst.): XI General Meeting of International Mineralogical Association, Novosibirsk, Abstracts, v. II, p. 136-137 (in English).

Ion microanalysis is a new technique for making in situ analyses. The sample is bombarded by a beam of primary ions (Ar^+, O_2^+, O^-); simple and polyatomic ions, ejected from the sample, are electrically accelerated and sorted in mass by a magnetic prism. The instrument is thus a mass spectrometer which makes possible: 1) To visualize during study, or to print on a film, the distribution of a given element over a 30 to 250 μm diameter range; 2) To calculate isotopic ratios or quickly obtain a mass spectrum where the elements present appear on a 10 to 4,000 μm^2 range.

Low concentration elements can be detected, for instance: 1 to a few ppm for alkaline and alkaline-earth elements, 10 to 50 ppm for metals from the transition first series, 50 ppm for silicon. Spatial resolution at the image surface is about 0.5 μm; penetration is some tens of Angstroms.

It is possible to obtain quantitative analyses by counting or from distribution maps by microdensitometry. Thus instrument utilization is well adapted to the study of melt inclusions on account of their small dimensions ($200<d<1$ μm). Indeed, through the images taken on all the present elements, the ion analyser makes quite obvious:

A) Heterogeneities in crystalline phases as host minerals, minerals deposited in epitaxy on the walls of cavities proceeding from the host mineral growth upon the included liquids, minerals mechanically trapped before the cavities locking up, so already present into magma (zircon, apatite, sphene, rutile, etc. ...) minerals proceeding from the experimental or natural crystallization of the included glass (pyroxene, olivine, magnetite, etc. ...) (sic).

B) Heterogeneities in vitreous phases as lessened zoned structures in elements entering into the host mineral constitution, resulting from slow diffusion at the liquid (melt inclusion) - solid interface (walls of the cavity). It is also the case for immiscible liquids proceeding from the last evolution in the filling up of some cavities.

The ion analyser is a tool, complementary to the optical microscope and electron microprobe and absolutely necessary to any advanced chemical study on magmatic liquids trapped in during the lava mineral growth. (Authors' abstract)

CLOCCHIATTI, R., HAVETTE, A. and NATIVEL, P., 1978, Petrogenetic relations between transitional basalts and oceanites from trapped melts in olivine and chromospinels phenocrysts of Piton de la Fournaise (Reunion Island, Indian Ocean), in Société Francaise de Minéralogie et Cristallographie, Colloque "Minéraux et Minérais," Nancy, 26-29 Sept., 1978--Programme et Resumes des Communications: (Nancy), p. 41. First author at ER 45 du C.N.R.S. - Laboratoire de Pétrographie Volcanologie Université Paris XI, 91405 - Orsay, France.

The phenocrysts of olivine and chrome spinel of recently erupted oceanites (1966 and 1977) from Piton de la Fournaise contain a not insignificant quantity of monophase and polyphase glass inclusions. The inclusions in the spinel contain glass or glass with gas bubbles; those in the olivine are most frequently glass with gas bubbles and daughter spinel crystals. In a few crystals of olivine some crystals of pyroxene and sulfides of Fe, Cu and Ni globules have been observed and analysed. The sulfides have separated at high temperatures (≽ 1,200°C) from an initial liquid saturated in sulphur. The melt inclusions of the olivines and spinels have a transitional basalt composition. The enriched contents of MgO and Cr_2O_3 in the melt trapped in spinel show that these minerals began to crystallize before the olivine. The comparison between petrographic and geochemical data of transitional basalt and oceanite shows a cumulative character of the oceanite. This is also suggested by a comparison between chemical composition of melt inclusions on one hand, and melt adhered to the crystals and whole rock on the other hand. The sulphur contents in the melt inclusions (1,800 ppm) are clearly greater than those measured in the whole rock and they provide a good approximation of the sulphur content of the mantle. (Authors' abstract)

CLOCCHIATTI, R., HAVETTE, A., WEISS, J., and WILHELM, S., 1978, The bytownite megacrysts of Asal Rift. - I. Study of trapped basaltic melts: a new approach to the study of some petrogenetic process: Bull. Mineral., v. 101, p. 66-76 (in French, English abstract). First author at E.R. 45 C.N.R.S., Lab. de Geochimie, Univ. Paris XI, 91405 Orsay.

Bytownite megacrysts during their fast and skeletal growth have trapped some liquid magma now present as glass inclusions.

Optical study, at room temperature and at high temperature, and analytical techniques (electron microprobe and ion microanalyser) give data on: The chemical composition of glass droplets (it is analogous to a tholeiitic basalt); the cooling rate and temperature of crystallization of bytownite (1,200±25°C); the experimental growth and zoning of host mineral from initial trapped melt during heating; the simultaneous growth of olivine, plagioclase, clinopyroxene and oxides in melt inclusions (these minerals melted in magma near 1200°C); the growth rate of clinopyroxene at 1,150°C (3 to 4 µm minute); the hour-glass zoning obtained by change of temperature during growth of pyroxene; the change in chemical composition of glass trapped during crystallization of host and other minerals; and the petrogenetic implications of melt inclusions studies in petrology. (Authors' abstract)

CLOKE, P.L., KESLER, S.E., JOWETT, R.E., and WILSON, J.W.J., 1978, The halite trend in magmatic-hydrothermal mineralization (abst.): Geol. Soc. Amer., Abstracts with Programs, v. 10, no. 7, p. 381.

CLOKE, P.L., KESLER, S.E., JOWETT, R.E., and WILSON, J.W.J., 1978, The halite trend in magmatic-hydrothermal mineralization (abst.): Geol. Soc. Amer., Abstracts with Programs, v. 10, no. 7, p. 381.

The most saline, sylvite-bearing fluid inclusions seen in Pb-Zn skarn at Naica, Chihuahua, and porphyry Cu deposits at Granisle and Bell, B.C., plot in the NaCl-KCl-H_2O system along lines (halite trends) passing through the NaCl corner. Inclusions falling on the halite trend: 1) are compositionally distinct from other less saline inclusions in each deposit; 2) homogenize by either vapor or halite disappearance (halite disappearance dominates at Bell and Naica, vapor at Granisle). Halite trends for Bell and Granisle coincide exactly, and that for Naica diverges slightly.

Inclusions falling on the halite trend are interpreted to represent solutions that separated from coexisting halite prior to entrapment thus providing the first evidence for the presence of halite during magmatic hydrothermal ore deposition. Solutions saturated in halite could arise in several ways of which we note only the most likely. Diagrams compatible with the NaCl-H_2O, albite-H_2O, and albite-NaCl-H_2O systems permit an initial direct magmatic expulsion of a very saline aqueous solution undersaturated in halite, possibly followed by nearly pure H_2O vapor. This vapor could condense in part to a limited volume of saline solution. We favor direct magmatic expulsion of saline solutions. Depending on the ensuing P-T history, saline solutions formed in either way could intersect the liquidus surface in equilibrium with vapor, thus giving rise to inclusions homogenizing by vapor disappearance, or the liquidus surface in equilibrium with halite, producing inclusions homogenizing by halite disappearance. We conclude that the halite trend provides the first direct evidence for the composition of essentially pristine magmatic hydrothermal solutions. (Authors' abstract)

COLLINS, P.L.F., 1978a, Composition of fluid inclusions--gas hydrates and the use of freezing data for estimation of salinity, in Notes for Workshop on Fluid Inclusions: Melbourne, Dept. Geology, La Trobe Univ. (unpaginated, mimeographed).

A 2-page abstract indicating that freezing data on such inclusions can be used to obtain salinity. (ER)

COLLINS, P.L.F., 1978b, Fluid inclusions in cassiterite-sulfide metasomatic replacement deposits, in Notes for Workshop on Fluid Inclusions: Melbourne, Dept. Geology, La Trobe Univ. (unpaginated, mimeographed).

A 3-page abstract of work on inclusions in a series of such deposits from western Tasmania (Renison, Cleveland, Mt. Bischoff and Queen Hill). (ER)

COUCHOT P., MERCIER R., PERRET R., and BERNARD J., 1978, Study of the infrared and Raman spectra of double sulfates $M'M'''(SO_4)_2$ of the hexagonal "anhydrous alum" type and their solid solutions $M'_xM'_{1-x}M'''(SO_4)_2$ and $M'M'''_xM'''_{1-x}(SO_4)_2$: Rev. de Chimie Mineral, v. 15, p. 373 (in French; English abstract). First author at Universite des Sciences et de la Technologie d'Alger.

Pertinent to identification of daughter minerals. (E.R.)

CRAIG, Harmon, 1978, Isotopic and chemical studies of geothermal gases (Cerro Prieto, Imperial Valley, etc.) (abst.): U.S. Geol. Survey Prof. Paper 1100, Geologic Survey Research 1978, p. 204.

CRAIG, H., LUPTON, J.E., WELHAN, J.A., and POREDA, R., 1978, Helium isotope ratios in Yellowstone and Lassen Park volcanic gases: Geophysical Research Letters, v. 5, p. 897.

CRAWFORD, M. L., 1978, Interpretation of multicomponent saline fluid inclusions in metamorphic rocks as applied to retrograde alteration, in Société Francaise de Minéralogie et Cristallographie, Colloque "Minéraux et Minérais," Nancy, 26-29 Sept. 1978 -- Programme et Resumes des Communications: (Nancy), p. 47. Author at Dept. Geol., Bryn Mawr College, Bryn Mawr, PA 19010.

Studies of aqueous fluid inclusions in greenschist and amphibolite facies metamorphic rocks show that these inclusions commonly contain a moderate to high content of dissolved salts. Estimates of fluid compositions from freezing point depressions of the aqueous phase show that fluid inclusions in calcareous and amphibolite rocks are enriched in Ca^{+2} as deduced from initial melting temperatures as low as -60°C in the calcareous samples and -45°C in the amphibolite. Melting point observations on these inclusions show several phase changes following the first observed melting. Brine solutions which contain more than 27-33 wt.% dissolved salts and more than 1.5 wt.% NaCl are saturated with NaCl at room temperature and contain a cube of halite. Freezing and melting of these solutions involve the incongruent melting of $NaCl.2H_2O$. Phase changes in solutions less saline than 27-33 wt.% dissolved salts provide information on the relative proportions of each species and the overall salinity of the fluid. As an example, aqueous fluid inclusions from a calc-silicate assemblage show initial melting at -60°C and subsequent melting phenomena at -52°C, -40°C and -20°C. Using the $CaCl_2$-$MgCl_2$-$NaCl$-H_2O model system the inferred wt.% of the three salt phases are: $MgCl_2$:$CaCl_2$:NaCl=25:62:13 and the total salinity is 21 wt.%. These estimates are approximate as the effect of species other than, or in addition to, $MgCl_2$ is not known. KCl can be recognized only if the concentration of KCl is high enough to produce a solid phase; we have not observed this situation in our studies.

In three of the metamorphic suites studied, retrograde phenomena are evident, particularly affecting hornblende, biotite, calcic

plagioclase and microcline. The retrograde reactions inferred include:
3 $\text{microcline}+H_2O = \text{muscovite}+6\ \text{quartz}+2K^{+}+O^{-2}$
3 $\text{albite}+H_2O+K^{+} = \text{muscovite}+\ 6\ \text{quartz}+3Na^{+}+O^{-2}$
3 $\text{anorthite}+1.5H_2O+K^{+} = \text{epidote}+\text{muscovite}+Ca^{+2}+0.5O^{-2}$
2 $\text{biotite}+4H_2O = \text{chlorite}+3\ \text{quartz}+2K^{+}+(Mg,Fe)^{+2}+O^{-2}$
As $(OH)^{-}$ is removed from the system, the fluid phase will become more saline and simultaneously more oxidizing. Oxidation of Fe-bearing minerals is a feature of the retrograde reactions in these rock suites. Both oxidation and removal of $(OH)^{-}$ will increase the CO_2/H_2O ratio in retrograde fluids provided CO_2 and/or graphite were present initially. (Author's abstract)

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.): Eos, Trans. Amer. Geophy. Union, v. 59, p. 226.

See Fluid Inclusion Research - Proc. of COFFI, v. 10, p. 49-50, 1977.

CRERAR, D.A., SUSAK, N.J., BORCSIK, M. and SCHWARTZ, S., 1978, Solubility of the buffer assemblage pyrite + pyrrhotite + magnetite in NaCl solutions from 200 to 350°C: Geochim. Cosmo. Acta., v. 42, p. 1427-1437. Authors at Dep. Geol. and Geophy. Sci., Princeton Univ., Princeton, NJ 08540, U.S.A.

CRISS, R.E., and TAYLOR, H.P., Jr., 1978, Regional $^{18}O/^{16}O$ and D/H variations in granitic rocks of the southern half of the Idaho batholith and the dimensions of the giant hydrothermal systems associated with emplacement of the Eocene Sawtooth and Rocky Bar Plutons (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 10, no. 7, p. 384.

More than 300 analyses of the Idaho Batholith indicate: (1) Plutons E of the initial $^{87}Sr/^{86}Sr = .704$ contour originally had whole-rock $\delta^{18}O = +9$ to $+11$, compatible with partial melting of, or exchange with, high-^{18}O metasedimentary rocks. (2) Over broad areas rocks were depleted in ^{18}O by Eocene meteoric-hydrothermal activity ($\delta D\ H_2O \approx -120$). (3) W of 115°35', most rocks have $\delta^{18}O$ feldspar $>+8.0$ and $\delta D > -120$, indicating water/rock ratios were very low (≤ 0.1). (4) E of 115°35' most rocks have variable $\delta^{18}O = -8$ to $+8$, $\Delta^{18}O$ qtz-feld>2, and $\delta D = -130$ to -170; the lowest $\delta^{18}O$ is in chloritized rocks peripheral to the Eocene plutons, where overall w/r was at least 1 to 10. The core zones of two large Eocene plutons, the Sawtooth (400 km^2) and Rocky Bar (300 km^2) batholiths, are relatively unaltered, but $\delta^{18}O$ systematically decreases outward from the contacts, culminating in a low-^{18}O ring-zone or "moat". The low-^{18}O ring around the Sawtooth batholith is a 5 to 15 km-wide band that forms a N-S elongate oval, 40 x 60 km. The Rocky Bar low-^{18}O "moat" is 20 x 30 km, conforms to the irregular outline of the pluton, lies 1-4 km outside the contact, and extends vertically for at least 1.5 km. Sharp $\delta^{18}O$ gradients (as much as 10‰/km) are observed at the outer boundaries of the ring system (faulting?). These systems may be deeply eroded structures analogous to large calderas in the San Juan and Yellowstone volcanic fields. Such ring fracture systems would be the locus of most intense hydrothermal convective circulation. D/H effects extend far beyond the ring-zones, and may represent partial exchange with cooler ground waters migrating radially inward. Several large Au-Ag-(Pb-Zn) ore deposits are located near the periphery of the low-^{18}O areas; the isotopic systematics may provide a significant exploration tool in the heavily forested batholith. (Authors' abstract)

CUNEY, MICHEL, 1978, Geologic environment, mineralogy, and fluid inclusions of the Bois Noirs-Limouzat uranium vein, Forez, France: Econ. Geol. v. 73, p. 1567-1610.

The genesis of the Bois Noirs-Limouzat uranium deposit involves a very complex history. The Bois Noirs granite resulted from the anatexis of uranium-rich sediments near granulite facies conditions. The temperature is estimated to have been at least 800°C accompanied by a low H_2O partial pressure (possibly resulting from the presence of carbon dioxide). This magma was syntectonically emplaced along the east-west structures in a nonmetamorphic environment. Progressive crystallization and differentiation proceeded inward from the margins toward the core of the intrusion. A fluid phase formed after a large part of the magma had crystallized. This fluid migrated toward the core and altered the primary magmatic minerals, quartz, orthoclase, oligoclase, and biotite, to quartz, microcline, albite, and chlorite. The alteration of the primary accessory minerals sphene, zircon, monazite, and xenotime, resulted in the partial liberation of their uranium content. When all the magma had crystallized, the fluid phase migrated outward to precipitate uraninite, with an associated quartz-muscovite alteration. This critical step produced an easily leachable uranium source in the granite in the form of uraninite.

Thermal activity was maintained in the Bois Noirs area from the emplacement of the granite, at 335 m.y., until the intrusion of the quartz porphyry, at 270 m.y. The enrichment of the Bois Noirs granite in K, U, and Th could have provided an essential or additional heat source for the hydrothermal convective circulation. Water of a supposed meteoric origin, mixed with carbon dioxide of a deep origin, produced the remobilization of the uranium contained in uraninite. The east-west foliation of the granite was reopened and tectonic activity produced open zones filled with porous, crushed, granite breccias. The fluid which dissolved the uraninite crystals in the granite was rich in carbon dioxide, and the uranium was transported mainly in the form of uranyl monocarbonate $(UO_2CO_3)^0$ with a significant amount of H_2S in solution. The fluid pressure, which was nearly lithostatic in the deep zones of the granite (265-775 bars), became progressively hydrostatic (100 to 300 bars) near the breccia zones where pitchblende was deposited. The CO_2 concentration decreased from a maximum of 3 mole percent to less than 1 mole percent. Part of the remaining dissolved CO_2 could have reacted with ions such as Al^{+3} and Ca^{+2} liberated by the alteration of the plagioclase to form a carbonate phase. The uranyl carbonate complex was destabilized and the hexavalent uranium was immediately reduced by the oxidation of the reduced sulfur species in solution.

Marcasite and pyrite deposition alternated with pitchblende. Oxidation of the reduced sulfur species in solution during pitchblende deposition stopped the growth of iron sulfides. Pitchblende deposition took place between 77° and 100°C.

After this initial stage five other stages of mineral deposition occurred under different conditions of temperature and fluid composition. Pitchblende was transformed to coffinite during the second stage without new uranium being introduced. Important "per descensum" remobilization of the primary uranium ore occurred during the Oligocene uplifting of the

Montagne Bourbonnaise horst, with precipitation, mainly with bearings in a range of N 165° to N 135°, of hexavalent uranium minerals and sooty pitchblende. (Author's abstract).

Editor's note: Although not specifically mentioned in the above abstract, the paper has extensive measurements of Th & Tm, estimates of pressure, 14 water (and also acid) leachate analyses for K, Na, Ca, Mg, Cl, SO_4, and Al, two gas analyses by chromatography (major H_2O, minor CO_2, & traces of CH_4 and other hydrocarbons), and daughter mineral identifications, including hydroalumocalcite, hematite, calcite & unknown.

CUNEY, Michel, and KISH, Leslie, 1978, Fluid inclusion studies in the uranium and thorium showings of the Mont-Laurier Area (Quebec), (abst.), in International Assoc. Genesis Ore Deposits, 5th Symp., Snowbird, Alta, Utah, 1978, Program and Abstracts: (Alta, Utah), p. 78

The uranium and thorium occurrences of the Mont-Laurier area (Quebec) are situated in the highly metamorphosed metasedimentary units of the Grenville Group. This group overlies a pre-Grenville group composed of monotonous quartzofeldsapthic gneiss without radioactive anomalies. U geochemical anomalies tend to be concentrated in the noses of major folds of the Grenville gneisses and near the contact zone of these gneisses with the pre-Grenville group. The intensity of metamorphism reaches the beginning of anatexis. Pegmatitic rocks with diffuse contacts and sub-parallel to discordant relations, and feldspathic quartzite are the main host rocks of the uranium and thorium concentrations, and are cut by later coarse grained pegmatites and quartz-veins. The Th/U ratio decreases from northeast to southwest. Uraninite and thorian-uraninite are the main ore minerals where Th/U is low (0.1 to 1), and uranothorite or thorite where Th/U is relatively high.

Fluid inclusions have been studied in the different rocks of this area to follow the fluid evolution from anatexis to late quartz-vein formation, with special attention to the fluids present in the mineralized pegmatitic rocks. The composition of the fluids ranges from pure high density CO_2 fluids ($d = 0.98\ g/cm^3$) in orthopyroxene bearing rocks to lower density H_2O-CO_2 fluids ($0.71 < d < 0.76\ g/cm^3$) in the pegmatitic rocks with quartz-microcline-biotite assemblage. Several generations of later aqueous fluids are also present.

The differential concentration of uranium and thorium may be either of sedimentary origin, or the result of a differential mobilisation of thorium and uranium under conditions of anatexis. Mineralogical and fluid inclusion data are used to interpret these alternatives.

CUNNINGHAM, C.G., 1978, Pressure gradients and boiling as mechanisms for localizing ore in porphyry systems: Jour. Research U.S. Geol. Survey, v. 6, p. 745-754.

Fluid inclusions in ore zones of porphyry systems indicate that extensive boiling of hydrothermal fluids accompanies deposition of ore and gangue minerals. The boiling commonly accompanied a change from a lithostatic to a hydrostatic environment during evolution of an epizonal stock. Pressure gradients near the margin of the stock can determine whether ore or only a diffuse zone of mineralization is formed. A sharp drop in pressure in an epizonal environment is more likely to cause extensive boiling than a comparable change in a deeper environment, as the slope of the boiling curve steepens with an increase in pressure. The drop in pressure causes the hydrothermal fluids to boil and creates a crackle (stockwork) breccia, which hosts the veinlets of gangue quartz and ore minerals. The boiling selectively partitions CO_2, H_2S, and HCl into the vapor phase, changing the pH, composition, ionic strength, and thus the solubility product of metal complexes in the remaining liquid and causing the ore and gangue to come out of solution. Fluid inclusions trapped from boiling solutions can exhibit several forms, depending on the physical and chemical conditions of the hydrothermal fluid from which they were trapped. In one case, inclusions when heated can homogenize to either liquid or vapor at the same temperature, which is the true boiling temperature. In another case, homogenization of various inclusions can occur through a range of temperatures. The latter case results from the trapping of mixture of liquid and vapor. Variations in salinity can result from boiling of the hydrothermal fluid, or intermittent incorporation of high-salinity fluids from the magma, or trapping of fluids of varying densities at pressure-temperature conditions above the critical point of the fluid. In places, paleo-pressure-temperature transition zones can be recognized by fluid-inclusion homogenization temperatures and phase relationships and by the presence of anhydrite daughter minerals. Boiling of a hydrothermal fluid in the porphyry environment affects light stable isotopes. Hydrogen is preferentially fractionated into the vapor phase from water boiling below 223°C; above this temperature deuterium is selectively enriched in the vapor phase. In certain environments boiling creates a vapor-dominated system in which the condensate is swept away by meteoric waters and the H/D in the residual fluids is progressively increased through time. (Author's abstract).

DALL'AGLIO M., GHIARA, E., PROIETTI, W., 1978, New data on the hydrogeochemistry of selenium: Rendiconti Soc. Ital. Mineral. Petrol. v. 34, p. 591-604. Authors at CNEN-RAD-PA - Laboratorio di Geochimica Ambientale - 00060 CASACCIA (Roma), Italy.

Contains a description of an analytical method to detect Se in concentrations of few nanograms/liter, and data on Se content in geothermal fluids. (P. Lattanzi)

DANBURG, J.S. and YUHAS, D.E., 1978, Acoustic microscope images of rock samples: Geophysical Research Letters, v. 5, p. 885. First author at Shell Devel. Co., P.O. Box 481, Houston, Texas 77001.

We have used an acoustic microscope to examine polished sections of sedimentary rock samples, producing elastic-wave images with a resolution of about 25μ. We have observed variations of rock elastic properties on a granular scale and compared them with optical features in the same field of view. (Authors' abstract).

Editor's note: With refinements, this procedure might be used on inclusions in opaque minerals?

DAVIDENKO, I.V. and KUMEEV, S.S., 1978, Possibilities of chemical and mineralogical-structural geothermobarometers of pegmatitic processes, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in Geology: Vladivostok, Acad. Sci. USSR, p. 48-50 (in Russian). First author at Geol. Inst. of Kola Division of Acad. Sci. of the USSR, Apatity.

No inclusion data. (A.K.)

DAVIDENKO, N. M. and CHIBISOV, N. P., 1978, Vertical zoning of a gold-ore deposit in the North-East of the USSR: Geokhimiya, 1978, no. 9, p. 1360-1367 (in Russian with Engl. abst.). Authors at the All-Union Sci. Research Inst. of Marine Geol. and Geophysics, Riga, Latvian SSR.

The deposit (name not given) belongs to the gold-quartz, low-sulfide plutogenic formation, located in Triassic sandy-clayey sediments with dikes of biotite-hornblende granodiorites and granites of Cretaceous age. The deposit consists of series of steep (60-70°) veins. General T range of the deposit formation is 410-90°C, commercial ores formed at 265-110°C. P gradient is $\sim$30 atm/100 m, T gradient - 20°C/100 m, as indicated by inclusion studies. (Abst. by A. K.)

DAVIDSON, D.W. and RIPMEESTER, J.A., 1978, Clathrate ices-recent results: Journal of Glaciology, v. 21, p. 33-49. Authors at Div. of Chem., Nat. Research Council, Ottawa, Ontario K1A 0R9, Canada.

The last five years have seen an increasing interest in clathrate ices as a result of the discovery of extensive deposits of natural gas hydrates in permafrost regions. Twenty-six new clathrate hydrates have been identified, mainly by NMR, including a tetragonal hydrate of dimethyl ether. (From the authors' abstract).

DEAN, W.E., 1978a, Trace and minor elements in evaporites: Section 5 in: Marine Evaporites, SEPM Short Course No. 4, Oklahoma City, 1978, p. 86-104.

In addition to trace and minor elements in the minerals of evaporites, includes discussion of the compositional changes in various brines up to and beyond precipitation of various solid phases. (ER)

DEAN, W. E., 1978b, Some uses of stable isotopes of carbon, oxygen, and sulfur in solving problems related to evaporite deposits: Section 7 in: Marine Evaporites, SEPM Short Course No. 4, Oklahoma City, 1978, p. 124-143.

A good review covering the isotopic changes in both solids and liquids during formation of evaporites. (ER)

DELANEY, J.R., ANDERSON, D.H., and KARSTEN, J., 1978, Analysis of water in basaltic glasses using an ion microprobe mass analyzer (abst.), Amer. Geophy. Union, Trans., v. 59, p. 1117.

The Ion Microprobe Mass Analyzer (IMMA) at the Johnson Space Center has been used to determine relative abundances of nuclides at masses 1, 16, 28, and 29 in glasses from the rims of tholeiitic pillow basalts with measured water contents ranging from 0.2 to 2.1 wt.%. A 20 micron NO_2^+ primary beam was used to sputter ions off the polished samples. Results were sufficiently consistent to empirically establish working curves of wt.% water vs. the ratios of $^1H/^{16}O$, $^1H/^{28}Si$ and $^1H/^{29}Si$. Lateral and vertical homogeneity of the standards was found to be constant within the precision of the instrument. The consistency of the results implies that with low H background signals, the IMMA is a viable tool for analyzing H_2O in silicate glasses on a 20 micron scale to a precision of at least ±0.3 wt.% H_2O within the range covered by the glass standards. Glass inclusions within phenocrysts from basalts dredged near Bouvet Island and in the Marianas Interarc Basin appear to contain somewhat less water than the matrix glass which surrounds the phenocrysts. (Authors' abstract)

DELANY, J. R. and MATHEZ, E. A., 1978, Interpretation of volatile contents of glass-vapor inclusions in crystalline phases of submarine basalt glasses. (abst): Eos, Trans. Amer. Geophy. Union, v. 59, p. 409.

Interpretation of compositions of glass-vapor inclusions in crystals of submarine basalts are complicated by the following: (1) Inclusion formation requires rapid crystal growth, therefore entrapment occurs under disequilibrium conditions; (2) inclusions sample melt adjacent to growing crystals and may be depleted in components entering the crystal; (3) the host phase may continue to crystallize after entrapment; (4) those entrapped over a time interval should reflect differentiation or mixing processes.

Observed volume ratios (calc. assuming spherical geometry) of glass-vapor in > 2000 inclusions from 10 oceanic tholeiites rarely exceed ∿ 20:1. This implies post-entrapment vapor phase formation, and at least three processes may contribute to it: (1) Continued crystallization of the host increases volatile fugacities of residual melt; (2) total pressure in the inclusion may decrease in response to - ΔV of crystallization; (3) P may also decrease due to differential thermal contraction of the host phase and melt.

S contents of inclusions are generally similar to or slightly higher than those of matrix glasses at equivalent Fe concentrations. However, primitive inclusions having both low Fe and S are present in some rocks. Detailed inclusion data in several samples reveal distinct S-Fe compositional populations which allow interpretation of magmatic evolution. In one such rock from the Kolbeinsey Ridge the most primitive inclusions have S contents significantly below those corresponding to sulfide saturation, even though the matrix glass is saturated. At some pre-eruption stage this magma may not have been sulfide saturated. (Authors' abstract)

DELANEY, J.R., MUENOW, D.W., and GRAHAM, D.G., 1978, Abundance and distribution of water, carbon and sulfur in the glassy rims of submarine pillow basalts: Geoch. Cosmo. Acta., v. 42, p. 581-594. First author at Dep. Geosci., Univ. Ariz., Tuscon, AZ 85721, U.S.A.

Mass spectrometric analyses of phenocrysts, containing glass-vapor inclusions quenched in glassy rims of tholeiitic submarine pillow basalts from spreading centers and Hawaii, indicate that water released from the inclusions upon thermal decrepitation is much less than is released from equivalent volumes of the matrix glass enclosing the same phenocrysts. If water released represents water quenched in the two types of glass (inclusion and matrix) at the time of eruption, then the inclusions contained far less water than the magma surrounding the phenocrysts. Such a condition is consistent with a water depleted source mass for the basalts and an influx of water into the melt after inclusion formation but before quenching at the ocean floor.

Glass-vapor inclusions within phenocrysts in tholeiitic pillow basalts from the Marianas Interarc Basin released abundant water even though the adjacent matrix glasses contain only 50% more water than Hawaiian matrix glasses. Water contents of matrix glasses from the Marianas pillow rims are very close to experimental saturation values. In contrast, matrix glasses from MORs and Hawaii are distinctly below water saturation. Vesicles in these glasses are most reasonably accounted for by a CO_2-dominated vapor phase, because CO_2 contents of those basalt glasses closely approximate experimental solubility limits. Glass-vapor inclusions in phenocrysts from the same pillows appear to contain more CO_2 than adjacent matrix glasses, implying that a CO_2-dominated vapor developed and outgassed prior to eruption and after inclusion formation. Water influx and CO_2 degassing combine to make the $CO_2/(CO_2 + H_2O)$ ratio of seafloor basalt glasses a minimum value for the magma source mass. The sulfur content of the inclusion glasses is normally very similar to that of the enclosing matrix glass. (Authors' abstract).

DELÉ,*M. L., DHAMELINCOURT, P. and SCHUBNEL, H. J., 1978, Application of the laser microraman to the identification of inclusions in gems (in French), (abst.): XI General Meeting of International Mineralogical Association, Novosibirsk, Abstracts, v. 2, p. 87

Numerous solid inclusions were identified in various gems, as well as CO_2. (ER)

*Spelled Delhaye in other publications. (E.R.)

DELHAYE, M.L. -- See DELÉ, M.L.

DELIMARSKY, Yu.K., TUMANOVA, N.Kh., 1977, Polarographic method and its potentialities for investigation of aqueous 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. 3, p. 22-23 (in Russian).

DELITSYN, L.M., 1978, Vortex texture as liquation example in natural magma: Akad. Nauk SSSR Doklady, v. 239, no. 4, p. 948-950 (in Russian). Author at State Inst. of the Mineral-Chemical Raw Materials, Moscow.

Vortex textures were studied in the apatite-nepheline ore body at the deposit Apatitovyi tsirk (Apatite Circus) in Khibiny, USSR. Their size ranged from 0.5 mx 0.3 m to 6 mx x 4 m. Light bands consist of dotted apatite ore; dark ones - apatite ore of lenticular-laminar stucture. Two immiscible liquids (melts) were a silicate emulsion of urtite composition, and a phosphate melt. Similar vortex textures were described from ovoidophyres at Luyavrurt, where two silicate melts were immiscible: 1) melanccratic biotite alkaline syenite and 2) akaline feldspar. Maybe ijolite-urtite structure at Poachvumchorr is also giant immiscibility vortex. (Abst. by A.K.)

DELITSYN, L.M. and MELENT'YEV, B.N., 1978, Coexistence of immiscible liquid phases in the system: nepheline-sphene-villiaumite and its significance for processes of differentiation of alkaline magma: Akad. Nauk SSSR Doklady, v. 240, no. 4, p. 949-952 (in Russian). Authors at the State Inst. of the Mining-Chemical Raw Materials, Moscow.

In the system sphene villiaumite, complete liquid immiscibility was found, with a eutectic point at 915±5°C (sphene 38.5%, villiaumite 61.5%). System nepheline-sphene-villiaumite has immiscibility field occupying 25% of the total plot area, touching the side nepheline-villiaumite and closing at ∼18% of sphene. Temperature of liquation for the studied compositions ranges from 1050 to 1060°C. Pertinent to melt inclusions in minerals of ijolite-urtite rocks. (Abst. by A.K.)

DENISOV, V.I., 1977, Computer methods of statistical analysis and primary treatment of experimental 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. 3, p. 7-8 (in Russian).

DENISOV, V.I., 1977, Computer methods in planning experiments (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. 3, p. 9-10 (in Russian).

DERNOV-PEGAREV, V. F. and KHARLAMOV, Ye. S., 1978, Thermometry of inclusions in synthetic and natural crystals of calcite and certain problems of carbonatite formation: Geokhimiya, 1978, no. 9, p. 1332-1343 (in Russian, English abst.). Authors' institution not specified.

Calcite was synthetized from K_2CO_3-Na_2CO_3-H_2O solution at 200-500°C and up to 1400 atm, proving the possibility of its growth from such solutions to form carbonatites. Next experiments at 200-650°C and up to 1000 atm yielded calcite crystals from K_2CO_3 and $KHCO_3$ solutions. Fluid inclusions in synthetic calcite are two-phase or contain several dms, including $K_2CO_3 \cdot 1.5\ H_2O$ and $KHCO_3$. Inclusion fluids always become metastable on cooling and they crystallize at T of L N_2 (-195.8°C) after run of duration 30 days. Diagnostic feature are Te values: -5.43°C for $KHCO_3$ -H_2O and -36.5°C for K_2CO_3-H_2O systems. Homogenized inclusions with dms exhibit unusually extensive metastability on cooling; complete dissolution of dms on heating ranges from 170 to 190°C, but crystallization on cooling occurs at 50-80°C. Average T dissolution coefficient is 0.12 wt.%/°C. $K_2CO_3 \cdot 6H_2O$ exists at negative T, $K_2CO_3 \cdot 1.5H_2O$ - at T >0°C. The studied inclusions are comparable with inclusions in carbonatites from the deposit Kovdor. (Abst. by A. K.)(Ed.- This may be pertinent to identification of dms.)

DERNOV-PEGAROV, V. F. and MALININ, S. D., 1976, Solubility of calcite in high temperature aqueous solutions of alkali carbonates and the problem of formation of carbonatites: Geokhimiya 1976, no. 5, p. 643-658 (in Russian; translated in Geochem. Internat., v. 13, no. 3, p. 1-13.

The results of experimental study of solubility of calcite (Iceland spar) in K_2CO_3 and K_2CO_3 + Na_2CO_3 solutions with molalities from 1 to 15 at 400 and 500°C and at pressures not exceeding 1400 atm indicate that a complex of the $Ca(CO_3)_n(OH)_m^{p-}$ type may form in the calcium carbonate-alkali carbonate systems instead of the purely carbonate complex $Ca(CO_3)_2^{2-}$ (suggested in the investigation of the low temperature region of the systems). A number of properties of the systems, for example, the high positive value of the temperature coefficient of solubility of calcite (making possible its precipitation with temperature drop in the 200-650°C interval), and "evaporation" of the alkali carbonate solution (making possible gradual transition from hydrothermal solution to melt), suggest a model of formation of carbonatites, whose general features are in good agreement with field observation. (Authors' abstract)

DICKSON, R.W., RYE, R., RADTKE, A.S., 1978, The Carlin gold deposit: Product of an ancient geothermal system that extracted ore and gangue components from sedimentary rocks, (abst.), in International Assoc. Genesis Ore Deposits, 5th Symp., Snowbird, Alta, Utah, 1978, Program and Abstracts: (Alta, Utah), p. 82.

The Carlin gold deposit formed at shallow depths from hydrothermal fluids heated by late Tertiary volcanic energy. The fluids ascended from depth along steep faults into permeable thin-bedded carbonate rocks, where they dissolved carbonate minerals, principally calcite, and deposited quartz and pyrite and fine-grained gold. The fluids also introduced Al, K, and Ba,organic materials, plus Hg , As, Sb, and Tl, all closely associated with Au, and the base metals Zn, Pb, and Cu. Late fluids deposited barite and calcite, and minor quartz, in fractures, together with sparse sulfides of Hg, Sb, As, Tl, Pb, Zn, and Cu. During vein formation the fluids boiled, releasing H_2O vapor, CO_2, and H_2S to the oxygenated ground waters or to the aerated zone above the water table. Atmospherically derived oxygen oxidized H_2S to H_2SO_4. Rocks in the upper part of the ore deposit were strongly leached and oxidized during boiling.

Stable isotope data on fluid inclusions and on vein and rock-forming minerals indicate that the hydrothermal fluid was of meteoric origin, that the introduced sulfur is of sedimentary origin, and that Pb in galena in barite veins is similar to Pb in the host rocks of the Roberts Mountains Formation. Temperatures based on $\delta^{34}S$ fractionation between barite and sulfide minerals ranged from 270 to 305°C, in contrast to lower temperatures obtained from fluid inclusions in vein barite, calcite, and quartz of 175°C. Sedimentary rocks adjacent to and below the Carlin deposit contain organic carbon compounds, diagenetic pyrite, quartz, illite, calcite and dolomite. They also contain high levels of Au, Hg, As, Sb, and Tl.

We suggest that the introduced components were leached from Paleozoic sedimentary rocks below the deposit at temperatures above 300°C by mildly saline solutions, migrating as part of a circulating water system set into movement by a buried thermal anomqly. The fluids rose rapidly up steep faults, dropped in temperature and pressure, and became supersaturated with regard to quartz, pyrite, and gold, and undersaturated with regard to calcite. The solutions migrated into host rocks where they formed tabular-shaped ore bodies with attitudes similar to those of the sedimentary host rocks. The main-stage mineralization could have been accomplished in 50,000 years, assuming continuous flow. A minimum of about 10^9 tons of aqueous fluid passed through the rocks during main stage mineralization. The beginning of vein formation coincided with the onset of boiling. The vein-forming stage perhaps lasted about the same time as main-stage mineralization, but more than 10^{10} tons of fluid were involved. Boiling coincided with more rapid fluid flow from hotter regions at depth. The vein formation ceased when the excess pressures of the system were relieved, and cold ground waters were able to reoccupy the fractures. The Carlin deposit is the integrated result of igneous heat, injected into sedimentary rock-fluid systems, dispersed by convective movements of fluids, which dissolved components at high temperatures and deposited them at low temperatures.(Authors' abstract)

DIMAN, E.N. and OLEYNIKOV, B.V. 1977, Gold distribution coefficients between melt, fluid and solid phases (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. 3, p. 97 (in Russian).

DMITRIYEV, L.V., SOBOLEV, A.V. and SUSHCHEVSKAYA, N.M., 1978, Primary melt of oceanic tholeiite and composition of the upper mantle of the ocean area: Akad. Nauk SSSR Doklady, v. 240, no. 1 p. 177-180,(in Russian). Authors at the Vernadskiy Inst. Geochem. and Anal. Chem. of the Acad. Sci. USSR, Moscow.

Th of inclusions in olivine and plagioclase from oceanic tholeiite are 1240-1260°C (A.K.)

DOLENKO, G. N., ed., 1978, Carbon and its compounds in endogene processes of mineral formation (data of studies of fluid inclusions in minerals): Kiev, "Naukova Dumka" Pub. House, 172 pp. (in Russian).

Contains 23 papers from the L'vov meeting on this subject held Sept. 30-Oct. 1, 1975. Abstracts of most (but not all) of these were printed in COFFI vol. 8 (1975); these are only cited in this volume of COFFI, with a cross reference to the original abstract. (Many of these have changes in the junior authorship). (E. R.)

DOLFI, D. & TRIGILA, R., 1978, The role of water in the 1944 Vesuvius eruption: Contrib. Mineral. Petrol. v. 67, p. 297-304. Authors at Istituto di Mineralogia e Petrografia, Universita di Roma, Italy.

The estimated water contents of the magma for three P-T combinations are as follows (in kb, °C, & wt.%, respectively): 8.0, 1255, 0.7; 4.0, 1178, 0.9; 0.5, 1105, 1.1. These estimates are consistent with the pattern of activity of the 1944 Vesuvius eruption and with the relationship between the lavas.

The shallow depth of H_2O-saturation of the magma, 0.24 kbar at 1100°C, is consistent with the eruption sequence of lava flows followed by lava fountain activity. (From the authors' abstract).

DOLGIKH, G.A., DOSANOVA, B.A., KROL', O.F., KARABANOV, V.A., KOVIN, M.I. and CHERNOV, V.I., 1978, Prospecting for hidden tungsten ore mineralization by use of gas haloes, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. II, Thermobarogeochemistry and ore genesis: Vladivostok, Acad. Sci. USSR, p. 19-21 (in Russian). First author at the Kazakh Inst. Miner. Raw Minerals, Alma-Ata, USSR.

The studied deposit (name not given) forms a linear stockwork in sedimentary-metamorphic Middle Ordovician rocks and it is connected with leucocratic Upper Ordovician-Lower Devonian granites. Ores consist of pyrite and scheelite. Wall-rocks are altered into hornfelses. In the deposits anomalous concentrations of CH_4, He and H in fluid inclusions show the places of hidden W mineralization. The halo is 2-3 times thicker than the ore body and its vertical extent reaches 600 m. There are similar haloes of iodine, bromine, chlorine and fluorine. Gas composition in wall rocks and granites is similar to air, as confirmed by a high content of ^{36}Ar of atmospheric origin. (From the authors' abst.)

DOLGOV, Yu, A., 1978, Adiabatic processes as determined from gas-liquid inclusions in minerals, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 14-16 (in Russian). Author at Inst. Geol. and Geophysics of the Siberian Branch of the Acad. Sci. USSR, Novosibirsk.

1. (...)

2. Studies of S inclusions in crystals from pegmatitic chambers and the crystals themselves prove that crystals were not subjected to dropping, pressure (changes) or crushing. Usually the degree of fill, density, Th and pressure at homogenization are higher in P than in S inclusions. Hence, fissure formation is connected with a change of parameters of the system. Rapid T decrease is possible in the magmatic bodies only under conditions of an adiabatic process, e.g. an extremely short-duration process of increase of the volume of the cavity bearing the solutions and growing crystals. Fracturing of the crystals is the first important result of such cooling. For quartz the shape of fracture network depends on the interval of the temperature drop; for topaz, cleavage fractures occur at the crystal margin; for beryl the characteristic network is absent.

3. Rapid cavity increase changes all other parameters in addition to T, like P and density. Changes of T, P and density were calculated for water, depending on the amount of adiabatic expansion. The cavity is in contact with wall rock pores filled with pore solution and makes with them a single system. Adiabatic expansion of the cavity changes equilibria in the system. Gradients of T, P and density develop. After expansion the equilibria become re-established by way of heat and mass transfer from wall rocks.

4. Establishing of new equilibria is connected with migration of pore solutions and rock heat to the cooler part of the system, i.e., to the cavity. This process is very complicated, e.g., solutions migrating through pores separate their components due to various volatility. Thus, T changes and front part of migrating solution becomes enriched in volatiles. This separation causes increased or decreased crystallization rate, precipitation of easily-soluble components of hydrothermal solution, etc.

5. All the above processes are confirmed by studies of the composition of fluid inclusions. Fracture network in quartz approximately shows adiabatic T change. Especially distinctly T and other changes are visible from fluid inclusion studies, including inclusions along healed fracture planes attributable to high → low quartz inversion. Change of the degree of fill proves P changes. Measured P values in inclusions in topaz, quartz and beryl suggest distinct deviations from evolution regime. Experimental separation of gases during flowing through micrometer-size pores confirmed the alternation of S inclusions in topaz bearing either high or low volatile content.

6. Migration of pore solutions from wall rocks to cavity causes transport of ore and barren elements. (Author's abst., translated by A.K.)

DOLGOV, Yu. A., BAZAROV, L. Sh., BAKUMENKO, I. T., GIBSHER, N. A., CHUPIN, V. P., CHUPINA, L. Yu., VISHNEVSKII, S. A. and SHUGUROVA, N. A., 1976, Gas-liquid and molten inclusions in minerals and their genetic importance. Geokhim., Mineral., Petrol., p. 251-261 (in Russian). Edited by A. I. Tugarinov, G. D. Afanas'ev, and D. S. Korzhinski. "Nauka": Moscow, USSR.

Gas-liq. and molten inclusions in endogene, exogene, and cosmic minerals were studied. The temp. of magmatic crystn. of the studied minerals was estd. as well as the chem. compn. of the inclusions. Characteristic properties of terrestrial and cosmic materials were compared. (Chem. Abstracts 87: 41902k)

DOLGOV, Yu.A. and SHUGUROVA, N.A., 1974, Results of studies of gases from inclusions in Lunar glasses: Lunar soil from Mare Serenitatis: "Nauka" Publ. House, pp. 357-362 (in Russian). See Translations.

DOLGOV, Yu. A., TOMILENKO, A. A. and CHUPIN, V. P., 1978, Determination of the conditions for metamorphism and anatexis: Teor. Prakt. Termobarogeokhim., (Dokl. Vses. Soveshch.) 5th 1976, N. P. Ermakov, ed.: Moscow, Izd. Nauka, p. 21-28 (in Russian).

The thermodn. conditions of metamorphism and anatexis was studied by the use of thermobarogeochem. The CO_2 content in fluid inclusions in minerals is higher in granite-gneisses than in quartzites or the rocks of granulite amphibolite facies. During regional metamorphism of the rocks of these 2 facies, CO_2 and water are the predominant fluids; CO, H, CH_4, HCl, etc., are present in subordinate amts. Fluid inclusions with dense liquified gases are characteristic for metamorphic rocks and can be used for detg. the pressure and compn. of fluids during metamorphism. (Chem. Abstracts 91: 60603n, 1979)

DOLGOV, Yu.A., VISHNEVSKY, S.A., 1978, Gas inclusion in glasses and minerals from extraterrestrial samples (abst.): XI General Meeting of International Mineralogical Association, Abstracts, v. 3, p. 21 (in English).

Quantitative gas analyses of the inclusions from minerals of meteorites show appreciable amounts of CO_2, CO, H_2, N_2, hydrocarbons and rare gases, inclusions in enstatite from Northon County's (sic.) meteorite homogenize at the temperature range from 1400-1420°C. In accordance with the experimental data those temperatures correspond to real temperatures of crystallization.

Gas inclusions from tektites are divided into 2 groups: inclusions containing gases of mixed (terrestrial-comet) atmosphere, which are discovered in moldavites, and inclusions of pure CO_2 composition similar to Venus atmosphere. Gas pressure in tektite inclusions is 5,000 times smaller than terrestrial atmospheric pressure. The gas composition of tektite inclusions significantly differs from terrestrial atmosphere and is not affected by diffusion during long geological epochs up to 15 m.y. and more.

Various gas mixtures were found in inclusions from glass spherules and fragments of lunar soil, which were brought to the Earth by Soviet automatic station "Luna-16." Hydrogen is present in all the inclusions. Most of them are vacuum in relation to terrestrial atmospheric pressure and only 2 inclusions were found to have a gas pressure more than twice terrestrial atmospheric pressure. (Authors' abstract)

DOLOMANOVA, E. I., BOYARSKAYA, R. V., VARLAMOV, N. I., DMITRIEVA, M. T., DUBAKINA, L. S. and LOSEVA, T. I., 1978, Cassiterite from Central African deposits and its typomorphic characteristics. Osob. Geol. Gidroterm. Rudn. Mestorozhd. p. 112-135 (in Russian). F. I. Vol'fson, ed.: Izd. Nauka: Moscow, USSR.

The compn. of different-colored zones in cassiterite (Ct) from central African Sn deposits is nonuniform even within a single crystal or grain. The cassiterites shown mineral microinclusions (columbite-tantalite and ilmenorutile-struverite) and inclusions of various other minerals. Solid solns. of columbite-tantalite and ilmenorutile-struverite are present in Ct crystd. from a gaseous phase, whereas that crystd. from gaseous solns. has vacuoles filled by gas (sic.). In cassiterites crystd. from hydrothermal solns. the vacuoles vary in form and the vols. of liq. and gas phases also vary. Ppts. on the walls of the vacuoles contain Nb, Ta, Ti, Fe, Mn, W, Al, Si, Ca, Mg, K, Na, and Cl. In Ct formation the Sn was transported as complex compds. with Nb, Ta, Fe, Cl, K, and Na. (Chem. Abstracts 90: 90201b)

DONALDSON, C.H. AND DAWSON J., 1978, Skeletal crystallization and residual glass compositions in a cellular alkalic pyroxenite nodule from Oldoinyo Lengai; implications for evolution of the alkalic carbonatite lavas: Contrib. Min. and Pet., v. 67, p. 139-149. First author at Dep. Geol. Univ. St. Andrews. St. Andrews, Fife KY16 9ST, Scotland.

The alkalic pyroxenite nodule consists of megacrysts of diopside, apatite, perovskite and titanomagnetite in a groundmass consisting of diopside, apatite, titanomagnetite, nepheline, melilite, garnet and vishnevite crystals of various shapes, including previously undescribed skeletal and dendritic shapes, together with vesicles and residual glass. The residual glass is poor in SiO_2 (38-40 wt%), and extraordinarily rich in Na_2O (12.8-15 wt%), SO_3 (1-1.5 wt%), and Cl (0.25-0.7 wt%) as a result of rapid, non-equilibrium crystallization of groundmass phases from a CO_2-rich nephelinite melt.

The Oldoinyo Lengai alkalic carbonatite lavas do not represent extreme products of the fractional crystallization of pyroxene, wollastonite, nepheline and alkali feldspar from the carbonated nephelinite melt. The most likely connection between the carbonatite and silicate magma types is one of liquid immiscibility, probably involving phonolite melt. (Authors' abstract).

DORFMAN, M. D. and PETERSIL'E, I. A., 1978, Gases in the inclusions of Kazakhstan quartz veins as an indicator of their tungsten content: Teor. Prakt. Termobarogeokhim., (Dokl. Vses. Soveshch.) 5th 1976, N. P. Ermakov, ed.: Moscow, Izd. Nauka, p. 194-196 (in Russian).

Chromatog. detns. were made of the gases sepd. during heating of vein quartz (Q) formed in different stages of the hydrothermal process. The compn. and content of inclusion gases differed for different-generation vein Q. Different types of veins were most clearly distinguished by the H_2 content, which increased with the temp. of Q formation. The gases released were mainly H_2 and CO_2 (96-8 vol. %); the amt. of C_4H_4 was insignificant. (Chem. Abstracts 91: 60439p, 1979)

DOROGOVIN, B.A. and BYDTAEVA, N.G., 1978, Decrepitophonic mapping of the Archean quartz-bearing rocks in the Aldan shield, (Abst.): Abstracts of Thermobarogeochemistry and ore genesis: Vladivostok, Acad. Sci. USSR, p. 25-26 (in Russian). Authors at the All-Union Sci.-Res. Inst. of Synthesis of Artificial Mineral Raw Materials, Alexandrov, USSR. of Artificial Mineral Raw Materials, Alexandrov, USSR.

In samples of deeply metamorphosed quartz-feldspar rocks and quartzites two Td intervals were found: 80-320°C - decrepitation of mostly CO_2-filled inclusions connected with regional metamorphism, and 320-480°C - decrepitation of inclusions syngenetic with retrograde metamorphism. Intensity of decrepitation displays pattern typical of this kind of rocks, as described elsewhere. (A.K.)

DOROGOVIN, B.A., BYDTAEVA, N.G. and SHATAGIN, N.N., 1978, Thermobarogeochemical zoning in rock-crystal deposits in Southern Yakutia, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, V. II, Thermobarogeochemistry and ore genesis: Vladivostok, Acad. Sci. USSR, p. 29-30 (in Russian). First author at All-Union Sci.-Res. Inst. of Synthesis of Artificial Raw Materials, Alexandrov, USSR

Rock crystals at 200-300°C from HCO_3-Cl-Na solutions, practically without ore trace elements. Their deposits occur in quartzite levels, where quartz grains bear LCO_2 inclusions of regional metamorphism origin. Td forms two maxima: 320°C (Σn_1) connected with LCO_2 inclusion decrepitation and 320-480°C (Σn_2) - LH_2O inclusion decrepitation. Vein quartz shows a total decrepitation maximum at 320-480°C (Σn_3). Hydrothermal solutions forming rock crystal deposits caused a local thermal metamorphism, the intensity of which was evaluated by the ratio $D_1 = \Sigma n_1/\Sigma n_2$. Simultaneously, those solutions caused recrystallization of quartzites; the intensity of this process was evaluated by the ratio $D_2=\Sigma n_2/\Sigma n_3$, which decreases with distance from the vein. Positive correlations of D_2 with Cr, Zr, Ti, Ga and Pb, and negative correlations with Mn, Cu, Fe, Co, Ni, were found. Mineral-forming processes were checked by experimental runs. (From the authors' abst.)

DOROGOVIN, B.A., BYDTAEVA, N.G. and SHATAGIN, N.N., 1978, Experimental modelling of thermal influence of solutions on carbon dioxide inclusions in quartzites: Akad. Nauk SSSR Doklady v. 241 no. 4, pp. 915-916 (in Russian). Authors at the Moscow State Univ.

Archean quartzites from the Aldan shield have two decrepitation intervals: 20-320°C and 320-480°C, and intensity of the first interval strongly exceeds that of the second interval, which is typical of the decrepitation background in that area. Wall quartzites of the ore veins have high intensity in the second interval, whereas the first interval is frequently lower than the background. The first interval of decrepitation appears due to inclusions (with density $1.1 g/cm^3$), which are removed due to recrystallization caused by vein-forming solutions.

This presumption was confirmed by experiments with "background" quartzites in autoclaves (P 80-580 atm, T 200, 250 and 300°C). Ratio of intensities in two intervals is a function of P and T during runs. (Abst. by A.K.)

DOROGOVIN, B.A., OKRUGIN, V.M., and SHIROKIY, B.I., 1978, First find of solid magmatic inclusions in biotite of silicic extrusives: Bull. Volcanic Station, no. 55, p. 147-150 (in Russian).

Inclusions homogenize at 930-1080°C. (E.R.)

DOROSHENKO, Yu.P. and PAVLUN' N.N., 1978, Prognosis and evaluation of rare-metal ore mineralization in Central Kazakhstan, on the basis of the thermobarogeochemical criteria, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. II, Thermobarogeochemistry and ore genesis: Vladivostok, Acad. Sci. USSR, p. 12-13 (in Russian). Authors at the L'vov State Univ, L'vov, Ukrainian SSR.

Main stages of formation of rare metal mineralization developed at T and P as follows: molybdenite-quartz 450-300°C, 1400-1000 atm; complex rare-metal 480-330°C, 1500-700 atm; wolframite-quartz 370-250°C, 800-500 atm. In the studied deposits (their names not given) the deeper the level of mineralization studied, the higher the Th; vertical gradient was 20-30°C/100m, horizontal gradient 8-12°C/100m. Hence, the actual Th may be applied for evaluation of the degree of erosion for those deposits. Solutions forming parageneses of the molybdenite-quartz stage initially were pneumatolytic, and then condensed into hydrotherms of NaCl equiv. concentration 28-40 weight %. Molybdenite crystallized from the condensing and high-T hydrothermal solutions; inclusions in paragenetic quartz continuously bear NaCl dms. Complex rare metal and wolframite stages formed from concentrated high hydrotherms (29-65 wt. % of NaCl+KCl), occasionally boiling; inclusions always bear 1-12 dms. Post-commercial galena-sphalerite-quartz stage (Th 320-250°C) formed from H_2O-CO_2 solutions often heterogenizing due to P decrease from 550-200 atm. The above features permitted suggestions as to which veins and greisen zones in the deposits Akchatau, E. and N. Kounrad, may contain commercial mineralization, which were confirmed by boreholes. (From the authors' abst.)

DOWNS, W.F., 1978, Experimental calibration of the quartz-magnetite oxygen isotope geothermometer (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 10, no. 7, p. 392.

DUFFIELD, W. A., 1978, Vesicularity of basalt erupted at Reykjanes Ridge crest: Nature, v. 274, p. 217-220. Author at U.S. Geolo. Survey, Menlo Park, CA 94025.

Average vesicularity of basalt drilled at three sites on the west flank of the Reykjanes ridge increases with decreasing age. This change apparently records concomitant decrease in water depth at the ridge crest where the basalt was erupted and suggests substantial upward growth of the crest during the past 35 Myr. (Author's abstract).

DUNGAN, M.A., and RHODES, J.M., 1978, Residual glasses and melt inclusions in basalts from DSDP Legs 45 and 46: Evidence for magma mixing: Contrib. Mineral. Petrol. v. 67, p. 417-431. First author at

Lunar and Planetary Inst., 3303 NASA Road 1, Houston, Texas 77058, USA.

Compositional relations among natural glasses in basalts recovered by Legs 45 and 46 (DSDP) provide powerful constraints on their differentiation histories. Residual glass compositions in the moderately evolved aphyric and abundantly phyric basalts within each site demonstrate that none of the units is mutually related to any other or to a common parent by simple fractional crystallization. At Site 396, where clinopyroxene phenocrysts are absent, progressively more evolved liquids (lower Mg/(Mg+Fe) and higher TiO_2) are characterized by lower calcium-aluminum ratios, which can only be generated by clinopyroxene fractionation. This paradox is amplified by some melt inclusions in olivine phenocrysts that have higher CaO/Al_2O_3 and lower TiO_2 than any residual glasses. The occurrences of these distinctive compositions are correlated with the highly magnesian character of the host olivines (Fo_{90-89}), and the melts are interpreted as trapped primitive liquids parental to the more fractionated derivatives.

Melt inclusions intermediate in composition between the residual glasses and the most primitive olivine melt inclusions are present in the cores of some plagioclase phenocrysts that have had a history of resorption. On the basis of a petrographic and microprobe analysis of the zoning relations in these phenocrysts, the inclusions are inferred to be melts entrapped at the time of extensive corrosion of the host crystals.

Interpreted in conjunction with other mineral and geochemical data, the compositional trends in the glasses indicate that magma mixing has played a major role in the genesis of the Leg 45 and 46 basalts. The reality of mixing is demonstrated by extensive disequilibrium textures in the plagioclase phenocrysts and the presence in evolved lavas of refractory plagioclase and olivine phenocrysts bearing primitive melt inclusions. The chemical imprint of clinopyroxene fractionation despite the absence of clinopyroxene phenocrysts is believed to be accomplished by plating of gabbro on to the upper walls of the subvolcanic magma chamber as it evolves between mixing events. Repeated influxes of primitive magma batches will move the resultant hybrids away from clinopyroxene saturation and generate olivine-plagioclase cotectic magmas. This model provides a physical buffering mechanism that accounts for the volumetric dominance of moderately evolved basalts among ocean floor tholeiites. Major and trace element models based on the combination of mixing and fractional crystallization also explain heretofore enigmatic geochemical characteristice of mid ocean ridge basalts. (Authors' abstract).

DUNNING, J.D. and DUNN, D.E., 1978, Chemomechanical weakening of synthetic quartz during stable crack propagation: experimental, submicroscopic, and microseismic evidence (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 10, no. 7, p. 393.

ĎURIŠOVA, Jana, 1978, Fluid inclusion studies in the minerals from the tin deposits of the Eastern Krušne Hory Mts (Czechoslovakia), in Société Francaise de Minéralogie et Cristallographie, Colloque "Mineraux et Minerais", Nancy, 26-29 Sept., 1978--Programme et Résumés des Communications: (Nancy), p. 63-64. Author at Geological Survey, Prague, ČSSR.

Tin-tungsten mineralization in eastern part of the Krusne Hory Mts. is spatially associated with small cupolas of Variscan granites, altered by hydrothermal processes. The main ore minerals, cassiterite and wolframite, occur in quartz veins and in greisen bodies.

Fluid inclusion studies were applied to quartz, cassiterite and topaz from two deposits: Cinovec and Krupka (Preisselberg). Four types of inclusions were distinguished: A - gas-rich inclusions, B - liquid rich inclusions, C - inclusions with critical degree of filling and D - multiphase inclusions.

Inclusions in cassiterite are of A and C type and are primary or pseudosecondary. The temperature range of homogenization in the gas phase or by fading of the boundary between gas and liquid is 370-410°C. In some inclusions boiling of the solution was observed at 379°C. According to the measurements of freezing temperatures the concentration of the solutions does not exceed 8 eq. % NaCl. The presence of small amounts of CO_2 was detected.

Inclusions in topaz are of A, B, C, and D type. The homogenization temperature range of primary or pseudosecondary inclusions is the same as for cassiterite (380-420°C). Inclusions of type D contain solid phases. In some inclusions of this type more than 10 phases were observed. Halite is always present. It is completely dissolved at 310-324°C. The gas bubble disappears at 330-350°C, whereas some solid phases remain undissolved in this temperature range. Freezing measurements indicate concentrations similar to those in cassiterite ($<$ 8 eq. % NaCl), except in multiphase inclusions, which have very high salinity (about 40% NaCl).

Inclusions in quartz from the greisens (type A + C) homogenize between 374° and 387°C. Inclusions in quartz from veins have a very large temperature range, from 100 to 500°C. Secondary inclusions found on late healed fractures homogenize between 100 and 300°C. Homogenization temperatures of pseudosecondary and secondary inclusions of the earliest hydrothermal phase (types A, B, C, D) vary from 320 to 500°C. Halite in inclusions of type D is completely dissolved at 280-320°C. In all the types of inclusions, except for the type D, dilute solutions (3 eq. % NaCl) were observed.

It may be summarized from this study:

1. The three studied minerals of the early hydrothermal stage indicate approximately the same temperature range of homogenization.
2. Similar concentrations of NaCl in the gas and liquid phases, the narrow temperatures of homogenization of gas-rich and liquid-rich inclusions and the observation of boiling in inclusions suggests that the hydrothermal solution was probably very close to the critical curve. Thus the homogenization temperatures are considered to be real temperatures of fluid trapping and thus no pressure correction is needed.
3. The greisenization stage was related to the activity of low-concentrated solutions ($<$8 eq. % NaCl). However, highly saline solutions (more than 40 eq. % NaCl) were found in early quartz and topaz.
4. Cassiterite was formed from boiling solutions in the temperature range 370-410°C and pressures about 300 atm. (Author's abstract)

ĎURIŠOVÁ J., 1978, Geothermometry in the minerals from the tin deposits of the eastern Krušné hory Mts. (Czechoslovakia), in - Metallization Associated with Acid Magmatism, v. 3: Prague, Geological Survey, p. 325-335 (in English).

This is the full paper corresponding to the previous abstract. (E.R.)

EADINGTON, P.J., 1978a, Fluid inclusions in greisens and related vein Sn-W-F deposits (abst.), in Notes for Workshop of Fluid Inclusions: Melbourne, Dept. Geology, La Trobe Univ. (unpaginated, mimeographed).

Divides such deposits into two groups, those in granite, and those in sediments above granites, that differ in salinity and temperature range. See also Fluid Inclusion Research--Proc. of COFFI, v. 10, p. 68-69, 1977. (E.R.)

EADINGTON, P.J., 1978b, A study of fluid inclusions and their significance in minerals from hydrothermal ore deposits, New England, New South Wales (abst.), in Notes for Workshop on Fluid Inclusions: Melbourne, Dept. Geology, La Trobe Univ. (unpaginated, mimeographed).

See previous item. (ER)

EADINGTON, P.J., 1978c, Composition of fluid inclusions--nondestructive methods of analysis and the destructive determination of liquid compositions, in Notes for Workshop on Fluid Inclusions: Melbourne, Dept. Geology, La Trobe Univ. (unpaginated, mimeographed).

A 16-page review. (ER)

EADINGTON, P.J. and NASHAR, Beryl, 1978, Evidence for the magmatic origin of quartz-topaz rocks from the New England batholith, Australia: Contrib. Mineral. Petrol., v. 67, p. 433-438. First author at CSIRO Div. of Min., North Ryde, N.S.W., Australia.

Quartz-topaz rocks from the New England district, New South Wales, have mineralogical, textural and field relationships suggesting a magmatic origin. These rocks (called topazites) occur as dykes and sills intruding a biotite granite and sediments in a roof pendant. Where they have intruded into sediments, the topazites have a narrow aureole of induration or hornfels. One type of primary solid inclusion, thought to be silicate glass, has a composition ranging from that of the topazite towards that of nearby granite. Primary fluid inclusions contain an aqueous solution of alkali chlorides with concentrations of total salts to 57 wt%. These fluid inclusions indicate crystallization temperatures in the range 570-620°C, close to the experimentally determined solidus of a vapour-saturated, topaz-normative melt. The presence of primary fluid inclusions indicates crystallization of topazite following saturation of a granitic magma with water and the formation of immiscible silicate and aqueous phases. Partitioning of alkali metals into the aqueous phase left a silicate melt that could only crystallize quartz and topaz. (Authors' abstract)

EASTOE, C.J., 1978a, The evolution of magmatic fluids in the Bougainville porphyry copper deposit, Papua New Guinea, in Société Francaise de Minéralogie et Cristallographie, Colloque "Mineraux et Minerais," Nancy, 26-29 Sept., 1978--Programme et Résumés des Communications: (Nancy), p. 59. Author at University of Tasmania, Hobart, Australia.

Fluid inclusion evidence shows that magmatic salt-rich liquid and its vapor are closely associated with copper ore in the Bougainville deposit. Both fluids occur as primary inclusions in quartz phenocrysts and are therefore of magmatic origin. The liquid varies in composition from less than 45% to 75% NaCl + KCl, and existed at temperatures from >700°C to 400°C. At 400°C there was one fluid, at the critical point, at a pressure of about 300 bars. This was the boundary of the two phase system, and was flanked during mineralization by liquid (temperatures up to 400°C and salinity mainly less than 5 % NaCl) of probable meteoritic origin.

Applying the results of Sourirajan and Kennedy (1962) for the $NaCl-H_2O$ system, and the work of Henley and McNabb (1978), to the Bougainville data allows the following interpretation (which appears to be little affected by the presence of 16 % KCl in the salt-rich liquids). On the horizontal section through the two-phase system at the level of major copper mineralization, the zone adjacent to the critical-point boundary was occupied by unsaturated liquid and its vapour, the liquid ranging in composition from 2-3 % NaCl (the critical fluid) to the saturation composition at a temperature over 430°C. The succeeding zone probably consisted of saturated fluids up to a maximum temperature of 580°C, and at higher temperatures the fluids were unsaturated. Saturation is proven by the fluid inclusion data only at the upper and lower temperatures of the range indicated. In the system $NaCl-H_2O$ the lower saturation temperature is 475°C at 300 bars; the upper saturation limit of the real system appears to correspond with the temperature (600°C) at which saturated $NaCl-H_2O$ liquid has its maximum vapor pressure. The precipitation of halite is a possible explanation for the observed increase in the K/Na ratio of the salt-rich liquids with decreasing temperature and salinity. There is no evidence for the presence of a salt-rich liquid formed by condensation from magmatic vapor, the mechanism proposed by Henley and McNabb. (Author's abstract)

EASTOE, C.J., 1978b, A fluid inclusion study of the Panguna porphyry copper deposit, Bougainville, Papua New Guinea: Econ. Geol., v. 73, p. 721-748. Author at Dept. Geol., Univ. Tasmania, Hobart, Tasmania, 7001, Australia.

Copper mineralization at Panguna took place at a pressure of 200 to 300 bars and at temperatures between 350° and 700°C or higher. Cu, Fe sulfides, quartz, anhydrite, and hematite were deposited by dense, boiling, salt-rich liquids of magmatic origin. The composition of the salt-rich liquids (those which nucleated both KCl and NaCl in fluid inclusions) in terms of the system $NaCl-KCl-H_2O$ varied between 76 percent salts (60% NaCl, 16% KCl) and 46 percent salts (30% NaCl, 16% KCl) by weight. Other liquids, apparently more dilute, nucleated only NaCl. The salt-rich liquids also contained Fe, Ca, and SO_4 and minor quantities of Mg, Cu, Mn, and Zn. A Cu concentration of 1,900 ppm has been estimated in one liquid. The atomic K/Na ratios of salt-rich liquids from three principal phases of vein mineralization and from quartz phenocrysts conformed to a single trend, increasing from 0.17 to 0.46 as the NaCl content decreased. The first phase of mineralization (phase A) took place when the southern part of the Kaverong Quartz Diorite was at temperatures higher than 700°C. The temperature and salinity distribution for this phase were asymmetric; cooling and dilution of the salt-rich liquids took place south and southwest of the orebody but have not been detected to the north or east. The zone of cooling and dilution corresponds closely with the 0.3 percent Cu ore-grade contour and the edge of major quartz deposition and is paralleled by a pyrite halo. The system cooled below 400°C before undergoing renewed mineralization at temperatures over 400°C in the two approximately concurrent phases B and C. These phases were accompanied by the intrusion of porphyritic stocks. Phase B formed a well-defined cell bounded by a pyritic halo and centered on the Leucocratic Quartz Diorite. Phase C was expressed as veining of the Biotite Granodiorite, the Biuro Granodiorite, and the area between them. Ground water, generally of less than 10 percent salinity, inundated the orebody between phase A and phase B and C, and again after phases B and C, at temperatures below 400°C. Within the orebody there was no salinity continuum between ground water and the salt-rich liquids. Ground water deposited quartz-pyrite and probably pyrite-clay and sphalerite-pyrite veins at temperatures near 300°C and caused local phyllic alteration. The distribution of fluids in space and time is consistent with the porphyry copper model in which a magmatic-hydrothermal system is surrounded by a cooler meteoric-hydrothermal system, the latter collapsing inward as the former wanes. Given a hydrostatic pressure regime in the meteoric-hydrothermal system, the depth of formation was 2 to 3 km. (Author's abstract)

EASTOE, C.J., 1978c, Fluid inclusions in porphyry copper deposits, in Notes for Workshop on Fluid Inclusions: Melbourne, Dept. Geology, La Trobe Univ. (unpaginated, mimeographed).

See Eastoe, Fluid Inclusion Research--Proc. of COFFI, v. 8, p. 53-54, 1975. (ER)

EFIMOV, V.V. and SOLYANIK, A.N., 1978, Homogenization temperatures of inclusions in apatites of the Dzhugdzhur iron-titanium ore mineralized occurrences, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 69 (in Russian). Authors at the Far East Geol. Inst. of Far-East Sci. Center of Acad. Sci. of the USSR, Vladivostok.

Fluorapatites of Fe-Ti ores in anorthosites of the Dzhugdrhur range bear melt and G/L incs. P melt incs. of 1 to 80 µm in length are two-phase (glass + G), sometimes partly crystallized or decrepitated and surrounded with haloes of CO_2 inclusions. Softening of glass was observed at 750-1000°C, but at 900-1000°C most of the inclusions leak. Th is 1090-1190°C, but due to leakage these values may be somewhat too high. Paragenetic ilmenite and titanomagnetite probably formed at 920-1200°C (from the diagram of A.F. Buddington and D. Lindsley). Numerous G/L inclusions in apatite yielded Th-intervals: 440-518, 320-416 and 100-200°C. (Authors' abst., translated by A.K.)

EFIMOVA, M.I., BLAGODAREVA, N.S., VASILENKO, G.P., KOKORIN, A.M., STEPANOV, G.N., STEPANOVA, M.N. and FAT'YANOV, I.I., 1978, Temperature conditions of formation of endogene ores of the Far East: (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 17-19 (in Russian). Authors at Far East Geol. Inst. of the Far East Sci. Center of the Acad. Sci. of the USSR, Vladivostok.

1. Essential groups of endogene ore deposits in the [Soviet] Far East are as follows: Tungsten - a) skarn-scheelite-sulfide, b) wolframite-quartz vein-greisen, c) wolframite-sulfide; gold - a) gold-quartz-low sulfide, b) gold-silver-quartz; tin - a) cassiterite-quartz, b) cassiterite-silicate, c) cassiterite-sulfide; zinc and lead - a) skarn-

sulfide, b) apocarbonate-greisen, c) cassiterite-sulfide.

2. All deposits formed during several long stages. Three essential stages may be distinguished: early pre-ore, middle ore, late post-ore.

3. Comparison of T of the three stages in various ore formations proves that the main part of the metals precipitated within relatively narrow T ranges. This should be caused by existence of the similar types of heavy metal complexes stable under close conditions. Likewise, pH and Eh of hydrotherms in the studied deposits vary in narrow ranges. (Authors' abst., translated by A.K.)

EFIMOVA, M.I., KOGAN, B.S. and NAUMKIN, P.A., 1978, Inclusions in gabbroids of the Annenskiy massif, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 79 (in Russian). Authors at the Far East Geol. Inst. of Far East Sci. Center of Acad. Sci. of the USSR, Vladivostok.

The studied gabbroids occur in the S. Primorie, Putiatin, and Askol'd Islands. They are intensively metamorphosed rocks (60-70% brown hornblende, 15% ferrosalite, 10% apatite, 5-7% magnetite). Apatite bears three types of inclusions: G, $G \gg L$ and $G \gg dm+L$; dm is a fine ore mineral. Heating up to 1320°C (melting point of apatite) did not cause any phase changes, which may suggest the vacuole filling to be a dense brine saturated with gas (sic.). Similar inclusions are to be found in hornblende; their homogenization also was not achieved. Common G-L inclusions have Th 150-320°C. Gabbroids bear schlieren of quartz-feldspar composition; quartz contains crystallized melt inclusions (dms G+L) up to 15 μm long, G occupies to 5 vol.%, but on melting of dms (700-800°C) additional G appears. Some inclusions bear tiny ore dms, partly dissolving on heating. Th 960-1050°C. (From the authors' abst., by A.K.)

EFIMOVA, M.I., NAUMKIN, P.A., MIKHAYLOVA, V.A. and OVCHAREK, E.S., 1978, Temperature conditions of formation of Upper Cretaceous granitoids of Askol'd Island, (Abst),: Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 83-85 (in Russian). Authors at the Far East Geol. Inst. of the Far East Sci. Center of Acad. Sci. of the USSR, Vladivostok.

Quartz from granodiorites of Askol'd Island, Japan Sea, bears crystallized melt inclusions from several to 40 μm in size. Inclusions are oval, but after 1.5-2 hours run at 600-700°C they become euhedral negative crystals. Filling is similar to quartz-feldspar felsite. At 650-700°C filling begins to melt, G bubble separates and at 800-820°C inclusions homogenize. Moreover, numerous 2-phase S G/L inclusions (Th 300-320°C) and 3-phase S $G+LH_2O+LCO_2$ inclusions (decrepitation at 60-80°C) were found.

Inclusions in phenocrysts of granite-porphyries and quartz porphyries (3-50 μm) are glassy, partly crystallized, with quartz dms. Partial melting begins at 750-800°C, after 2-3 hours run at this T G bubble appears (30-35 vol.%). Homogenization was reached at 1100-1200°C. (From the authors' abst., by A.K.)

EGGLER, D. H., 1978a, The effect of CO_2 upon partial melting of peridotite in the system $Na_2O-CaO-Al_2O_3-MgO-SiO_2-CO_2$ to 35 kb, with an analysis of melting in a peridotite-H_2O-CO_2 system: Am. J . Sci., v. 278, p. 305-343, Author at Geophys. Lab., Carn. Inst. Wash., Wash, D.C. 20008.

Several joins in the system Na_2O-CaO-Al_2O_3-MgO-SiO_2-CO_2 have been investigated at pressures to 30 kb in order to examine the effect of CO_2 on composition of partial melts of peridotite. In the presence of CO_2, phase fields of pyroxenes, particularly orthopyroxene, are expanded relative to the field of olivine.

In the presence of both CO_2 and H_2O, peridotite can melt to any composition that is intermediate between those produced in the presence of CO_2 or H_2O alone if a vapor of variable composition is present. It is proposed, however, that variation in vapor composition can occur only if relatively large amounts of volatiles are present in the mantle ($>$0.5 wt percent). If smaller amounts are present, vapor composition is controlled within zones of invariant vapor composition, and ranges both of solidus temperatures and of near-solidus partial melt compositions are restricted. By example, amphibole peridotite (and a coexisting vapor) at 15 kb with H_2O and CO_2 in any ratio, but a total amount less than 0.37 wt percent, will melt to a nephelinitic liquid. Andesitic liquid is produced only if CO_2 is absent. Supersolidus partial melt compositions ($\sim$1 to 10 percent melting) may diversify because of vapor fractionation. (From the author's abstract)

EGGLER, D. H., 1978b, Stability of dolomite in a hydrous mantle, with implications for the mantle solidus: Geology , v. 6, p. 397-400.

EGGLER, D. H. and BURNHAM, C., 1978, Activity of H_2O in diopside melt and CO_2-H_2O vapor to 20 kilobars, 600-1400 C (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 10, P. 395.

EGGLER, D.H., and ROSENHAUER, M., 1978, Carbon dioxide in silicate melts: II. Solubilities of CO_2 and H_2O in $CaMgSi_2O_6$ (diopside) liquids and vapors at pressures to 40 kb: Am. J. Sci., v. 278, p. 64-94. Authors at Geophy. Lab., Carn. Inst. Wash., Wash., DC 20008.

Crystal-liquid-vapor equilibria in the join $CaMgSi_2O_6$-CO_2-H_2O have been investigated to pressures of 40 kb by a combination of quenching experiments and DTA methods. Physiochemical properties determined include the solubilities of H_2O and CO_2 in diopside liquid; the solubility of $CaMgSi_2O_6$ in H_2O-rich and CO_2-rich vapor; the melting curves of diopside in the presence of H_2O, of CO_2, and of mixtures of H_2O and CO_2; and the partitioning of H_2O and CO_2 between $CaMgSi_2O_6$ liquid and vapor.

The isopleths also denote the composition of vapor evolved from liquid (containing crystals); if magmas evolve vapor in an open system, the vapor will be relatively CO_2-rich at pressures in excess of about 5 kb and can become H_2O-rich only at lower pressures. This pattern of vapor evolution from basic magmas will lead to a crust zoned in volatile composition, the lower crust being more CO_2-rich and the upper crust more H_2O-rich. (From the authors' abstract)

ELLIS, D. E., 1978, Stability and phase equilibria of chloride and carbonate bearing scapolites at 750°C and 4000 bar: Geochim. Cosmo. Acta, v. 42, p. 1271-1281. Author at Dep. Geol. and Geophy., Yale Univ., New Haven, CT 06520, U.S.A.

At 750°C and 4000 bar scapolite is stable relative to plagioclase + calcite over the range of plagioclase compositions An_{53}-An_{83}. The assemblage plagioclase + scapolite + calcite is stable relative to plagioclase + calcite over the ranges of plagioclase composition An_{48}-An_{53} and An_{83}-$An_{91.5}$. When NaCl is present in the coexisting fluid the range of scapolite compositions stable relative to plagioclase increases. High mole fractions of NaCl in the fluid stabilize scapolite relative to plagioclases from An_{25} to An_{87} in the presence of excess calcite. Determinations of the $Cl/(Cl+CO_3)$ ratios of the synthetic scapolites shows that the range of stable scapolite compositions is significantly larger than heretofore proposed, and that even the chloride and carbonate bearing scapolites must be considered a four component solid solution. The K_D for the exchange of NaCl and $CaCO_3$ between coexisting scapolite, fluid and carbonate is given by the equation $\ln K_D = (-0.0028)[Al/(Al + Si)]^{-5.5580}$ This equation implies that Cl-poor natural scapolites coexisted with fluids low in NaCl, and that regional occurrences of Cl-rich scapolites are likely to represent metamorphosed evaporite sequences. (Author's abstract)

ELOY, J.F., LEBEL, L., 1978, Preliminary analysis of fluid inclusions using a laser probe mass spectrometer, (abst.), in International Assoc. Genesis Ore Deposits, 5th Symp., Snowbird, Alta, Utah, 1978, Program and Abstracts: (Alta, Utah), p. 85.

Fluid inclusions in chromite have been found in massive chromite layers of the dunite complex of Al Ays (Saudi Arabia). This complex is tectonically emplaced in the Precambrian Arabic basement. The fluid inclusions with negative crystal shape have been studied previously by classical microthermometry, gas-chromatography and mass-spectrometry.

The fluid is an aqueous solution with 5 equivalent weight percent NaCl, and has a density of 0.68 g/cm^3. Other dissolved constituents are CO_2, CH_4, and heavier hydrocarbons. The petrological implications of such a fluid are discussed in another place (JOHAN and LE BEL, in preparation).

A tentative direct analysis of the fluid was made using a mass spectrometer with an ionizing laser probe. The diameter of the volume sample is in the range 18-50 µm, with a thickness of about 0.4 um per laser shot(sic.).

On the mass spectra one observes the major components of the host-spinel, and in addition the masses attributed to the fluid inclusions. The masses we found are: 1, 2, 3 and 4 (H_1, H_2, H_3 and H_4), 13, 14 and 15 (CH_1, CH_2 and CH_3), 17 (OH), 23 (Na), 29 and 30 (C_2H_5 and C_2H_6), 35 (Cl), 38 (C_3H_2), 39 and 41 (K), 40 (Ca), 42 and 43 (C_3 hydrocarbons) and 44 (CO_2).

However, at the present stage of development of the homemade equipment, the mass resolution does not allow the identification of the proposed species from their mass defects only.

The development of this technique is in progress in order to analyze individual fluid inclusions. Special efforts are being made to improve on the one hand the detection of minor components and on the other hand the definition and the observation of the sampled area. (Authors' abstract).

EL SHATOURY, H.M., 1978, Homogenization temperatures of liquid inclusions in sphalerite and associated quartz from Toyoha mine, Hokkaido: Chem. Erde, v. 37, p. 172-175 (in English). Author at Nuclear Raw Materials

Department, Cairo, Egypt.

The epithermal vein-type deposit of Pb-Zn-Ag in Toyoha mine is a typical example of such a type of mineralization sporadically distributed in the "Green Tuff" province of Japan. Geothermometric measurements on liquid inclusions in sphalerite and associated quartz from different levels of the mine reveal that the deposition of ore occurred at about 200°C.(Author's abstract)

ENJOJI, M., 1978a, "Melt" inclusions in garnet from Yamanowo pegmatite, Tsukuba, Japan (abst.), in International Assoc. Genesis Ore Deposits, 5th Symp., Snowbird, Alta, Utah, 1978, Program and Abstracts: (Alta, Utah), p. 86.

Many pegmatite dikes intrude into biotite granite at Yamanowo, Tsubuka Province, Ibaraki Prefecture, Japan. One of them is more than 5m in thickness and was once mined for feldspar and quartz. Garnet crystals occur with muscovite in a later stage in this pegmatite. Garnet is of almandite-spessartite series, well grown tetragonal trisoctahedral in shape, dark red in color, about a few mm in size. In the central part of the crystals, muscovite flakes are present as the seed of the crystals.

Inclusions are distributed in zones parallel to the outer surface of the garnet crystals, and in a given zone, their phase compositions are similar to each other. From the modes of occurrence, these inclusions are considered to be primary in origin. They are flat oblate to amoeboid in shape, as if they were melt, and show no negative crystal shapes. A few kinds of crystals make up the bulk of these inclusions. These solid phases contact the host crystal smoothly along the inner wall of the vacuole, and hence resemble glass melt inclusions in this respect. The solid phase having the largest volume is colorless, transparent, and anisotropic, with a relatively low refractive index. The fluid phase (liquid + vapor) is often separated into two or more parts in a given inclusion, and occupies only several volume percent. The shape of the fluid phase is controlled by that of the solid phases.

Electron microprobe analysis revealed that the composition of the major solid crystal is very similar to that of muscovite. On heating runs up to about 900°C, the solid crystals remelt, and on cooling to room temperature they become a glass (devitrified ?).

The inclusions are obviously considered to be the garnet-forming media. However, the reason why the shape of the inclusions resembles that of a melt is not known. (Author's abstract).

ENJOJI, M., 1978b, Melt inclusions in garnet from Yamanowo pegmatite, Tsukuba, Japan: Ann. Rep., Inst. Geosci., Univ. Tsukuba, no. 4, p. 15-18 (in English).

This is the full paper corresponding to the previous abstract. (E.R.)

EPSHTEYN, Ye.M., 1978, Composition and peculiarities of mineral-forming media inclusions in co-existing minerals of carbonatite complexes, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in Geology: Vladivostok, Acad. Sci. USSR, p. 64-65 (in Russian). Author at the All-Union Inst. of Mineral Raw Materials, Moscow.

Studied specimens were collected at the apatite-magnetite Kovdor deposit. Silicates bear crystal-fluid inclusions, and apatite that is paragenetic with them has P inclusions of G/L type. Th differences are significant: I stage - nepheline 930-850°C, wollastonite 790-780°C, apatite 490-350°C; II stage - forsterite 890-705°C, apatite 430-230°C. (From the author's abst., by A.K.)

EREMIN, N.I. and SERGEEVA, Nat. Ye., 1978, Two types of sulfide deposits in Japan: Geol. Rudn. Mest., v. 20, no. 6, p. 75-89 (in Russian). Authors at the Moscow State Univ., USSR.

The paper bears (p. 87-88) some Th values cited from Japanese sources. (A.K.)

ERLICH, N. T., 1978, Application of the ion-selective electrodes for determination of ions in analysis of liquid phase of inclusions, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 155 (in Russian). Author at All-Union Inst. of Mineral Raw Materials, Moscow, USSR.

Fluorine is determined by ion-selective electrode with membrane made of Lanthanum fluoride monocrystal, reference electrode is the chloride-silver electrode EVL-1M3, the potentiometer used is the "pH-121" model. Chloride-selective electrode was with Cl-Ag membrane, sulfide one was of S-Ag type; the latter was also applied for SO_4 determinations. (From the author's abst.)

ERMAKOV, N. P. - see also YERMAKOV, N. P.

ERMAKOV, N. P., 1978a, Method of carbon dioxide analysis for the detailed exploration of quartz bodies and zones of hydrothermal alterations: Teor. Prakt. Termobarogeokhim., (Dokl. Vses. Soveshch.) 5th 1976, N. P. Ermakov, ed.: Moscow, Izd. Nauka, p. 158-162 (in Russian).

In fluid inclusions in quartzites, the H_2O concn. successively decreases but the CO_2 concn. increases, with increasing distance from a quartz-crystal deposit. A similar pattern of inverse H_2O and CO_2 behavior is obsd. with increasing distance from a pegmatite body. In the quartzites, max. decrepitation activity at 120-300° coincided with max. CO_2 concn. in the inclusions. The high-temp. (300-480°) decrepitation activity in the quartzites in parts of quartz-crystal bearing bodies was also an index of the similarity between these bodies. The change in the H_2O and CO_2 contents of the solns. of secondary inclusions in minerals provides a basis for a CO_2-anal. method of detailed prospecting, esp. in combination with the decrepitometric method. (Chem. Abstracts 91: 110309u, 1979)

ERMAKOV, N.P., ed., 1978b, Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, 3 vols., Vladivostok, Acad. Sci. USSR, (in Russian).

Translations of these abstracts will be found in this volume of <u>Fluid Inclusion Research</u> -- <u>Proceedings of COFFI</u>. (E.R.)

ERMAKOV, N. P., 1978c, Defectology of minerals by fluid inclusions of mother solutions (abst.): XI General Meeting of International Mineralogical Association, Novosibirsk, Abstracts, v. 2, p. 66 (in English).

A review of the importance of fluid inclusions to commercial crystal (natural) production. (E.R.)

ERMAKOV, N.P., 1978d, The present-day state of theory of endogene ore formation and applicable possibilities of thermobarogeochemistry (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 5-11 (in Russian). Author at the Moscow State Univ.

The paper consists of a historical review of the Russian inclusion works since the 1940's, mostly those performed by Ermakov. Also data on fluid inclusions in various types of deposits are given, e.g., Cu-Ni deposits from liquation in silicate rocks bear inclusions of ore-silicate melt Th 1120-1170°C; magmatic apatite-rare metal deposits -- apatite bears alkaline-silicate melt inclusions of Th 980-700°C, with phosphate melt immiscibility; studies of melt inclusions in carbonatites (Th from 930-550°C) suggest the magmatic origin of major parts. Granite pegmatites Ermakov divides into two groups: primary chamber and vein pegmatites and secondary pegmatites formed by replacement zones of pegmatites formed from volatile-rich silicate melts, solution-melts and brine-melts, and gaseous solutions. High-silica granites surrounding pegmatites bear crystallized melt inclusions with Th 700-630°C, aplite-620-580°C, granophyric intergrowths 570-550°C, pegmatoids and silexites 560-550°C. The same T are found for the cores of morion crystals, then after the high → low quartz inversion, they crystallized from pneumatolytic and hydrothermal solutions.

Rare-metal and mica pegmatites formed by pneumatolytic and hydrothermal alteration resulting in accumulation of raw material at 500-200°C. Inclusion haloes around pegmatites are 10 times wider than the vein thickness, and hence are prospecting guides.

Significance of fluid inclusion studies for recognition of origin of greisens, skarns and hydrothermal deposits is discussed, as well as the uses of inclusions in prospecting are summarized.

The author suggests the organization of a special institute for the development and use of fluid inclusion studies (Abst. by A.K.)

ERMAKOV, N.P., 1978e, Logic and semantics in thermobarogeochemistry, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in Geology: Vladivostok, Acad. Sci. USSR, p. 42-43 (in Russian). Author at the Moscow State Univ., Moscow.

A review of the theoretical principles of thermobarogeochemistry; the role of dialectic logics and dynamic way of studies is especially expressed. Special importance of the inductive method (multiple verification of models - hypotheses) being the basis of scientific semantics is also discussed (sic). (A.K.)

ERMAKOV, N.P., ed., 1978f, Thermobarogeochemistry of the earth's crust and ore formation: Moscow, Nauka Press, 203 pp. (in Russian).

Contains only a part (45) of the papers presented at the Ufa meeting (see vol. 10 of COFFI, p. v.). Issued under the aegis of the Inst. Geology, Bashkir A.S.S.R. (ER)

ERMAKOV, N.P., ed., 1978a, Theory and pratice of thermobarogeochemistry: Moscow, "Nauka" Press, 275 pp. (in Russian).

Many of the 47 papers in this book are abstracted in this volume of COFFI. (ER)

ERMAKOV, N.P., (ed.)b, 1978, Thermobarogeochemistry and ore genesis - Abstracts of the Sixth All-Union Meeting on Thermobarogeochemistry, vol. II, 222pp., Vladivostok (in Russian); 500 copies printed.

The second volume of the Sixth All-Union Meeting abstracts has a different title than the first volume. It contains 157 abstracts, divided into two sections: Section III: Applied thermobarogeochemistry, with subsections a) Prospecting methods, criteria and prognoses, b) Thermobarogeochemical mapping and zoning, c) Katagenesis of sedimentary rocks in the oil-and-gas-bearing and salt-bearing areas, and other problems, and Section IV (seemingly erroneously printed "section II"): Thermobarogeochemistry of the ore-forming processes. (A.K.)

ERMOLENKO, V.I. and ERMOLENKO, G.I., 1978, Vapor-liquid phase transition from point of view of the association equilibrium: Akad. Nauk SSSR Doklady, v. 243, no. 4, p. 963-965 (in Russian). First author at the Inst. of General and Inorganic Chemistry of Acad. Sci. of Ukrainian SSR, Kiev.

Pertinent to condensation of pneumatolytic solutions and G and G/L inclusions. (A.K.)

ERMOLOV, P.V. and KOROLYUK, V.N., 1978, Composition and structure of the magnetic spherules in granitoids: Akad. Nauk SSSR Doklady, v. 240, no. 1, p. 155-158 (in Russian). First author at the Altay Division of the Inst. Geol. Sci. of the Kazakh Acad. Sci., Ust-Kamenogorsk.

Spherules were found in various rocks of the Zaysan folded area: granites, pegmatites and coarse-grained sandstones. Following types of spherules were distinguished: magnetite + wüstite (seemingly melted magnetite crystals), Fe-Mn-Ti silicates (late magmatic and post-magmatic origin), and native Fe (similar to Fe crystallizing on serpentinization, hydrothermal processes and reduction of ulvospinel in hydrogen). No signs of cosmic origin were found. (A.K.)

ERSHOVA, Z.P. and DMITRIEV, R.V., 1978, Hydrogen evolution during heating of amphiboles: Acad. Sci. USSR Doklady, v. 238, no. 6, p. 1455-1458 (in Russian). First author at Inst. Geol. of Ore Deposits, Petrography, Mineralogy and Geochemistry of Acad. Sci. USSR, Moscow.

Eight samples of various amphiboles were investigated by means of mass spectrometry to determine the evolution of hydrogen on calcination. Experiments were carried out to verify the hypothesis of the Fe^{+2} oxidation by OH groups from the amphibole structure. Various amphiboles produced hydrogen from 0.002 ml/g of mineral to 1.5 ml/g at T from 300 to 800°C. The amount of hydrogen produced was higher at higher T than at lower ones; a ground sample released less H_2 than an unground one; on the second calcination of the same sample the amount of the released H_2 was as low as 3-10% of H_2 released on the first calcination. Authors explain tentatively the differences in H_2 amounts with specific surface of acicular mineral, varying from 1 to 10 m^2 per 1 g. Pertinent to G studies in fluid inclusions. (Abst. by A.K.)

ERWOOD, Robin J. and KESLER, Stephen E., 1977, Supersaline, hypothermal main-stage mineralizing solutions, Naica chimney-manto deposit, Chihuahua, Mexico (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 9, p. 909.

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 of Naica provide the first direct observations of main-stage fluids in these deposits. The inclusions can be divided into: A) Liquid + Vapour (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; $\sim$40% e.w. NaCl with $\sim$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. 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) and 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. (Author's abstract)

ESSENE, E.J. and BOHLEN, S.R., 1978, Adirondack metamorphic fluids: Discussion of fluorine and oxygen fugacities (abst.); Eos, Trans. Amer. Geophy. Union, v. 59, p. 407.

Thermodynamic calculations for selected silicate-fluorite ± Fe-oxide assemblages indicate that several commonly occurring fluorite-bearing assemblages are restricted to relatively narrow fO_2-fF_2 fields at constant P-T. Fayalite-ferrohedenbergite-fluorite-quartz ± magnetite and ferrosalite-fluorite-quartz-magnetite assemblages in orthogneisses from Au Sable Forks (sic), Wanakena, and Lake Pleasant, New York buffered fluorine and oxygen fugacities during the granulite facies metamorphism in the Adirondack Highlands. These buffering assemblages restrict fF_2 to $10^{-28\pm1}$ and fO_2 to $10^{-16\pm1}$ at the estimated metamorphic P-T of 7 kb and 1000°K. The F_2 fugacities inferred here are similar to the upper limits possible for plagioclase-bearing rocks, and probably the upper limit for metamorphism in the Adirondacks and in other granulite facies terranes. Coexisting biotite-magnetite-kspar-ilmenite, found in the same Au Sable outcrop as the fayalite-fluorite-ferrohedenbergite-quartz-magnetite assemblage, restricts fH_2O to less than $10^{3.3}$. These gas fugacities limit fH_2 and fHF to less than 10^1 for the Au Sable outcrop. The data indicate that O_2, H_2, F_2 and HF are geologically significant but not major components of the metamorphic fluid phase in Adirondack orthogneisses. The preliminary data suggest that for the Au Sable area, and possibly much of the Adirondack Highlands, P_{H_2O} is $\leq$ approximately .25 Psolid and that Pfluid $\ll$ Psolid unless other gas species such as CO_2 or Ar are present in large quantities helping to maintain high fluid pressures. (Authors' abstract)

ESSENE, E. J., BOHLEN, S. R. and VALLEY, J. W., 1978, Determination of regional water fugacities in the Adirondacks (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 10, p. 397-398.

Several occurrences of bio-mag-ilm-kspar assemblages in orthogneisses of the Adirondacks allow estimation of H_2O fugacities throughout the region. Coexisting biotite $(K_{2.07}Na_{.04})(Fe^{2+}_{2.79}Mg_{2.32}Ti_{.64}Mn_{.01}Fe^{3+}_{.00}Al_{.24})(Al_{2.41}Si_{5.59})(O_{21.2}OH_{2.34}Cl_{.28}F_{.17})$-magnetite($Usp_{32}$)-ilmenite($Hm_5$)-Kspar($Or_{60}$) at Au Sable Forks, New York fixes T=700°C, $fO_2=10^{-17}$ and restricts fH_2O to 10^2-$10^{3.3}$ for metamorphic P=7±1kb. Structure refinement (R=.04) of the biotite indicates a lack of octahedral site deficiencies and octahedral and tetrahedral cation ordering-three variables of crucial importance to careful application of H_2O barometry. Similar bio-mag-ilm-Kspar assemblages in orthogneisses of the NW Adirondacks restrict fH_2O to $10^{2.5}$ -$10^{3.3}$ for metamorphic P-T of 6 1kb and 630° ± 30°C. Sporadic occurrences of primary muscovite-quartz in the NW Adirondacks require $fH_2O>10^{2.8}$. These low, variable fH_2O cast uncertainty on the validity of isograds involving dehydration equilibria mapped by Engel and Engel and DeWaard. For most orthogneisss in the Adirondacks $PH_2O<<Psolid$, reflecting the crystallization of orthogneisses from relatively dry magmas pre- or syntectonically which maintained their initial low fH_2O during regional metamorphism. In the marbles several assemblages of trem-cc-qtz-diop-sph±graph and phlog-cc-qtz-trem-Kspar-sph±graph found in the NW Lowlands and Highlands require that PH_2O + PCO_2 Psolid with $.6 \leq XH_2O \leq .85$. Several invariant assemblages (phlog-cc-qtz-trem-Kspar-diop) found in the central Adirondacks require $XH_2O \simeq .85$. Oxygen isotope data from equilibrium assemblages in marbles and orthogneisses indicate that the two rock types are not in isotopic equilibrium, indicating that they did not exchange with a pervasive O bearing fluid. Coupled with petrologic evidence this suggests that these rocks were not an open system and that large fluid gradients occurred across their contacts during metamorphism. (Author's abstract)

ETMINAN, H., 1978, Fluid inclusion studies of the porphyry copper ore bodies at Sar-Cheshmeh, Darreh Zar and Meiduk (Kerman Region, South Eastern Iran) and porphyry copper discoveries at Songun, Gozan and Kighal (Azarbyjan Region-North Western Iran). (abst.), in International Assoc. Genesis Ore Deposits, 5th Symp., Snowbird, Alta, Utah, 1978, Program and Abstracts: (Alta, Utah), p. 58.

The characteristic types of fluid inclusions already recognized in most important porphyry copper deposits all over the world are present in all of these 6 Cu-Mo porphyry type mineralizations in Iran.

The fluids associated with potassic, phyllic and propylitic alteration are studied in detail at Sar Cheshmeh, and each stage is recognized by its very distinct physicochemical character.

The fluid phase in K-alteration shows the systematic coexistence of the vapor and the liquid with a salinity up to 55 wt% equiv. NaCl and the grade of copper up to 5000 ppm. The homogenization temperature varies between 650 and 350°C. The phyllic alteration, which is superimposed on the earlier potassic alteration, is characterized by the association muscovite, chlorite and pyrite. Boiling in the fluid phase in phyllic alteration is less important and the homogenization temperature varies between 400 and 260°C. The prophylitic alteration is characterized by the association quartz, chlorite, albite, epidote, calcite and pyrite. This type of alteration occurs in the outer part of the deposit in andesitic country rocks. The fluids are essentially liquid, with a salinity between 2 to 15 wt% equiv. NaCl. The homogenization temperature varies between 280 and 200°C. The types of fluid inclusions in Darreh Zar, Meiduk, Songun, Kighal and Gozan are identical to those in Sar Cheshmeh. The presence of potassic alteration, intense boiling, and high copper grades in the fluid phase in Songun and Kighal (up to 4000 ppm Cu) might be considered as promising factors for further prospection in these localities. (Author's abstract).

FAIZIEV, A.R., and ALIDOROV, B.A., 1976, Thermometry of minerals with perfect cleavage: Akad. Nauk SSSR, Sibirsk. Otdel., Geol. Geofiz., v. 17, no. 8, p. 140-144 (in Russian; translated in Soviet Geol. and Geophys., v. 17, no. 8, p. 118-121).

Abstract in Fluid Inclusion Research -- Proc. of COFFI, v. 9, p. 40, 1976. (E.R.)

FERGUSON, L. J. & EDGAR, A. D., 1978, The petrogenesis and origin of the analcime in the volcanic rocks of the Crowsnest Formation, Alberta: Canad. Jour. Earth Sci., v. 15, p. 69-77.

Inclusions of glass in the analcime phenocrysts (p. 74) suggest the analcime crystallized along with pyroxene from a silicate liquid. (E.R.)

FERRY, J.M., 1978, What do mapped isograds tell us about regional patterns of heat transfer and fluid flow during metamorphism? (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 10, no. 7, p. 400.

FERRY, J. M., 1978, Fluid interaction between granite and sediment metamorphism, South-Central Maine; American Journal of Science, v. 278, n. 8, p. 1025-1056.

FIENI, C., BOUROT-DENISE, M., PELLAS, P. and TOURET, J., 1978, Aqueous fluid inclusions in feldspars and phosphates from Peetz (L6) chondrite: (A special abstract, presented at Meteoritical Society annual meeting, but not in printed program; published later in somewhat revised form - see next item). Authors at Lab. de Min. du Museum, 61 rue Buffon, 75005 Paris, France.

Fluid inclusions containing moving bubbles have been found in separated grains of feldspar and phosphate from Peetz (L6) chondrite. They were observed in about 1% of the ~1000 examined crystals.

On the basis of their shape and mode of occurrence they are apparently primary or, for a few of them, pseudosecondary. Melting temperatures are very close to 0°C (- 1.3 to - 0.2°C), while homogenization temperatures (always in liquid state) range between 156 to 270°C (with most measurements converging between 180-220°C). These data indicate that the fluid is almost pure water. If feldspar and phosphate have crystallized at an equilibration temperature of ~900°C (Dodd, 1969; Onuma et al. 1972), pressure conditions inferred from the linear extrapolation of the isochores of the fluid would be above 10 Kb.

Similar fluid inclusions have been observed in whitlockites of St. Severin (LL6) chondrite. (Authors' abstract)

FIENI, C., BOUROT-DENISE, M. PELLAS, P. and TOURET, J., 1978, Aqueous fluid inclusions in feldspars and phosphates from Peetz chondrite:

Meteoritics, v. 13, p. 460-461. Authors at Min. du Museum et L.A. 286 du C.N.R.S., 61 rue Buffon, 75005 Paris, France.

Fluid inclusions containing moving bubbles have been observed in separated grains of feldspar and phosphate from Peetz (L6) chondrite. They were found in about 1% of the ∼1000 examined crystals; their average dimensions range between 2 and 10 μm. On the basis of their shape and mode of occurrence these fluid inclusions are apparently primary. Melting temperatures are very close to 0°C (-1.3 to -0.2°C), while homogenization temperatures (always in liquid state) range between 156 and 270°C (with most measurements converging between 180-220°C). These data indicate that the fluid is almost pure water, with less than 1 mole % of dissolved equivalent NaCl. From the P-V-T of H_2O, pressures corresponding to metamorphic temperatures (800-900°C) would be between 9 and 11 kb. These estimates are grossly inconsistent with petrological evidences and cooling rate data which indicate that Peetz material cannot have been subjected to pressures higher than 0.7 kb. Therefore we conclude that the fluid inclusions do not contain a synmetamorphic fluid phase.

Similar fluid inclusions have been observed in whitlockites from St. Severin (LL6) chondrite. They have not been found during a systematic survey of phosphate and feldspar grains from nine other ordinary chondrites (L6-7; H4-5-6). Any attempt to find CO_2 inclusions in Peetz chondrite, especially in pyroxene and olivine, has been unsuccessful. (Authors' abstract)

FLORAN, R. J., PRINZ, Martin, HLAVA, P. F., KEIL, Klaus, NEHRU, E. E., and HINTHORNE, J. R., 1978, The Chassigny meteorite: a cumulate dunite with hydrous amphibole-bearing melt inclusions: Geochim. Cosmo. Acta, v. 42, p. 1213-1219. First author at Dep. Min. Sci. Amer. Museum Nat. History, New York, NY 10024, U.S.A.

The Chassigny meteorite is a moderately shocked olivine achondrite or chassignite with features indicative of a cumulate origin with some subsolidus annealing. Chassigny is an iron-rich dunite (Fo_{68}) with minor amounts of Ca-rich and Ca-poor pyroxene, alkalic feldspar, chromite, and melt inclusions in olivine. Accessory phases include chlorapatite, troilite, marcasite, kaersutite amphibole, pentlandite, ilmenite, rutile and baddeleyite. Kaersutitic amphibole containing hydrogen and lesser amounts of fluorine represents the first extraterrestrial occurrence of hydrous amphibole and the first meteoritic amphibole type other than fluorichterite. Kaersutite is found only in melt inclusions.

Melt inclusion bulk compositional data suggest crystallization from a low-Ca melt that may have been similar in major element abundances to the silicate portion of LL group chondrites. However, Chassigny has a fractionated pattern for REE and the lack of metallic iron, possible presence of minor Ni in the olivine and Fe^{3+} in the chromites indicates that Chassigny formed under relatively more oxidizing conditions than most other achondrites. Therefore its parental melt could not have been directly derived from a chondritic composition in a simple single-stage process. The iron-rich bulk composition, cumulate texture and abundance as well as alkalic nature of the interstitial feldspar indicate that Chassigny could not have generated eucritic magmas. This places further constraints on its relationship to other meteorites and the parent body from which it is derived. The Brachina meteorite is similar to Chassigny except that it is finer grained, more feldspathic and is unshocked. It extends the fractionation range of this group which now represents two unusual meteorites. (From the author's abstract)

FLYNN, R. T. and BURNHAM, C. W., 1978, An experimental determination of rare earth partition coefficients between a chloride containing vapor phase and silicate melts: Geochim. Cosmo. Acta, v. 42, p. 685-701. Authors at The Penn. State Univ. Dep. Geosci., Univ. Park, PA 16801.

The partitioning bahavior of cerium, europium, gadolinium and ytterbium between an aqueous "vapor" phase and water saturated silicate melt have been experimentally examined using a new experimental approach employing radioactive tracers and a double-capsule technique. Equilibrium was established by reversing the partition coefficient^1 and by beta track autoradiography. Aqueous solution compositions were varied by adding different amounts of chloride, and in some cases fluoride or carbon dioxide. The H_2O contents of the Spruce Pine pegmatite melts were varied by conducting experiments at 4.0 kb, 800°C and at 1.25 kb, 800°C. A jadeite-nepheline composition (75 wt% jadeite) also was employed at 4.0 kb, 800°C.

The chloride experiments (Spruce Pine 4 kb, 800°C) show a linear relationship between the cube of the chloride molality and the partition coefficients of the trivalent rare earths. Europium, under the experimental fO_2 conditions (quartz-fayalite-magnetite buffer), varied linearly as the fifth power of the chloride molality. At the chloride molalities examined (<1.1 m_{Cl}), all the rare earths partitioned preferentially into the melt phase ($K_p^{RE} < 1$). Relative to pure water, the presence of chloride and fluoride ion increased the partitioning of the individual rare earths into the vapor phase, while carbon dioxide did not. Europium anomalies were recorded in all experiments, particularly those involving the Spruce Pine melt at 4.0 kb and 800°C which displayed a large positive europium anomaly at all chloride molalities. Furthermore, a relative fractionation of the trivalent rare earths was also observed in these experiments, such that $K_p^{Ce} > K_p^{Gd} > K_p^{Yb}$. The smaller ytterbium ion was consistently concentrated in the melt phase relative to the other rare earths in all experiments on the Spruce Pine composition. Experiments on the jadeite-nepheline composition showed no relative fractionation and a positive europium anomaly. The 1.25 kb experiment on the Spruce Pine composition showed a negative europium anomaly in plots of K_p^{RE} vs. REE.

The overall rare earth partitioning at a constant chloride molality ($m_{Cl} = .914$) was such that $K_p^{SP(1.25kb)} > K_p^{SP(4.0\ kb)} > K_p^{Jd\text{-}Ne(4.0\ kb)}$ where SP = Spruce Pine, Jd-Ne = jadeite-nepheline. Using the model of Burnham (1975), it is suggested that the trivalent rare earth partitioning is related to the cube of the melt octahedral site concentration; a property which in hydrous melts is dependent on melt composition and hydroxyl molality. Excellent agreement was found for the Spruce Pine melt, whereas the jadeite-nepheline melt gave apparent hydroxyl molalities which were too high for the measured partition coefficient. Additional octahedral sites are proposed for this unusual composition perhaps due to some aluminum in 6-fold coordination. The apparent compositional variation of europium partitioning at a constant oxygen fugacity is believed to be related to both the octahedral melt site concentration for trivalent europium and an 8-coordinated site concentration for divalent europium. Any parameter which affects the numbers of these sites (pH_2O, melt composition) will affect the rare earth partitioning. The observed dependency of the partition coefficient on the structural state of the melt could be as significant as its dependency on crystalline structural constraints. Furthermore, since pH_2O can drastically effect the melt structural state, its effects could be reflected in melt/crystal partition coefficients. (Authors' abstract)

FOURNIER, R.O., 1978, Precipitation of quartz in convecting hydrothermal systems (abst.): U.S. Geol. Survey Prof. Paper 1100, Geologic Survey Research 1978, p. 204.

FRANTZ, J. D. and POPP, R. K., 1978, An experimental study of complexing and thermodynamic properties of aqueous $MgCl_2$ in the system $MgO-SiO_2-H_2O-HCl$: Carn. Inst. Wash. Yearbook 1977-1978, p. 812-823 (pub. in 1978).

FRECKMAN, J.T., OLSON, E.R., 1978, Polythermal history of fracture filling episodes in active geothermal systems, (abst.), in International Assoc. Genesis Ore Deposits, 5th Symp., Snowbird, Alta, Utah, 1978, Program and Abstracts: (Alta, Utah), p. 91.

Two independent methods of measurement indicate that fracture filling episodes in active geothermal systems may occur over a significant range of temperatures.

For the Cerro Prieto Geothermal Field (CPGF), Mexico and the Salton Sea Geothermal Field (SSGF), California mean homogenization temperatures (T_H) for fluid inclusions and mean temperatures calculated from oxygen isotope data (T_I) for authigenic calcite and quartz show close agreement with measured temperatures in the boreholes. However, for three fracture systems from restricted vertical intervals the samples show a wide range of temperatures with T_H ranges of 88, 45, and 44°C (±6°C) and T_I ranges of 57, 65, and 35°C (±5°C) respectively.

We believe these temperature ranges, determined by the two methods, are not fortuitous, but indicate a polythermal history for vein mineral deposition in active and ancient hydrothermal systems. These geothermometric data have practical applications in geothermal resource investigations. (Authors' abstract).

FRENKEL', M. Ya. and YAROSHEVSKIY, A. A., 1978, Crystallization differentiation of intrusive magmatic melt: Geokhimiya, No. 5, p. 643-668 (in Russian, English abst.). Authors at Inst. Geochem. and Anal. Chem. of Acad. Sci. USSR, Moscow.

Pertinent to melt inclusion studies. (A. K.)

FREY, Martin, TEICHMILLER, Marlies, and MULLIS, Josef, 1978, Very low-grade regional metamorphism of the Helvetic Alps:mineral assemblages, illite crystallinity, vitrinite reflectance and fluid inclusion data (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 10, no. 7, p. 404.

Three zones of increasing metamorphism can be distinguished in the Helvetic Alps, Switzerland, based on 1500 illite crystallinity (IC) data: (i) a non-metamorphic zone (IC>7.5) comprising the higher Helvetic Nappes along the Alpine border, (ii) a 10-30 km wide anchimetamorphic zone (IC=7.5-4.0,∼prehnite-pumpellyite facies), and (iii) an epimetamorphic zone (IC<4.0,∼greenschist facies) in the lower Helvetic units. Four isograds have been mapped in metapelites and glauconite-bearing limestones, based on the following reactions: (1) kaolinite+quartz (qtz)=pyrophyllite (pyro)+H_2O and (2) glauconite± chlorite (chl)+qtz=stilpnomelane (stilp)+K-feldspar (kf)+H_2O within the anchizone; (3) pyro+chl=chloritoid+qtz+H_2O and (4) chl+kf=biotite+ stilp+H_2O within the epizone. The mean reflectivity (Rm) of phytoclasts from 70 samples along three traverses show that Rm is increasing from 0.9-3.1% in the non-metamorphic zone, 2.4-5.6% in the anchizone, to

>4.7% in the epizone. Both IC and Rm data prove the existence of inverted metamorphism between different tectonic units. Therefore, post-metamorphic thrusting was important in the Helvetic Alps. Fluid inclusion studies on 200 late fissure quartzes show that (i) the fluid composition changes from higher hydrocarbons in the non-metamorphic zone, methane-rich fluids in the anchizone to water-rich fluids in the epizone; (ii) minimum T and P estimates for isograds (1) and (2) are 260°C/1.6 kb. Comparison of these T and P values with hydrothermal experimental data of reaction (1) with $aH_2O=1$ indicate that in the anchizone aH_2O was as low as 0.4. (Authors' abstract)

FRIDMAN, A.I., REMIZOVA, L.I., VOYTOV, G.I., and CHEREVICHNAYA, L.F., 1977, Natural gas of the Belorechenskoye barite deposit, northern Caucasus: Akad. Nauk SSSR Doklady, v. 233, p. 470-472 (in Russian; translated in Dokl. Academy Sci. USSR, v. 233, p. 194-197, 1978).

See Fluid Inclusion Research -- Proceedings of COFFI, v. 10, p. 83 (ER).

FROST, B. R., 1978, Phase relations in the system Fe-Si-C-O-H as inferred from metamorphosed iron-formation (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 10, p. 405.

GALKIN, A. V. and KOPYATKEVITCH, I. R., 1977, The use of radioactive tracer methods for experimental investigations of hydrothermal processes (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. 3, p. 66-67 (in Russian).

GANEEV, I.G., 1977, Composition and properties of 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. 3, p. 95-96 (in Russian; abstract courtesy Dr. A.P. Berzina).

The conditions of vein mineralization are considered under non-equilibrium dynamic conditions and a predominant role of convective mechanism of solution movement. Electrolyte solutions typical of hydrothermal solutions under Δt in a thermal gradient are subjected to space differentiation with the formation of acid solutions in the upper zone and alkaline ones in the lower zone. Using a model of the thermal gradient in a vein, the author assumes that the zones of contrasting chemical composition are formed under natural conditions with respect to acidity-alkalinity. Within this model the idea of migration of mineral substances in hydrothermal solutions in the form of carbonate, chloride, fluorine complexes is unlikely because of their non-stability under non-equilibrium conditions (sic.). The main form of migration of mineral substances is imagined to be hydroxycomplexes formed in the deep parts of the veins.

GANEEV, I.G., 1978, Composition and properties of hydrothermal solutions as indicated by thermobarogeochemistry and experimental studies, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, pp. 28-30 (in Russian). Author at Ministry of Geol. of the USSR, Moscow.

Considerations of the temperature gradient, density, composition and properties of hydrothermal solutions are presented, including an outline of essential controversion concerning NaCl solution as the main migration agent for both quartz (barren minerals) and ore minerals, since quartz is poorly soluble in NaCl solution, whereas most of ore minerals are easily soluble in it. This may be explained by the concept that ore parageneses formed in closed systems of anisotropic thermal field. In most common natural electrolytes thermal gradients cause differences of pH: in upper part of the system the solution is more dense and acid, in lower part - less dense and alkaline. Under the studied conditions even an only slightly hydrolizing solution such as NaCl appears to be hydrolized. Hydroxycomplexes may be the real form of migration of substances. (Abst. by A.K.)

GARANIN, V.K., DOROGOVIN, B.A., KUDRYAVTSEVA G.P., OKRUGIN, V.M. and SOLOLOV, V.N., 1978, Inclusions of solidified melts in products of eruptions of Kamchatka volcanoes, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 92-93 (in Russian). First author at Moscow State Univ., Moscow.

Liparite-dacites extruded by volcano Alney-Chashakondzha, andesites of dome Novyi of volcano Bezymyannyi and basalts of the Great Fracture Eruption of volcano Tolbachik (1975-1976) were studied. The largest Th difference between phenocrysts and "subphenocrysts" was found for plagioclase: 1430-910°C, smaller for olivine and pyroxene. Th ranges for biotite and hornblende are 1180-1040°C; all inclusions are filled by silicate melt, sometimes with dms: sulfides, spinels, pyroxene, plagioclase. (From the authors' abst., by A.K.)

GARBARINI, J. Michael and CARPENTER, Alden B., 1978, Albitization of plagioclase by oil-field brines (abst.): Geol Soc. Amer. Abstracts with Programs, v. 10, p. 406.

Sandstones of the Hosston Formation at a depth of 3000 meters in the east central part of the central Mississippi salt basin contain up to 35 percent detrital feldspar. Both the potash feldspar and plagioclase are rounded, lack authigenic overgrowths, and do not appear turbid in transmitted light. The potash feldspar grains display a characteristic bright blue cathodoluminescence while most of the plagioclase is non luminescent. Data on twinning, luminescence and composition (microprobe analysis) of 278 plagioclase grains in a typical sample are given below.

Composition(Mole% Ab)	100-99	99-95	95-90	90-85	85-80	all grains
% of total plagioclase	35	29	10	11	14	100
% twinned	23	35	32	45	32	32
% luminescent	5	13	82	87	97	40

These data indicate that most of the plagioclase in the rocks cannot be detected on the basis of twinning, cathodoluminescence, or a staining technique which depends on the presence of calcium. No source area is known to have existed during the deposition of the Hosston which could have contributed plagioclase with these characteristics. The most likely explanation is that the plagioclase acquired these characteristics as a result of reaction with the sodium to the Na-Ca-Cl brines now present in these rocks. This hypothesis is supported by the fact that the Ca/Br ratio of the Hosston brines is higher than in the brines which are closer to the evaporites. The albitization of plagioclase appears to be responsible for the precipitation of carbonate cement in some of the sandstones and increases the difficulty of determining the source area for these sedimentary rocks. (Author's abstract)

GARCIA, M.O., MUENOW, D.W., and LIU, N.W.K., 1978, Volatiles in submarine rocks from the Marianas Island arc and trough (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 10, no. 7, p. 406.

High temperature mass spectrometric analyses of glasses from quenched pillow rims of andesites dredged from 1170 m water depth in the northern portion of the Marianas Island arc indicate that these samples have substantially less H_2O and more CO_2 than previously reported for volcanic arc rocks. Glass-vapor inclusions within plagioclase phenocrysts from quenched rims have CO_2/H_2O ratios of from 1:2 to 2:1. These results are similar to analyses of basaltic samples from the Marianas Trough. Generally, F and Cl contents are higher and S lower in the arc rocks compared to the samples from the trough. These results favor models for the production of island arc magmas from the subducted slab, rather than from the overlying mantle wedge because of the high volatile content needed to produce island arc magmas from peridotite (5-15 wt.%). The trough samples, although nearly identical in non-volatile composition to mid-ocean ridge rocks, have much higher H_2O, somewhat higher CO_2 and lower S contents. Either near surface addition of volatiles has enriched the magmas or H_2O must be an important component in the generation and evolution of back-arc basin lavas. (Authors' abstract)

Volatile Abundances in Glassy Rims (Wt.%)

Glasses	H_2O	CO_2	S	F	Cl
Arc	1.006	0.245	0.006	0.103	0.107
Trough	1.023	0.209	0.082	0.031	0.030
MOR	0.210	0.132	0.117	0.023	0.006

GARCIA-IGLESIAS, J., 1978, Study of fluid inclusions in the fluorite deposits of Berbes, Asturias, Spain: Bol. Geol. Min., v. 89, p. 69-83 (in Spanish).

Fluid inclusion studies by freezing and heating methods indicated that fluorite deposits in the La Cabana and Cueto del Aspa areas were of the hydrothermal type. The fluorites in the Cueto del Aspa area were deposited under a nearly const.-temp. condition, whereas the fluorites in the La Cabana area were deposited under a rising-temp. condition. Both deposits (esp. the La Cabana deposit) showed effects of mixing with petroleum fluids (C.A., 90:9198 m). (Author's abstract)

GELETY, V. F. and TCHERNYSHEV, L. V., 1977, Exchange equilibria between solid phases of PbS-CdS-ZnS system and aqueous chloride 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. 3, p. 84-85 (in Russian; abstract courtesy Dr. A. P. Berzina).

Cd distribution coefficient between galena and NH_4Cl and NaCl solutions at 300, 350 and 400°C and 1000 atm is constant, hence ideal. The limits of isomorphic galena capacity in respect to CdS are 0.87 at 300°, 1.23 at 350° and 1.55 mol% at 400°C.

ZnS solubility in galena is 0.24 and 0.14 mol% at 400° and 350°C, respectively. The assumption about ideal solution character of components at the level of microadmixtures appears to be wrong.

Cd and Zn distribution between galena and the solution are mutually independent, and phase relations in the CdS-ZnS system do not depend on galena presence. Galena and greenockite solubility are directly proportional to the mineralizer concentration.

Values of co-crystallization coefficient are only slightly sensitive to temperature changes and to composition variation of solutions, which permits using them for reconstructing the Pb, Cd and Zn concentration in natural hydrotherms from the known galena composition.

GEOTIMES, 1978, Extrusion retraced: Geotimes, v. 23, p. 22.

A brief review of the work of Moore, et al., 1977, on CO_2-rich vesicles in glassy basalts, with 4 photomicrographs, taken at low temperatures. See Fluid Inclusion Research -- Proceedings of COFFI, v. 10, p. 184, 1977. (E.R.)

GIGASHVILI, G.M., 1978, Paleothermics of katagenetic processes - new field of practical use of results of fluid inclusion studies, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. II, Thermobarogeochemistry and ore genesis: Vladivostok, Acad. Sci. USSR, p. 36-37 (in Russian). Author at Inst. Geol. Geoch. of Natural Fuels of Acad. Sci. of Ukrainian SSR, L'vov.

In Devonian carbonate oil reservoirs in the Pripyat' area, oil appeared after crystallization of katagenetic dolomite, calcite and anhydrite in vuggy carbonate rock; these minerals bear S inclusions of L hydrocarbons. The latest mineral filling vugs at 3100m depth bear P inclusions of brownish oil (Th 56-60°C); Th of P incs. in dolomite in these vugs - 100-120°C. Similar studies in L'vov and Orenburg oil-gas condensate deposits revealed that present T in the deposits are 30-70°C lower than the highest - T katagenetic stage. (From the author's abst.)

GIGASHVILI, G.M., AKHVLEDIANI, R.A., 1978, Hydrocarbon inclusions in quartzes from hydrothermal veins of the Telet Ridge (USSR), in Carbon and its compounds in endogene processes of mineral formation, G.N. Dolenko, ed.: Kiev, "Naukova Dumka" Pub. House, p. 134-139 (in Russian)

In the Telet Ridge primary inclusions cont. CO_2 and C_{1-5} hydrocarbons (mainly CH_4) occur in quartz crystals of laumontite-quartz-calcite veins cutting Eocene volcanic-sedimentary beds. The inclusions also have solid phases of carbonaceous matter. The quartz crystd. from a heterogeneous aq.-hydrocarbon fluid at temps. 70-220° and a pressure at times >200 atm. The hydrocarbon part of the fluid changed its compn. and properties in relation to the processes of filtration, disproportionation, and metamorphism at its contact with aq. solns. (Chem. Abstracts 90: 9039k)

GIGASHVILI, G.M., STUPKA, O.S., PLOTNIKOV, A.M., 1978, Migration conditions and evolution of hydrocarbon fluids (according to liquid hydrocarbon inclusions in hydrothermal minerals of the Mountainous Crimea), in Carbon and its compounds in endogene processes of mineral formation, G.N. Dolenko, ed.: Kiev, "Naukova Dumka" Pub. House, p. 121-127 (in Russian).

This is full paper corresponding to abstract given in COFFI v. 8, p. 62-63, 1975 (ER)

GITS-LÉON, Sylvie, ROBERT, Marie-Claire, and ZARKA, Albert, 1978, Growth defects induced during dissolution periods in synthetic and natural crystals: Bull. Minéral., v. 101, p. 399-402 (in French). Authors at Univ. Pierre-et-Marie-Curie, tour 16, 4, place Jussieu, 75230 Paris Cedex 05.

Growth defects in single crystals of potash alum grown with an imposed dissolution period have been examined by X-ray topography. They are compared with the growth defects of a single natural crystal of beryl and some information concerning the development of this natural crystal are then given. (Authors' abstract)

GLEBOVITSKIY, V.A., DRUGOVA, G.M. and SEDOVA, I.S., 1978, Conditions of the oldest metamorphism, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok Acad. Sci. USSR, p. 118-119 (in Russian). Authors at IGGD of Acad. Sci. of the USSR, Leningrad.

1. In the Baltic shield, Belomor'ye-Lapland zone, endogene processes during 3860 m.y. developed under slightly variable, middle and high-temperatures and usually high pressures.

2. Three groups of granitoids were distinguished, formed in the sequence:

a. Charnockites of vein material of migmatites and charnockite-gneisses formed during granitization of gneisses and crystalline schists of the granulite facies.

b. Pegmatoid charnockites forming the cross cutting veins during metamagmatic processes under higher alkali activity.

c. Magmatic hypersthene diorites (enderbites).

3. Distribution of Fe and Mg between coexisting garnets and biotites in the oldest gneiss. T were determined for 725-830°C and P for 7.5-9 kbar. Average T for two-pyroxene-garnet gneiss based on Fe and Mg distribution between garnet and clinopyroxene was 780°C. Rocks listed under 2a and 2b gave T 740-750°C by the garnet-biotite geothermometer, i.e. T of subsolidus crystallization; P is evaluated for 5-6.5 kbar.

4. Minerals of the vein migmatitic charnockites and charnockite gneiss bear following types of inclusions: crystallized melts+G(10 vol.%), H_2O + dm NaCl, L $H_2O + CO_2$, one-phase dense CO_2, L H_2O + G (10-20 vol %), the latter are S and most common, with Th 150-300°C. Th of rare melt inclusions are 750-950°C, salt-rich inclusions - 400-600°C. Pegmatoid charnockites bear the same inclusions plus crystal-fluid ones which show no changes on heating up to 750°C; at 750-800°C solids begin to dissolve, and at 800-900°C when G dissolves, inclusions decrepitate. Those types of inclusions prove the activity of melts during charnockite formation. (From the authors' abst., by A.K.)

GLUKHOV, Yu. Yu. and KUZNETSOV, A. G., 1978, Thermobarogeochemical conditions of anthracite formation from coals of the eastern Donbass, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 150 (in Russian). Authors at the Shakhta Division of the Sci.-Ind. Inst., USSR.

Coals layers of the Kamenskiy complex in the Shakhta-Nesvetaevskiy region of the Donbass bear quartz intercalations coeval with coal formation, hence the conditions of anthracite formation may be evaluated from fluid inclusion data. Samples were taken from layers K_4^2 and K_5^n. P, PS and S inclusions were filled by G, L, L>G, L>G+dms, L>dms, L >CO_2>G, CO_2>L. Composition of fluid is of Cl-Na and Cl-HCO_3-Na type (by water leachate method), of low total salt content (by cryometry). By gas analysis N_2, CO_2 and C_nH_{2n+2} hydrocarbons were found. Th was 440-470 and 490-530°C (in G phase). (Authors' abst.)

GODBEER, W.C., and WILKINS, R.W.T., 1977, The water content of a synthetic quartz: Australian CSIRO, Div. Mineralogy, v. 62, p. 831-832.

Same as in Fluid Inclusion Research -- Proceedings of COFFI, v. 10, p. 90, 1977. (E.R.)

GODOVIKOV, A.A., (ed.), 1977, Main parameters of natural processes of endogenetic ore formation, v. 3, Experimental methods of investigation of ore systems under hydrothermal conditions (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, 110 pp. (in Russian).

Those abstracts most pertinent to COFFI have been translated in this issue; less pertinent items are given by citation only. (E.R.)

GOLDMAN, D.S., ROSSMAN, G.R., and PARKIN, K.M., 1978, Channel constituents in beryl: Physics and Chemistry of Minerals, v. 3, p. 225-236.

GOMELAURI, A. I., 1978, Temperature conditions of barite formation in Georgian SSR deposits and their verification in autoclaves, in Thermobarogeochemistry of the earth's crust and ore formation, N. P. Ermakov, ed.: Moscow, "Nauka" Press, p. 127-130 (in Russian).

Barites can cryst. in nature at 220-80°. Th of fluid inclusions in synthetic barites, grown in the upper part of autoclaves, nearly coincides with true temps. (Chem. Abstracts 89: 149634e, 1978)

GONCHAROV, V. I. and KOZLOV, V. K., 1977, The influence of pH on the behavior of silver in chloride 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. 3, p. 68-69 (in Russian).

GONCHAROV, V. I., SIDOROV, A. A. and LITVIN, O. N., 1978, Characteristics of the gaseous composition of hydrothermal solutions forming deposits of volcanic origin in the northeastern USSR, in Thermobarogeochemistry of the earth's crust and ore formation, N. P. Ermakov, ed.: Moscow, "Nauka" Press, p. 167-170 (in Russian).

Detns. were made by the volumetric method of gases in fluid inclusions in minerals from volcanogenic Au-Ag deposits. In concluding stages of mineral formation the content of acid gases in solns. increased, whereas the concn. of N_2 and rare gases decreased. The O content tended to increase during ore (sulfide) formation. The inclusions which contained CO also had highly variable O and N contents, independent of the mineral-forming stages. The gas phase in the inclusions represents part of the volcanic emanations entering into hydrothermal solns. under endogenic conditions. (Chem. Abstracts 89: 166309v, 1978)

GORDEEVA, V. I., AKIMTSEV, V. A. and SURZHKO, A. S., 1978, Thermobarogeochemical conditions of beryl crystallization in apogranite, in Thermobarogeochemistry of the earth's crust and ore formation, N. P. Ermakov, ed.: Moscow, "Nauka" Press, p. 82-86 (in Russian).

Complex study of the inclusions in beryl crystals led to recognition of genetic types of inclusions: primary, of soln.-melts; secondary, of soln.-melts; and secondary fluid. Homogenization of the solid phase in the secondary soln.-melt inclusions indicated crystn. of the beryl in greisens and topaz-quartz-beryl veins from soln.-melt at 520-740°. Significant amts. of liq. CO_2 and H_2O occur in the soln.-melts. The solid phases of the inclusions do not include readily sol. salts, such as chlorides and bicarbonates of alkali elements. The max. concn. of ions, detd. from successive aq. exts. occurred at 500°. (Chem. Abstracts 89: 166248z, 1978)

GORYAINOV, I.N. and ARKHIPOVA, A.I., 1978, Nickel-bearing native iron in olivine of the Norilsk differentiated intrusions: Akad. Nauk SSSR Doklady, v. 241 no. 4, pp. 940-942 (in Russian). Authors at the Sci.-Industrial Enterprise "Sevmorgeo", Leningrad.

GOVOROV, I.N., 1978, Thermodynamics of hydrothermal equilibria and index minerals, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 21-23 (in Russian). Author at Far East Geol. Inst. of the Far East Sci. Center of Acad. Sci. of the USSR, Vladivostok.

Thermodynamic calculations based on published Th values. (AK)

GRANOVSKAYA, N.V., 1978, Fluid regime of the Dakhovskiy massif (Northern Caucasus), (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 88-89 (in Russian). Author at the Rostov State Univ., Rostov-on-Don, USSR.

The Dahovskiy massif formed in several phases which produced diorite, granodiorite, biotite granite, alaskite and plagiogranite dike series, aplites, pegmatoids. Th of melt inclusions in quartz from granitoids are 750-1200°C, P 2000-3000 atm. Essentially G two-phase inclusions, in porphyroblasts of quartz and microcline from metasomatized granites have Th 600-650°C, G/L inclusions in minerals of quartz- and barite-polymetallic veins - Th 80-160°C, P 150-400 atm.

One mm^3 of granodiorite contains 1.8×10^5 inclusions, the same volume of pegmatoid - 3×10^5 inclusions, and of metasomatites - 6×10^5 inclusions. (From the author's abst., by A.K.)

GRANOVSKII, A.G., 1978, Thermobarogeochemical criteria of the depth of polymetallic mineralization in the northern Caucasus: Izv. Sev.-Kavk.

Nauchn. Tsentra Vyssh. Shk., Ser. Estestv. Nauk, v. 6, no. 1 p. 69-73 (in Russian).

Thermobarometric study of fluid inclusions in minerals of the polymetallic deposits indicate hydrothermal mineralization at well-defined temp. and pressure intervals. The temps. and pressures were 310-60° and 500-700 atm. in the pre-ore mineral-forming stage and 140-320° and 280-460 atm in the ore stage. The paleotemp. and paleobaric gradients were 5-12° and 10-20 atm per 100 m. Ore formation occurred by sharp drop in pressure in local. structural-lithol. favorable areas; boiling of the mineralizing soln.; and pptn. of ore components. (Chem. Abstracts 90: 9140m)

GRANT, J.N., HALLS, C., AVILA, W., and AVILA, G., 1977, Igneous geology and the evolution of hydrothermal systems in some sub-volcanic tin deposits of Bolivia: Geol. Soc. of London Bull. (spec. issue) no. 7, p. 117-126. First author at Dept. Geol., Royal School of Mines, Imperial Coll., London, England.

The tin deposits of the southern part of the Cordillera Oriental of Bolivia consist of complex vein systems and pervasive disseminated mineralization within zones of strong hydrothermal alteration in, or at the margins of, eruptive centres of late Tertiary age. At some centres erosion has removed the volcanic superstructure completely and only intrusive rocks are preserved (Llallagua, San Pablo de Morococala). At others, both the intrusives and coeval volcanics are preserved (Chorolque, Oruro, Potosi), whereas in some cases only the partially eroded volcanic superstructure is exposed and no unequivocally intrusive rocks are known (Chocaya, Tatasi).

In general, the geological relationships at all these deposits suggest that the mineralization is the product of hydrothermal systems generated in the inner, deeper regions of terrestrial strato-volcanoes.

The igneous rocks most closely associated with mineralization are strongly altered quartz porphyries. Their original composition was probably rhyodacite. Where stocks are preserved, they are complex bodies, often conical in vertical section, narrowing with depth. They show evidence of several phases of intrusion, igneous brecciation and explosive hydrothermal brecciation, which pre-date the formation of the major vein systems.

Silicate alteration assemblages include quartz-tourmaline, tourmaline-sericite and sericite-clay, which often show rough concentric zonation in that order outward from the centre. An outermost aureole of propylitic alteration is sometimes present where there are remnants of the volcanic superstructure. Alteration is pervasive and not controlled by the major veins. Low-grade cassiterite mineralization is dispersed throughout the inner zones.

Fluid inclusion studies at Chorolque show that the hydrothermal system was initiated by the separation of a highly saline brine, or melt, of complex chemistry, which formed at temperatures above 500°C. The pervasive quartz-tourmaline alteration, initial fracturing of the igneous rocks of the vent and the hornfelsing of the adjacent sedimentary rocks were accomplished while temperatures fell to below 450°C and intermittent boiling took place. Widespread disseminated cassiterite was deposited during this phase. The earliest stages of growth of the major quartz-cassiterite veins took place at temperatures of around 400°C, from a fluid the composition of which was similar to that of the earliest fluid, though substantially diluted (about 40 wt% NaCl equivalent). Vein growth continued while temperatures fell to below 200°C and salinity decreased. Most cassiterite deposition seems to have taken place in the temperature range 300-250°C and may have been accompanied by a major decrease in the salinity of the fluids.

The data obtained from the fluid inclusion studies, taken in conjunction with the gross geometry of the mineralization, suggest that hydrothermal processes at the volcanic centres were initially controlled by failure of the balance between confining lithostatic pressure and the pressure of the hydrous fluid residuum in the differentiated parts of the rhyodacite magma, leading to pervasive hydraulic fracturing, brecciation and alteration, of which the early generation of cassiterite mineralization was an integral part. The upper levels of the mineralized volcanic structures appear to have stabilized following the hydrothermal exhaustion of the apical portions of the sub-volcanic stocks. The focus of hydrothermal activity must then have been relocated at greater depths from which mineralization was controlled by the interplay of tectonic stresses in the volcanic infrastructure and surrounding basement and the build-up of hydrothermal fluid pressure in parallel vein-fault systems.

This concept of a bimodal style of mineralization related to a retreating hydrothermal focus can lead to a clearer understanding of the xenothermal or "telescoped" type of mineral and temperature zonation in sub-volcanic systems. Temperature data obtained from fluid inclusion studies show, however, that mineral paragenesis is not an unambiguous criterion of temperature zonation and that the two have to be considered independently before a combined synthesis becomes meaningful. (Authors' abstract)

GREBENSHCHIKOVA, V.I., 1978, Fluid regime of pegmatite formation in Adun-Chelon granite massif, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in Geology: Vladivostok, Acad. Sci. USSR, p. 51-53 (in Russian). Author at the Gechem. Inst. of Siberian Branch of Acad. Sci. of the USSR, Irkutsk.

In the Adun-Chelon massif of Upper Jurassic age (E.Transbaikalia, ca.80km^2) about 200 pegmatitic bodies were studied. Pegmatites are mineralogically azonal quartz-feldspar veins. Zonality was found by geochemical means; it is expressed mostly in the composition of fluid inclusion fillings. Temporal changes of volatiles agrees with solubility of volatiles in melt: $CO_2 \rightarrow HCl \rightarrow H_2O \rightarrow HF$. (From the author's abst., by A.K.)

GRIB, Ye.N., 1978, Melt and gaseous inclusions in plagioclases from extrusive lavas of the Uzon-Geyzernyi region, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 93-94 (in Russian). Author at Volcanology Inst. of Far East Sci. Center of Acad. Sci. of the USSR, Petropavlovsk-Kamchatskiy.

Plagioclases in lavas contain large amounts of melt and crystallized inclusions, often with G bubble. Crystallized inclusions usually are filled with tiny acicular crystals; inclusions with distinct dms such as plagioclase, green pyroxene and magnetite in glass are rare. L is sometimes present in melt inclusions, either at room T or after cooling down to -65.5°C. At $T \leqslant 450°C$ L evaporates (homogenization $L + G \rightarrow G$). Acid effusives of the post-caldera stage bear early plagioclase with Th 1300-1340°C, which has crystallized under abyssal conditions. Outer zones of this plagioclase contain inclusions of Th 1250-1290°C. Liparite flows of extrusions: Geyzernaya and Kruglaya, bear two generations of plagioclase: Th 1240-1290 and 1140-1190°C. Crystallized inclusions in andesite-dacites of the last flow of the Geyzernaya extrusion have Th 1200-1250°C (P) and 1140-1180°C (PS). High T proves connection of acid magma with high-T source, possibly a chamber of basic magma. (Author's abst., translated by A.K.)

GROMOV, A. V. and FILIPISHIN, F. L., 1979, Temperature conditions for crystallization of postphlogopite mineral associations in Central Aldan magnesia skarns: Izv. Vyssh. Uchebn. Zaved., Geol. Razved., v. 22, no. 7, p. 52-58 (in Russian).

Five distinct post-phlogopite mineral assemblages are recognized in the skarns, including pyrrhotite, chalcopyrite, pyrite, molybdenite, epidote, calcite, actinolite, prehnite, fluorite, zeolites, datolite, chalcedony, etc. The first 4 correspond to a single hydrothermal stage of sulfide, calcite-fluorite-silicate, quartz-calcite-hematite, and zeolitic units. In the oxidn. zone, supergene minerals are formed. Data from gas-liq. inclusions show that the formation temp. varied 150-320°. (Chem. Abstracts 91: 160451e)

GROVES, D.I. and McCARTHY, T.S., 1978, Fractional crystallization and the origin of tin deposits in granitoids: Mineral. Deposita (Berlin), v. 13, p. 11-26 (in English). Authors at Dept. Geol., Univ. Witwatersrand, Johannesburg 2001, South Africa.

A comparison between tin-bearing granitoids in an anorogenic setting (Bushveld Complex) and an orogenic setting (Blue Tier Batholith, Tasmania) reveals a number of genetically important similarities. These include: in situ fractional crystallization characterised by marked decrease in Ba and Sr and increase in Rb; the accumulation of late melt in a sheet-like form near the roof zone; the association of barren pegmatites overlying the ore; and of aplites; and the occurrence of conformable tin-bearing sheets, often exhibiting greisenization. These features allow the formulation of the following genetic model. A crustally-derived granitoid magma is emplaced and undergoes fractional crystallization from the margins inwards, with bottom crystallization dominating. Disruption of earlier formed solids by rest liquid commonly occurs. Continued fractional crystallization causes enrichment in volatiles and incompatible elements in the late rest melts, which have a sheet-like habit. The efficiency of enrichment of incompatible elements is critically dependant on the degree of separation of melt from solids throughout crystallization. An early, tin-poor vapour may separate after initial water-saturation of the magma is achieved, and this collects under the roof, commonly forming an impermeable barrier to later tin-bearing fluids. Continued fractional crystallization on the floor further enriches incompatible elements, and at a very late stage a Sn-rich vapour separates within the intercumulus phase and becomes concentrated by progressive crystallization of the intercumulus melt. At a late stage of solidification, this vapour loses equilibrium with the earlier formed feldspars and greisenization ensues, accompanied by the crystallization of cassiterite and other ore minerals. The nature of the mineralization changes if through-going fractures tap the late fluids. This model predicts systematic changes in trace element geochemistry with crystallization which provide useful tools for assessing the tin potential of a granitoid, and for indicating the direction of crystallization of the magma, and hence the location of possible ore. (Authors' abstract)

GRUSHKIN, G. G. and VEDERNIKOV, P. G., 1977, The "rhyolite" association of tin-ore deposits (as in the Dzhalinda deposit): Sovets. Geologiya, 1977, no. 8, p. 98-106 (in Russian; translated in Intern. Geol. Review, 1978, v. 20, no. 9, p. 1059-1066).

Td on quartz listed as 280°.(ER)

GUILHAUMOU, Nicole, DHAMELINCOURT, Paul, TOURAY, J.-C., and BARBILLAT, Jacques, 1978, Raman microprobe analyses of gaseous inclusions in the system N_2-CO_2: C.R. Acad. Sci. Paris, v. 287, Series D, p. 1317-1319 (in French).

Studies of gas inclusions in dolomite and quartz from Tunisian diapirs indicate fossil fluids, of variable composition, in the system N_2-CO_2. Some liquid hydrocarbons were also found. (E.R.)

GUNTER, B.D., 1978, C_1-C_4 hydrocarbons in hydrothermal gases: Geoch. et Cosmoc. Acta, v. 42, p. 137-139. Author at Dept. Chem., Southwestern Oklahoma State Univ., Weatherford, OK 73096, U.S.A.

Twenty-two gas samples from Yellowstone National Park have been analyzed for C_1-C_4 hydrocarbons. All five alkanes in the sequence were identified, two alkenes were identified, and no alkynes were observed. The molecular species present in those samples and the quantitative distribution of those species seems more consistent with an organic origin (e.g., the thermal degradation of kerogen, etc.) for the hydrothermal gases than with the non-biological production of methane ($CO_2 + 4H_2 = CH_4 + 2H_2O$) followed by pyrolysis. The latter possibility cannot be completely eliminated, however, since the conditions of reaction are not well known. (Author's abstract)

GUPTA, A.K., 1978, Solubility of AgCl in NaCl-bearing solutions at 250°C and 400°C under different pressures: Jour. Fac. Sci., Hokkaido Univ., Ser. IV, v. 18, no. 3, Mar., p. 445-448 (in English). Author at Dept. Geol. and Min., Fac. of Sci., Hokkaido Univ.

Solubility measurements of AgCl in NaCl-bearing solutions at different temperatures and pressures show that with the increase of temperature, pressure and NaCl concentration the solubility also increases. The results show that at 250°C and 50 bar the solubility of AgCl in a 2 molar solution is 4.55% whereas in a 1.5 molar solution it can be as high as 25% at 400°C and 1120 bar. The study suggests that silver can be transported as silver-chlorine complexes by ore-bearing fluids. (Author's abstract)

GURNEY, J.J., HARRIS, J.W., HAWTHORNE, J.B., RICKARD, R.S., 1978, Inclusions in southern African diamonds (abst.): XI General Meeting of International Mineralogical Association, Abstracts, v. 2, p. 15 (in English).

The association of the extremely refractory peridotitic inclusions with diamond can be possibly explained by consideration of the effects of a small degree of CO_2/H_2O induced low temperature melting of mantle peridotite, whilst the eclogitic diamond inclusions may be formed in a small volume late stage differentiated liquid which has evolved from a larger partial melt towards water and CO_2 saturated compositions by eclogite accumulation. (From the authors' abstract)

GUSEL'NIKOV, V. N., 1978, Thermobarometric and petrographic zoning of the Precambrian paleovocanos of the Kursk Magnetic Anomaly, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 133-134 (in Russian). Author at Sci. Research Inst. of the Kursk Magnetic Anomaly, Zheleznagorsk, USSR.

In the area of the Mikhaylovsko-Kurbakinskiy paleovolcano in the Kursk Magnetic anomaly, volcanogenic-chemogenic taconites have the lowest Td 340-400°C (P 0.4-1.4 kbar), effusive jaspilites - the highest Td 580-850°C (P 2.4-4.2 kbar), and volcanogenic-hydrothermal itabirites - moderate Td 450-620°C (P 1.1-2.9 kbar). The Td values decrease from bottom to the roof of the jaspilite complex over an interval of 100-250°C. (From the author's abst.)

GUSTAFSON, L.B., and TITLEY, S.R., 1978, Preface to: Porphyry copper deposits of the southwestern Pacific islands and Australia: Econ. Geol., v. 73, p. 597-599.

This issue contains 27 articles on porphyry copper deposits; those having inclusion data are abstracted in the present volume. (E.R.)

HAAPALA, I.,1978, Fluid inclusion studies in apatite from the Solki carbonatite, northeastern Finland, (abst.), in International Assoc. Genesis Ore Deposits, 5th Symp., Snowbird, Alta, Utah, 1978, Program and Abstracts: (Alta, Utah), p. 94.

The Sokli carbonatite complex (age 360 Ma) consisting of sovites and phoscorites is surrounded by a wide fenite aureole. The intrusion represents either a relatively deep section through a volcanic plug, or a plutonic intrusion. Both magmatic and metasomatic processes have affected the evolution of the complex (Vartiainen and Woolley 1974 and 1976).

Apatite of the carbonatite contains two main types of primary inclusions:

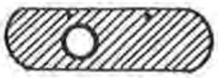
1) Multiphase inclusions consist mainly (about 70 vol-%) of daughter minerals (most of them anisotropic, also some opaques), but contain also a small amount of aqueous solution and gas. These inclusions presumably represent trapped carbonate - rich melt.
2) Aqueous inclusions consist of an aqueous solution (freezing temperature -15°C to -21°C), a small gas bubble and two minute opaque specks. An anisotropic daughter mineral (probably carbonate) and/or halite are present in many inclusions of some samples. Freezing experiments suggest the presence of CO_2 in the gas bubbles of some inclusions.

Inclusions with liquid CO_2, inclusions intermediate between types 1 and 2, and single-phase inclusions are occasionally present. Solid carbonate inclusions are not rare.

When heated, most of the daughter minerals of type-1 inclusions dissolve between 500° and 550°C, but the inclusions burst between 550 and 620°C, before the last daughter crystals are dissolved. Type -2 inclusions in sovites usually give filling temperatures around 200°C, but the opaques do not dissolve at this temperature.

The occurrence of apparently primary inclusions of type 1 and type 2 side by side in one and the same apatite crystal in some samples of unaltered sovite suggest that the inclusions represent carbonatite melt (type 1) and co-existing aqueous fluid (Type 2), but the evidence is not unambiguous.(Author's abstract)

Type 1



Type 2

HAAS, J.L., Jr., and POTTER, R.W., II, 1978, The measurement and evaluation of PVTX properties of geothermal brines and the derived thermodynamic properties: Proc., Seventh Symp. Thermophysical Properties, Am. Soc. Mech. Eng., New York, 1977, 604-614.

HAGNI, R.D., 1978, Ore microscopy and fluid inclusion geothermometry of ore and gangue minerals from the Viburnum Trend, Missouri (abst.), in International Assoc. Genesis Ore Deposits, 5th Symp., Snowbird, Alta, Utah, 1978, Program and Abstracts: (Alta, Utah), p. 95.

The Viburnum Trend ore deposits in southeast Missouri are comprised principally of the minerals dolomite, pyrite, marcasite, galena, sphalerite, chalcopyrite, calcite, and quartz. Minor minerals observed primarily by ore microscopic means include: analite, arsenopyrite, bornite, covellite, digenite, djurleite, fletcherite, gersdorffite, millerite, siegenite, polydymite, pyrrhotite, tennantite, vaesite. The ore minerals were deposited as massive bedded replacements, disseminated replacements, botryoidal replacements and fracture fillings, and crystal coatings of vugs and fractures. The major sulfide minerals were deposited in the general sequence: pyrite, chalcopyrite, sphalerite, marcasite and galena. Early deposited galena is dominated by the octahedral form, and the youngest galena is predominantly of cubic habit. Quartz deposition occurred at about the time of cubic galena deposition. Calcite was deposited subsequent to most sulfide deposition. Repeated and overlapping deposition of all the sulfide minerals is a common feature of the Viburnum ores. Period(s) of leaching occur late in the paragenetic sequence.

Measurements of homogenization temperatures for fluid inclusions in Viburnum Trend ores have shown that the largest sphalerite crystals exhibit a range from 131 to 104° C, with the highest temperatured in the core and the lowest temperatures at the edges. Subsequently deposited quartz formed at temperatures from 110-71° C. Calcite, the last major mineral to be deposited, was formed at temperatures from 84° C. The general pattern is that of declining temperature with the passage of time. (Author's abstract)

HALL, W.E., RYE, R.O., and DOE, B.R., 1978, Wood River mining district, Idaho-intrusion-related lead-silver deposits derived from country rock source: Jour. Research U.S. Geol. Survey, v. 6, p. 579-592. First author at U.S.G.S., Menlo Park, Calif.

Lead-silver deposits in the Wood River mining district occur in shear zones in hornfelsed argillite of the Devonian Milligen Formation near granitic plutons and under the Wood River thrust fault. The principal ore minerals are argentiferous galena and sphalerite; siderite is the principal gangue. The δ^{34}S values of the sulfide minerals range from +2.2 to +15.0 permil, indicating that the sulfur had a shallow crustal source. Δ^{34}S values between sphalerite and galena range from +2.3 to +3.4 permil, corresponding to sulfur isotope temperatures between 280° and 182°C. Hydrothermal barite has a $\delta^{34}S$ of +13.2 permil. Lead isotope ratios are radiogenic, also pointing to a shallow crustal source. Quartz gangue has $\delta^{18}O$ of +16.4 permil and a calculated $\delta^{18}O_{H_2O}$ at 270°C of +8.4 permil. This value is reasonable for a hydrothermal fluid that had reached equilibrium with the argillite country rock. The siderite gangue has $\delta^{18}O$ and $\delta^{13}C$ values of +14.0 and -5.5 permil, respectively. Fluid inclusions have homogenization temperatures of 244°-307°C and average 270°C. Freezing-stage measurements ranged from -1.85 to -2.8°C, suggesting salinities of 3.2 to 4.8 weight percent. The δD values of inclusion fluid in ore and gangue minerals are -110 to -120 permil. The geology, isotope, and fluid-inclusion data are consistent with a model of hydrothermal systems of meteoric water in faulted and shattered Paleozoic rocks near plutonic masses. This environment permitted deep circulation of the hydrothermal fluids, which dissolved the metals and sulfur from the Paleozoic host rocks and deposited ore in favorable beds or structures under the regional Wood River thrust fault. (Authors' abstract)

HAMANN, R.J., and ANDERSON, G.M., 1978, Solubility of galena in sulfur-rich NaCl solutions: Econ. Geol., v. 73, p. 96-100.

Galena has been found to be relatively insoluble (<1 ppm) in reduced, sulfur-rich (up to 3 molal) solutions over pH range 4-13 at temperatures of 25-90°C at one atm., so bisulfide or sulfide complexes are very unlikely in this range. (E.R.)

HARDIE, Lawrence A., 1978, Evaporites, rifting and the role of $CaCl_2$ hydrothermal brines (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 10, p. 416.

Rift and block-fault valleys are ideal sites for the deposition of evaporites. They not only provide the necessary hydrologic closure but form orographic deserts that impose a local arid climate independent of latitude. Modern evaporites in such settings are found from the equator to the high temperature zones. An additional spectacular feature of some modern rifts are $CaCl_2$-rich, SO_4-poor hydrothermal brines, some rich in heavy metals such as Pb, Zn, Fe, Mn. These upwelling brines appear to be a special product of rifts, formed by interaction of deep circulating groundwaters (marine or non-marine) with bedrock at greenschist temperatures (Hardie, 1976). Such hydrothermal brines that reach the surface as springs (either undiluted or mixed with shallow groundwaters or surface waters) may be the principal source of the unusual $CaCl_2$ saline lake waters, and their precipitated salt deposits, in the Dead Sea, the Salton Sea, Bristol Dry Lake, etc. The idea can be extended to explain the odd SO_4-free tachyhydrite ($CaMg_2Cl_6.12H_2O$)-bearing Aptian salt deposits of the Cretaceous grabens along the Atlantic coasts of Brazil and West Africa. That these Aptian salts are "rift valley hydrothermal evaporites" is supported by their tectonic and stratigraphic setting, their unusual composition and the presence in associated "failed rift arms" of Cretaceous Pb-Zn hydrothermal veins. Other puzzling SO_4-free "marine" evaporites, such as the Tertiary potash deposits of the Rhine Graben, may have a similar origin. (Author's abstract)

HARMON, R.S., 1978, Variations in the D/H ratio of meteoric water in the East Central United States during the past 250,000 years (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 10, no. 7, p. 416.

The hydrogen isotopic composition of ancient meteoric waters can be estimated from measurements of the D/H ratios of fluid inclusion waters extracted from $^{230}Th/^{234}U$ dated speleothems that were originally deposited under conditions of isotopic equilibrium. Analysis of 44 fluid inclusion samples from 10 speleothems collected at cave sites in Iowa, West Virginia, Kentucky, and Missouri indicates that over the past 250,000 years, the deuterium content of meteoric waters in the east-central United States has differed from modern values by no more than about 25%. Ancient glacial-age waters are observed to be depleted in deuterium relative to interglacial-age waters at each site, glacial-age precipitation averaging about 10% lighter than interglacial-age precipitation. This isotopic shift can be explained in terms of an increased ocean-continent temperature gradient during glacial times which more than compensated for the increase in deuterium content of the world ocean. (Author's abstract)

HARMON, R.S., SCHWARCZ, H.P., and ALEY, T., 1978, Isotopic studies of speleothems from a cave in southern Missouri, U.S.A.: U.S. Geol. Survey Open File Report 78-701 (Short Papers Int. Conf. Geochronol. Cosmochronol. and Isotope Geol., 4th), p. 165-167. First author at Isotope Geol., United Scottish Univ. Research and Reactor Centre, East Kilbride, Scotland.

Radioactive disequilibrium age dets. and O and C isotopic anlayses of stalagmites, etc., and D/H dets. on fluid inclusions in calcite were made. The latter gave unreasonable apparent temperatures (down to -8°C), which are explained on the basis of a shift in the D/H ratio of the original waters. (E.R.)

HASELTON, H.T., Jr., SHARP, W.E., and NEWTON, R.C., 1978, CO_2 fugacity at high temperatures and pressures from experimental decarbonation reactions: Geophysical Research Letters, v. 5, p. 753-756. First author at Dept. Geophys. Sci., Univ. Chic., Chicago, Illinois 60637.

The presence of CO_2 in the upper mantle has been inferred from several sources of evidence. To aid the understanding of the behavior of CO_2 at high pressures and temperatures, CO_2 fugacities have been deduced from the following decarbonation reactions: $MgCO_3 + SiO_2 = MgSiO_3 + CO_2$, $MgCO_3 + MgSiO_3 = Mg_2SiO_4 + CO_2$, $MgCO_3 + TiO_2 = MgTiO_3 + CO_2$, and $CaCO_3 + SiO_2 = CaSiO_3 + CO_2$. The deduced fugacities indicate that CO_2 is more compressible at high pressures than previously predicted. This discrepancy could cause serious errors in the calculation of stabilities of mineral assemblages under upper mantle conditions. (From the authors' abstract)

HATTORI, Keiko, MUEHLENBACHS, K., and MORTON, R. D., 1978, Oxygen isotope geochemistry of uraninites (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 10, p. 417.

A preliminary series of $\delta^{18}O$ data for uraninites and associated phases has been obtained. $\delta^{18}O$ values of uraninites are the lowest yet observed in terrestrial minerals; being as low as -30‰ (SMOW: α H_2O-CO_2 = 1.0407). Absolute $\delta^{18}O$ values for the uraninites are constantly lower than reported by Hoekstra and Kata (1956); (due to errors in their working standards). Clayton (Univ. of Chicago) found ^{18}O, ^{17}O and ^{16}O values of uraninite from the Oklo core zone to infer that low $^{18}O/^{16}O$ ratios of uraninites are not due to neutron-isotope interactions.

Silicates and carbonates in vein- and metavolcanic hosted-deposits examined have high $\delta^{18}O$ values. Calcites, quartz and uraninite from the vein-type deposit of the Martin Lake mine, N. Sask. have $\delta^{18}O$ values of +16.8, +19.1 and -30‰ respectively. In the Cardiff mine, Ontario, the $\delta^{18}O$ values of calcite, epidote, biotite and uraninite are +16.6, +14.2, +14.4 and -27‰. In the metavolcanic hosted Kitts deposit, Labrador the $\delta^{18}O$ of calcite is +10‰, quartz + Kfeldspar +16‰, magnetite -2.0‰ and uraninite - 24‰. The results suggest ore fluids enriched in ^{18}O. As the minerals have not attained isotopic equilibrium, neither the $\delta^{18}O$ of the fluids nor the temperature of formation may be computed. However, the $\delta^{18}O$ of aqueous fluid from inclusions in fluorites of the Cardiff mine was +3.8‰, precluding genetic involvement of low- ^{18}O surficial waters; but the large mineral-water fractionation implies a low temperature of formation (100-200°C). The preliminary nature of results do not permit the solution of whether depleted $\delta^{18}O$ values in uraninites are due to large isotopic fractionation factors, or to later equilibration with low ^{18}O waters.

Silicates from granitoid-hosted uraninite occurrences in N. Sask. exhibit "normal igneous" $\delta^{18}O$ (quartz - 10‰, biotite - 4.5‰) i.e. inferring high temperatures and no meteoric contributions. (Authors' abstract)

HATTORI, K. and SAKAI, H., 1978, D/H and O-18/O-16 ratios of ore fluids for the Neogene vein-type and Kuroko mineralizations of Japan and their implications (abst.), in International Assoc. Genesis Ore Deposits, 5th Symp., Snowbird, Alta, Utah, 1978, Program and Abstracts: (Alta, Utah), p. 97.

The Neogene vein-type mineralization is generally found in the Tertiary submarine volcanics and pyroclastics which also are the host rocks for the Kuroko mineralization. Coupled with this, geological, mineralogical and chemical similarities led to the currently most widely accepted view that the vein-type mineralization took place contemporaneously and under the similar submarine environments to the Kuroko ore deposits. In order to test this view, fluid inclusions were extracted from quartz, chalcopyrite, sphalerite and calcite of these ore deposits and measured for the D/H ratios. The O-18/O-16 ratios of ore fluid were estimated from those of quartz, the filling temperature and the fractionation factor between quartz and water. Major ore deposits of Japan (seven Au-Ag vein-type, nine Cu-Pb-Zn vein-type and six Kuroko ore deposits) were studied, the localities of which cover a full range of the north-south span of the Japanese Islands.

The D/H ratios of fluid inclusions from the vein-type ore deposits range from -40 to -70 ‰ relative to S.M.O.W. A strong parallelism exists between the D/H ratios of fluid inclusions from the Au-Ag vein-type deposits and their respective meteoric waters. A similar, though weaker, correlation also is found between late stage mineralization of the Cu-Pb-Zn vein-type deposits and local meteoric waters. These results and a model calculation based on a rock-water interaction model which takes into account hydration reaction of original rocks, strongly indicate that the ore fluids for the vein-type mineralization were essentially meteoric in origin. On the other hand, the D/H ratios of the Kuroko ore depisits from the Northeast Honshu are confined within -10 to -30 ‰ and can be interpreted as mixtures of sea water and local meteoric waters.

Major implications of the present results are, among others, that the vein-type mineralization occurred under terrestrial environment and thus, their ages of mineralization must be younger than the Kuroko mineralization, probably in the upper Miocene to the lower Pliocene, and that the ore constituents of the vein-type deposits must have come from the Tertiary country rocks. Many similarities in the isotopic compositions of sulfur and lead and chemistry between the Kuroko and the vein-type deposits can be explained on the basis of the present view. (Authors' abstract)

HELGESON, H.C., 1978, Theoretical calculation of the thermodynamics of equilibrium and mass transfer among minerals and aqueous solutions at high pressures and temperatures (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 10, no. 7, p. 418-419.

Correlation of research progress in theoretical geochemistry over the past decade permits calculation of equilibrium constants, activity coefficients, kinetic parameters, entropies, enthalpies, and heat capacities of reaction, and mineral and fluid compositions for a wide variety of geochemical processes at pressures and temperatures to 5 kb and 600°C. Extrapolation to higher pressures and temperatures affords estimation of reaction rates and mineral solubilities in fluids liberated by dehydration/decarbonation reactions in the upper mantle. The calculations include explicit provision for long and short-range interaction as well as electrostriction collapse and solvation of aqueous species, compositional variation and displacive and substitutional order/disorder in minerals, and nonideal mixing of gas components in hydrothermal fluids. Coupling the composite set of equations and thermodynamic data employed in the calculations with remote interactive numerical and graphic computer techniques facilitates rapid and comprehensive thermodynamic analysis of complex phase relations in multicomponent systems, which can be represented accurately on two-dimensional activity diagrams. Multiple generation of such diagrams on graphic display terminals affords a comprehensive topographic framework for guiding experimental studies or mapping phase relations observed in the field on chemical potential coordinates. Because these coordinates can be correlated with their geographic counterparts, the approach enhances considerably detection of spatial and temporal trends in temperature, pressure, and fluid composition, and affords a means to discriminate quantitatively among casual and dependent variables in geochemical processes. (Author's abstract)

HENLEY, R.W., and McNABB, Alex, 1978, Magmatic vapor plumes and groundwater interaction in porphyry copper emplacement: Econ. Geol., v. 73, p. 1-20.

Porphyry copper deposits, all showing similar geological characteristics, occur in Tertiary and older orogenic-volcanic belts around the world. Recent isotope and fluid inclusion studies have shown that in a number of deposits the development of the characteristic ore alteration pattern, at some stage, involved the interaction of meteoric ground waters with saline fluids evolved from a magma. A fluid dynamic model is proposed for porphyry copper emplacement which focuses on the interaction of a buoyant low-salinity magmatic plume with surrounding ground water. As the magmatic vapor rises and cools, high-salinity liquid condenses in a two-phase plume core, drains under gravity, and is diverted to vertical lower salinity stream lines tangential to the two-phase core boundary. Cool ground water is entrained into the rising fluid, giving rise to a buoyant dispersion plume. The potassic core and inner part of the phyllic alteration envelope of the porphyry copper system is regarded, in compliance with isotopic data, as the remnant imprint of the plume on the ground-water regime.

Although the model may be modified to a ground-water source for the "magmatic fluid," the authors favor an orthomagmatic hypothesis by which water and essential ore components are derived from a cooling magma column convecting lighter, more volatile components from a deeper level. The temperature profile of the steady-state plume is calculated using empirical data for permeability and heat input from the active Wairakei and Broadlands geothermal systems. Chemical implications of the physical model are in accord with the observed alteration-mineralization patterns and available high-temperature solubility data. Metals enter the system as hydroxyl or chloride complexes in the low-salinity magmatic gas precipitating in response to ground-water entrainment, temperature, and wall-rock induced pH and fO_2 variations. Some transport analogies are tentatively drawn with the observed chemistry of volcanic gases.

The plume model also provides an interpretation of the characteristics of the deep portion of active geothermal systems and may be extended to other ore-forming systems such as epithermal veins and massive sulfides. In the majority of such hydrothermal systems, if ore formation occurred below around 350°C, the magmatic input may be marked by the then predominant entrained ground-water component. (Authors' abstract)

HENLEY, R.W. and SHEPPARD, D.S., 1977, Hydrothermal activity and hydrothermal chemistry in the metamorphic environment: Geochemistry 1977, N.Z.D.S.I.R. Bull 218, p. 84-94. Authors at Dept. of Geol. and Chem., Univ. of Otago.

Petrological evidence is reviewed in support of the presence of an aqueous fluid as a discrete phase in rocks undergoing progressive regional metamorphism. Hydraulic fracturing may be an important mechanism for water migration in metamorphic environments and under some conditions may cause sufficient fracture permeability for substantial convective heat and mass transfer to occur.

Fluid inclusion studies indicate that, in general, a metamorphic fluid phase would contain of the order of 8 weight per cent dissolved solids from dissolution alone, and higher salinities could occur if a significant proportion of connate fluid were present. Chloride ion concentrations of around 1 molal are considered likely, while alkali ion and silica contents are buffered by the coexisting whole rock mineral assemblage, in accordance with Gibbs' Phase Rule.

The stability of a metamorphic assemblage may be considered as a set of coupled ionic equilibria, with the stability field of each mineral phase expressed as a function of the composition of the fluid phase at specified pressure and temperature. Where closed system conditions are approached, the fluid phase composition and the mineral assemblage are interdependent, but under open system conditions the fluid composition is externally controlled and metasomatic assemblages may develop, governed by the same set of ionic equilibria. As an example the solution chemistry of the system $CaO-Al_2O_3-SiO_3-H_2O-HCl$ is considered with some preliminary experimental data. Geological applications are discussed, particularly where exemplified by New Zealand rocks. (Authors' abstract)

HERR, F.L., Jr., and HELZ, G.R., 1978, On the possibility of bisulfide ion-pairs in natural brines and hydrothermal solutions: Economic Geology, v. 73, p. 73-81.

HING, T.T. and KWAK, T.A.P., 1978, Fluid inclusions in skarn deposits, in Notes for Workshop on Fluid Inclusions: Melbourne, Dept. Geology, La Trobe Univ. (unpaginated, mimeographed).

A 25-page review (mainly figures) of work given in detail in a forthcoming (1979) PhD dissertation by Hing, on the King Island scheelite deposit. (E.R.)

HINKLE, M.E., DENTON, E.H., BIGELOW, R.C., and TURNER, R.L., 1978, Helium in soil gases of the Roosevelt Hot Springs Known Geothermal Resource Area, Beaver County, Utah: Jour. Research U.S. Geol. Survey, v. 6, p. 563-576.

HINKLE, M.E., and HARMS, T.F., 1978, CS_2 and COS in soil gases of the Roosevelt Hot Springs Known Geothermal Resource Area, Beaver County, Utah: Jour. Research U.S. Geol. Survey, v. 6, p. 571-578. Authors at USGS, Denver, Colo.

HODENBERG, R. and STRUENSEE, G., 1978, $FeCl_2 \cdot 2H_2O$, A new salt mineral, (abst.): XI General Meeting of International Mineralogical Association, Novosibirsk, Abstracts, v. 2, p. 149 (in English).

The new mineral, named rokühnite, occurs as thin greenish plates or fibers in rinneite and carnallite in a potash mine. (This phase has previously been described as a dm.-E.R.)

HOEFS, J., 1978, Some peculiarities in the carbon isotope composition of "juvenile" carbon, p. 181-186 in Stable Isotopes in the Earth Sciences, Robinson, B. W., ed., Wellington, New Zealand, DSIR.

HOEVE, Jan and SIBBALD, T.I.I., 1978, On the genesis of Rabbit Lake and other unconformity-type uranium deposits in northern Saskatchewan, Canada: Econ. Geol., v. 73, p. 1450-1473.

Reviews (p. 1467) various data from inclusion studies, mainly by Pagel. (E.R.)

HOLLAND, R.A.G., BRAY, C.J., and SPOONER, E.T.C., 1978, A method for preparing doubly polished thin sections suitable for microthermometric examination of fluid inclusions: Mineralogical Magazine, v. 42, p. 407-408.

HOLLISTER, L.S., 1978, Physical conditions during uplift of metamorphic terranes, as recorded by fluid inclusions, in Société Francaise de Minéralogie et Cristallographie, Colloque "Mineraux et Minerais", Nancy, 26-29 Sept., 1978--Programme et Résumés des Communications: (Nancy), p. 45-46. Author at Dept. of Geol. and Geophys. Sci., Princeton Univ., Princeton, NJ, USA, 08540.

Constraints on the interpretation of fluid inclusions in quartz in metamorphic rocks include (1) the frequency and range of compositions and densities of the fluid inclusions, (2) the interpretation of the entrapment sequence of distinct compositional and/or density groups, and (3) pressure and fugacity of oxygen at maximum metamorphic temperature as inferred from the mineral assemblages and compositions of coexisting minerals. Because most, if not all, fluid inclusions in metamorphic rocks are secondary, one may consider that conditions of final entrapment of each inclusion occurred during uplift and cooling of the metamorphic rocks. Entrapment, or reintrapment, of a fluid would occur either as a result of tectonically-induced fractures filled by the ambient fluid, or by micro-hydrofracturing (autodecrepitation) by expansion of earlier entrapped fluids.

There are two additional constraints which permit using fluid inclusion data as monitors of uplift paths of metamorphic rocks. The first is the tensile strength of quartz (1-2 kb). Any fluid inclusion of given density cannot have existed in a rock at a lithostatic pressure more than 1-2 kb less than the pressure along the isochore for that inclusion. The second additional constraint is the temperature of immiscible separation of $CO_2 + H_2O$. For example, a fluid inclusion with a CO_2-H_2O mixture (e.g., $X_{CO_2} = 0.4$) must have been entrapped at a temperature above the top of the $CO_2 + H_2O$ solvus. Measurements on relatively low density $CO_2 + H_2O$ inclusions containing salts show that the temperature of this solvus can exceed 380°C. Higher temperatures are probable, but decrepitation occurs in most inclusions before homogenization, especially for those inclusions with high densities, which are typically the ones most likely to have formed nearest peak metamorphic conditions.

We have applied the above five constraints towards unravelling the P-T conditions during uplift of five metamorphic localities, four of which have been studied in our laboratories (Table). In all five localities, the densest inclusions of any composition are relatively more primary than the less dense inclusions. This implies an uplift P-T path convex towards the temperature axis. In localities (2), (4), and (5), isochores for the densest, most primary inclusions pass through the estimated metamorphic conditions. For the higher pressure localities (1) and (3), the isochores for the most primary inclusions pass 2-3 kb below metamorphic conditions. For these localities, at least this much uplift must have occurred prior to significant drop of temperature. For the other localities, the uplift P-T path had to drop to pressures below the isochores which pass through the metamorphic conditions in order to account for the later, lower density inclusions, but they could not have passed more than 2 kb below these isochores. For localities (1), (2), (4), and (5), abundant low density, pure CO_2 inclusions in each imply geothermal gradients of about 40, 25, 85, and 70°C/km, respectively, at some stage during uplift. This was probably after the rocks had cooled below the top of the CO_2-H_2O solvus (at least 380°C). For locality (3), abundant low density inclusions are $CO_2 + H_2O$ mixtures (0.8 gm/cc at $X_{CO_2} = 0.3$), implying it was on a geothermal gradient of about 40° C/km before it cooled below 380°C.

In conclusion, our review of the data strongly suggests that uplift pressure-temperature paths of metamorphic localities may be deduced from combined studies of fluid inclusions and metamorphic mineral equilibria. In addition, K-Ar, Rb-Sr, and fission track dating methods on samples from locality (4) by Armstrong and coworkers gives a rate of cooling which, when combined with our data, results in a determination of the rate of uplift. (Author's abstract)

Table

			Meta. Cond.		Densest inclusions in gm/cc		
	Locality	Reference	P(kb)	T(°C)	CO_2	H_2O	$CO_2+H_2O(X_{CO_2})$
1	British Columbia	Crawford, *et al*(ms)	9.5-10.5	600-635	1.10	1.13	-
2	Appalachians (Vt.)	Rich (1975)	4-5	400-500	1.05	0.9	0.92(.3)
3	Adirondacks (N.Y.)	Henry (1978)	6.5-9	750-800	-	-	0.89(.5)
4	British Columbia	Hollister & Burruss (1976)	4.5-5.5	775-800	0.88	-	0.91(.4)
5	Appalachians (Maine)	Burruss (1977)	3-4	630-700	0.90	-	0.81(.4)

HOLLISTER, L.S., and CRAWFORD, M.L., 1977, Melt immiscibility in Apollo 15 KREEP: Origin of Fe-rich mare basalts: Proc. Lunar Sci. Conf. 8th, p. 2419-2432.

We describe the chemistry and occurrence of immiscible silicate liquids in two KREEP-rich Apollo 15 basalts. The two samples have different cooling histories but the same composition. With fractionation, TiO_2, P_2O_5, and FeO/MgO increase in the Fe-rich immiscible melts. The earliest Fe-rich immiscible melts are chemically similar to the average compositions of several groups of Fe-rich Apollo 12 and 15 mare basalts. It is suggested that silicate liquid immiscibility may play an important role in the formation of the source regions of Fe-rich mare basalts. (From the authors' abstract)

HORN, E.E. and AMSTUTZ, G.C., 1978, Fluid inclusions in fluorites of the Crystal mine, Illinois, U.S.A.: N. Jb. Miner. Mh., v., 1978, no. 7, p. 289-297.

Fluid inclusions of various generations which formed during the diagenetic crystallization differentiation process are investigated. The related features resulting during diagenesis are well displayed in the fluorite rhythms and other features of Southern Illinois. Early-formed fluorites give temperatures ranging from 100 to 115°C, in some samples up to 140°C. Younger fluorite generations formed at higher temperatures (130 to 150°C). The freezing values for the inclusions range from -19.5 to -14.5°C, and -9.0 to -5.5°C and correspond to NaCl solutions of 22.4 to 18.6 wt.% and 12.9 to 8.5 wt.%, respectively. (Authors' abstract)

HUMPHRIS, S.E., and THOMPSON, Geoffrey, 1978, Hydrothermal alteration of oceanic basalts by seawater: Geochim. Cosmo. Acta, v. 42, p. 107-125.

IKORSKII, S. V., GAVRILENKO, B. V. and DANI, A. D., 1978, Study of the gases in the quartz veins of the Kola Peninsula: Teor. Prakt. Termobarogeokhim., (Dokl. Vses. Soveshch.) 5th 1976, N. P. Ermakov, ed.: Moscow, Izd. Nauka, p. 202-205 (in Russian).

Productive hydrothermal quartz (Q) veins from the Kola Peninsula had gas content 1.1-8.8 cm^3/kg. The principal components are

H_2, CO_2, and CH_4. Heavy hydrocarbon gases (C_{2-5}) are present in very small amt. The same gas components were present in ore-free Q veins but the gas content was 50-80 cm^3/kg, mainly because of higher CO_2 content. The CH_4/C_2H_6, CO_2/CH_4, and other ratios of gas components differed for the 2 types of Q veins. (Chem. Abstracts 91: 60363j, 1979)

IRVING, A.J., 1978, A review of experimental studies of crystal liquid trace element partitioning: Geochim. Cosmo. Acta v. 42, p. 743-770.

IVANOV, A.A., VALYASHKO, V.M., 1977, Electroconductivity of concentrated aqueous solutions of electrolyte at elevated T and P (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. 3, p. 24 (in Russian).

IVANOVA, G.F., MOTORINA, Z.M., and NAUMOV, V.B., 1977, Features of the formation of mineral associations of the Mo-W deposits of Yugodzyr, MNR: Geol. Rudnykh Mestor., 1977, no. 3, p. 26-36 (in Russian).

Essentially the full paper covered by abstract in COFFI, vol. 10, p. 110. (E.R.)

IVANOVA, G. F., MOTORINA, Z. M., and NAUMOV, V. B., 1978(?), Formation features of the mineral associations of the Yugodzyr' molybdenum-tungsten deposit (Mongolia): Akad. Nauk SSSR, Geol. Rudn. Mestor., v. 19, no. 3, p. 26-36 (in Russian; translated in Intern. Geol. Review, 1978, v. 20, no. 7, 1978, p. 855-863). Original date of publication not given.

Includes an extensive paragenetic diagram of the mineralogy of the 8 stages, with a Th value attached for each zone, from early 390°C to late 100°C. Boiling was common. Th values for quartz, fluorite, beryl, ankerite, rhodochrosite, and topaz are given. (ER)

JACKSON, N.J., 1977, The geology and mineralization of the St. Just district, with particular reference to Levant mine: Ph.D. thesis, Univ. of London; abstract published by Inst. Mining and Metal., Trans., Sect. B, v. 90, p. 135, 1981.

An attempt is made to integrate field and laboratory (geochemistry, petrology and fluid inclusion) studies, to produce a model for the development of hydrothermal activity in the St. Just district.

The surface geology between Botallack and Levant mine and the subsurface geology of Levant mine are described. The field data are presented on three maps (volume 2).

New chemical and mineralogical data are presented for samples of thermally metamorphosed and metasomatized basalts and pelites, and hydrothermally altered pelites, basalts, and granites.

The results of a fluid inclusion study of several paragenetically significant ore-gangue samples are also presented.

The last section of the thesis comprises a review of the inclusion data for southwest England, the presentation of new inclusion data for several specific mineral deposits from the province, and a discussion of the nature of the Cornubian batholithic hydrothermal system. (Author's abstract)

JANSHIN, A.L., and ZHARKOV, M.A., eds., 1977, Problems of salt deposition, Volumes 1 and 2: Novosibirsk, "Nauka" Publishing House, Siberian Branch (in Russian).

These volumes contain the papers submitted to the All-Union Meeting "Physico-Chemical and paleogeographical problems of salt accumulation and formation of deposits of potassium salts," Novosibirsk, June 3-June 6, 1974. Consists of many individual short papers, by various authors, under the following headings (trans. by A.K.):

Vol. I

Part I	Regularities of spatial and age distribution of the salt-bearing series and paleogeographical problems of salt deposition
Part II	Physico-chemical problems of halogenesis
Part III	Underground waters of salt accumulating basins
Part IV	Perspectives of development of the raw sources of the industry of potassium fertilizers and the salt industry of the USSR
Part V	Recent salt accumulation in the USSR territory
Part VI	Geology, conditions of formation and raw materials of the Neogene salt-bearing sediments of the USSR
Part VII	Geology, conditions of origin and raw materials of the Mesozoic salt-bearing deposits in the USSR

Vol. II

Part VIII	Geology, formation conditions and raw materials of the Permian salt-bearing deposits in the USSR
Part IX	Geology, conditions of formation and raw materials of the Devonian salt-bearing deposits in the USSR
Part X	Geology, conditions of formation and raw materials of the Cambrian salt-bearing deposits in the USSR
Part XI	Salt-bearing basins and deposits of potassium salts in other countries
Part XII	Salt tectonics and occurrence of oil and gas in basins of salt accumulation

JEANROT, P. and LE BEL, L., 1978, Simple approach to quantitative analysis of fluid inclusion daughter minerals by S.E.M. with X-ray energy dispersive analyser (abst.), in International Assoc. Genesis Ore Deposits, 5th Symp., Snowbird, Alta, Utah, 1978, Program and Abstracts: (Alta, Utah), p. 108.

X-ray spectra obtained using an energy dispersive spectrometer can be processed rapidly to yield a quantitative chemical analysis.

Each element has an X-ray signal with a specific energy level. The efficiency of the Si(Li) detector depends on the energy of the signal. Thus, different elements, with identical concentrations by weight, do not have identical signal intensities. After the efficiency, as a function of the energy, has been determined experimentally, one can use this function to correct the signal intensities of an X-ray spectrum. The normalization coefficient takes into account both variations of fluorescence efficiency of each element concerned and variations of detection efficiency of the spectrometer for the different energies analysed. Also, in a preliminary study the normalization coefficients were determined for pure elements having their $K\alpha$ emission in the range 0-10 KeV.

Knowing these two parameters (the efficiency function and the normalization coefficient), one can obtain a quantitative analysis without the use of standards. In addition, the geometry of the detector allows the analysis of unpolished surfaces. Therefore, the minerals in fluid inclusions, that are exposed to open air by crushing the host mineral, can be analyzed by this method.

The experimental concentrations are then processed by a correction program for inter-element effects.

The proposed method has been applied to the mineral phases in multiphase fluid inclusions from the porphyry-copper-type deposit of Cerro Verde/Santa Rosa, Peru, previously described in a preliminary paper (Le Bel, 1976).

The following mineralogy was found:

Chlorides: pure NaCl and KCl, "solid solutions" NaCl-KCl and chlorides of Fe and minor Mn. Some more complex chlorides were found containing S, Fe and Cu.
Sulfates: anhydrite
Sulfides: pyrite and chalcopyrite. The latter has the high temperature (cubic) modification.
Silicates: K - feldspar, plagioclase and phyllosilicates.

The limitation of the use of this simplified approach for quantitative analysis will be discussed in detail. (Authors' abstract)

JOHNSTON, D.A., 1978, Volatiles, magma mixing, and the mechanism of eruption of Augustine Volcano, Alaska: PhD dissert., Univ. of Wash. 177 pp.

A study of the 1976 eruption of Augustine Volcano, a calc-alkaline stratovolcano in Cook Inlet, Alaska. Roughly 0.17 km^3 or rock was erupted, including dacite, andesite, and basalt. Inclusion studies indicate that all three were sulfide-saturated. The mineral assemblage in the andesite was apparently produced by mixing the dacite with a magma more basic than a high-alumina basalt. The following evidence suggests that the basalt was moderately hydrous: (1) The presence of hornblende; (2) The absence of plagioclase; (3) Electron probe analyses of glass inclusions in olivine that yield summation deficiencies of 2.49 to 9.21 wt.%. Electron probe analyses indicate that before eruption the basalt contained roughly 3½-4½ wt.% H_2O, 0.2-0.6 wt.% Cl, and probably less than 100 ppm F. The basalt was also sulfide-saturated. Glass inclusions in plagioclase and pyroxene from the dacite contain 6.6 ± 1 wt.% H_2O (determined by difference), 0.3-0.6 wt.% Cl, 100-500 ppm S, and commonly less than 100-200 ppm F. The dacite also appears to have been sulfide-saturated. The following features of these glass inclusions suggest that the dacite was saturated with respect to a water- and Cl-rich vapor phase during crystallization: (1) The water content of glass inclusions in dacite is constant (within the analytical uncertainty) over a wide range of K_2O contents; (2) The H_2O- and Cl-contents of the inclusions in dacitic minerals are one-half to one-third of what would be expected if the dacite formed by fractional crystallization of a parent resembling the 1976 basalt; (3) Some glass inclusions contain vapor bubbles which are unusually large in relation to the trapped melt. These may have formed by entrapment of a vapor bubble along with the melt.

Several other aspects of the magmas have also been determined: (1) Geothermometers (ol-spinel, px-px) indicate that the basalt was at 1100-1150°C, the dacite at 840+30°C prior to mixing. (2) The viscosity of the basalt was probably between 5 and 100 poises at 1100-1150°C, and the dacite 50,500 p. at 840°C, decreasing to 1000 p. at 1000°C. (3) Hornblende in the basalt crystallized at roughly 75-25 km depth. The dacite resided in a shallow magma chamber between 10 km and 2 km deep, as indicated by the water content of the glass inclusions.

Plagioclase microphenocrysts grew in the groundmass of hybrid pumices for roughly 13-80 days, based upon growth rates of Kirkpatrick (1976, 1977). This roughly corresponds with the duration of the precursor seismic swarm (120 days), and suggests that magma mixing preceeded and may have triggered the 1976 eruption. Magma mixing may have led to a volume increase within the magmas by: (1) The addition of a volume of new magma (possibly a 15% volume increase; (2) By heating and thus "boiling" the dacite (less than 1-5% increase in the volume of the melt); (3) By "boiling" during crystallization of the hybrid magma (less than 5-25% increase in the volume of the melt).

The following conclusions are also suggested for the Augustine magmas: (1) There is no evidence from glass inclusions that the waning explosivity of the eruption was due to pre-eruption zoning of volatiles in the chamber, as suggested by Kennedy (1955). (2) Similar evidence for magma mixing is present in the deposits of each historic eruption of Augustine and many prehistoric eruptions. This suggests that the rate of magma supply from depth may be on the order of every 10-100 years. (3) The intimate apparent association of basalt and andesite and dacite implies a genetic relationship. This is implied despite the absence of basaltic lavas from Augustine. (4) Hornblende is too magnesian in basic magmas to produce the non-Fe-enrichment trend typical of calc-alkaline rock suites. Magnetite is, however, an early-formed phase, and might be removed in sufficient amounts to produce such a trend. (5) Magma mixing appears to be a second-order process, whose effect is overprinted onto the compositional variations that resulted from fractional crystallization. It does, however, obscure the latter variations, and moreover, will affect the evolution of trace elements in the magmas. This must be considered when interpreting trace element abundances of andesites. (Abridged by E.R. from the author's abstract)

KALININ, D. V., 1977, Kinetics and mechanism of mineral-forming reactions in 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. 3, p. 70-71 (in Russian).

KALOGEROPOULOS, S.I., 1977, Geochemistry and mineralogy of the St. Lawrence pyrochlore deposit, Oka, P.Q.: Master's thesis, Queens Univ.; Kingston, Ont.; Can.

Includes some study of fluid inclusions, but text unavailable at present. (E.R.)

KALYUZHNYI, V.A., 1978, Current status of the problem of carbon and its compounds in endogenic mineral formation processes (according to inclusions in minerals), in Carbon and its compounds in endogene processes of mineral formation, G.N. Dolenko, ed.: Kiev, "Naukova Dumka" Pub. House, p. 3-16 (in Russian).

This is full paper corresponding to abstract given in COFFI v. 8, p. 81-82, 1975 (ER)

KALYUZHNYI, V. A., DAVIDENKO, N. M. and SCHCHYRITSA, A. S., 1978, Typomorphism of fluid inclusions as indicator of the depth of formation of hydrothermal gold mineralization (abst.): XI General Meeting of International Mineralogical Association, Novosibirsk, Abstracts, v. 2, p. 146 (in English).

Data on the depth of hydrothermal ore genesis are necessary for geological practice, to make suggestions on the genetic group and depth of formation of mineral associations even for unique gold-bearing mineral parageneses. The results of investigation of gold-quartz low-sulphide formations of the abyssal class of East Siberia give evidence for a typomorphic importance of fluid inclusions in the minerals of hydrothermal gold-bearing veins. Golddeposits of various types were formed at various PTX, according to fluid inclusions. The highest (350-400°) temperatures are characteristic of the mineral associations of abyssal bodies; intermediate ones (285-295°C) characterize the formation of the hydrothermal slightly gold-bearing veins of the hypabyssal class; in sub-surface deposits, they are related to low-temperature fluids (170-195°).

Abyssal gold-bearing veins formed at a pressure that was a function of depth; for intermediate depths it was 850-900 atm.

According to the analytical results, the inclusions in the minerals of hydrothermal gold-bearing veins of abyssal class contain carbon dioxide (81.3-95.6%), nitrogen (11.5), methane (4.1-4.7%) and other gases. Carbon dioxide is the main gaseous component of fluid inclusions of gold deposits. High CO_2 concentration in homogenous aqueous mineral-forming solution favours gold migration. (Modified, from the authors' abstract)

KALYUZHNYI, V.A., DAVIDENKO, N.M., ZINCHUK, I.N., 1978, Role of carbon dioxide-water and methane-water fluids in the formation of gold-ore deposits in Chukotka (USSR), in Carbon and its compounds in endogene processes of mineral formation, G.N. Dolenko, ed.: Kiev, "Naukova Dumka" Pub. House, p. 100-107 (in Russian).

This is full paper corresponding to abstract given in COFFI v. 8, p. 82, 1975 (ER)

KALYUZHNYI, V. A., KOVALISHIN, Z. I., BRATUS, M. B., ZHOVTULYA, B. D., PLATONOVA, E. L. and ZINCHUK, I. N., 1978, Study of hydrothermal formations of Ukrainian Carpathian and Transcarpathian Mountains for establishing the composition and physicochemical characteristics of endogenic carbon-containing fluids (according to the relicts of mineral-forming media). Izv. Deposited Doc. 1978, VINITI-1979-78, p. 114-121 (in Russian).

Fluid inclusions in minerals of the Begerovsk Au-polymetallic deposit indicate formation of Au ore occurrences from solns, with high K^+ concn. ($\leq$29.95%) and a predominance among anions of SO_4^{2-} (67.11%). Quartz formation was accompanied by high CO_2 concn. in hydrothermal solns. and adularization occurred with increase in the CH_4 concn. ($\leq$66.6 vol.%) in the gas phase. Polymetallic ores formed at 240-300° from solns. enriched in K^+ and Mg^{2+}, with SO_4^{2-} as the predominant anion, and with N_2 as the predominant gas. The Au-barite-kaolinite assocn. formed at $\geq$120° from fluids rich in CO_2 gas and with Na^+, K^+, Ca^{2+}, Mg^{2+}, Cl^-, and SO_4^{2-} main ions in the mineral-forming solns. Crystn. temps. of magmatogenic minerals in effusive rocks are estd. from glass inclusions. Metamorphism, to which Au concn. is related, occurred at 170-250°. The carbonate C of Au ore occurrences has the isotopic compn. $\delta^{13}C$ from -0.46 to +0.15%; the C isotopic compn. of org. minerals assocd. with Hg ore occurrences indicates a deep source of the C. (Chem. Abstracts 91: 213979s)

KALYUZHNYI, Vl. A. and MATVIYENKO, A.D., 1978, Experience in the use of endogene CO_2 method for detailed prospecting for mineral raw materials, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. II, Thermobarogeochemistry and ore genesis: Vladivostok, Acad. Sci. USSR, p. 13-15 (in Russian). Authors at Inst. Geol. Geochem. of Mineral Fuels of the Acad. Sci. of Ukrainian SSR, L'vov.

Carbon dioxide displays a special role in formation of polymetallic, quartz, gold deposits, and morion-bearing pegmatites. The proposed prospecting method was checked in the Volhynia pegmatitic field. The first area, with a drilling network 50x80m, did not yield pegmatitic mineralization. The background CO_2 content was determined to be 3.5 cm^3/kg, and positive anomalies showed two zones where pegmatites were then found. In the second area the background CO_2 content was higher: 4-5 cm^3/kg, and anomalies 17-18 cm^3/kg and 8 cm^3/kg also located pegmatitic bodies. (From the authors' abst.)

KALYUZHNYI, V.A., SHUKAYLO, L.G. and ZHOVTULA, B.L., 1978, Melt inclusions in apatite from magmatic rocks of the Ukrainian Carpathians: (Abst): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 70-71 (in Russian). Authors at Inst. Geol. and Geochem. of Fuel Raw Material of Acad. Sci. of the USSR, L'vov.

Studied accessory apatite comes from perlite of Pelikan Mt., quartz diorite-porphyrite of the Varged' massif and diorite porphyrites of the Klobuk massif. All crystals were 0.5-0.2 mm in length and contained magmatic inclusions.

Apatites from Pelikan Mt. bear rare P melt 20-80 µm long inclusions without G phase, but with dms: hypersthene Ng' = 1.712 ± 0.002, Np' = 1.704 ± 0.002, with ca. 40% of FeO (30-40 vol. %), opaque ore mineral (10-20 vol. %), and glass (40-50 vol. %). At 1150°C glass becomes soft and ore dm moves, at 1300°C inclusion appears light, but homogenization was not achieved.

Apatite from diorite-porphyrite of the Varged' massif is "saturated" with magmatic P inclusions of 10-80 µm size, essentially occurring in central part of crystals. Contents: glass with refractive index 1.520 (i.e., SiO_2 content of glass 63%), dm light-green hydromica(?) with refractive indices Np' = 1.563, Ng' = 1.5777 ± 0.002 (crystal picked from inclusion), and G- 8-10 vol. %. At 720-830°C glass softens, at 930°C hydromica disintegrates into single flakes and partly dissolves into melt with appearance of additional G bubble. Hydromica dissolves completely at 1050-1075°C, at 1270-1290°C inclusion homogenizes in L. By gas chromatography (device MSK_h-3a), G phase consists of (vol. %) CO_2 7.58, N_2 56.96, CH_4 11.54, C_2H_4 2.98, H_2O 20.86 (analyses recalculated without H_2).

Apatite from diorite porphyrite of the Klobuk massif bears rather rare inclusions filled with glass (60-70 vol. %), hydromica(?) (10-30 vol. %) and ore dm (3-5 vol. %), some inclusions homogenize at $T \leq$ 1060°, the others do not homogenize up to 1300°C.

Hence, apatite is assumed to have crystallized at T reaching 1300°C; these data are similar to published values of Th in plagioclase (1390-1280°C) and in quartz (1440-1250°C); in inclusions in plagioclase and quartz also N_2 is the main G component. Presence of hydromica in inclusions and of H_2O in G analyses proves the enrichment of melt in water. (Authors' abst., translated by A.K.)

KALYUZHNYI, V. A., VYNAR, O. N., GIGASHVILI, G. M., MATVIENKO, A. D., and REMESHILO, B. G., 1978, Geochemistry and thermobarometry of carbon-containing postmagmatic fluids of intrusive complexes in the Ukraine (Lower Proterozoic intrusives and hydrothermally altered rocks adjacent to the Ukrainian Shield of gas-containing regions). Deposited Doc. 1978, VINITI 1979-78, p. 105-113 (in Russian).

The Zhitonir- and Kirovograd-type porphyritic and equigranular granites and the assocd. vein pegmatites are studied. The primary and secondary gas-liq. inclusions in minerals of these granites were evaluated for Th & Td. The postmagmatic fluids of these intrusive rocks had a salinity 104-107 (for granites) and 30-14 mL/kg (for pegmatites). The $\delta^{13}C$ value in CO_2 of inclusions ranges from -1.28 to -4.55 in granites and from -0.93 to -1.92% in pegmatites. The crystn. temp. and pressure were, resp., $<+280^{o}$ and <500 atm. (Chem. Abstracts 91: 214061y)

KAMILLI, R.J., 1978, The genesis of stockwork molydbenite deposits: implications from fluid inclusion studies at the Henderson Mine (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 10, no. 7, p. 431.

The multiple hydrothermal events which formed the Henderson molybdenite deposit left a record in a consistent vein sequence. Symmetrical banding and equilibrium growth textures indicate that many if not all of these veins formed by open-space filling. Fluid inclusion studies yield temperatures that range from >600°C in the earlier stages to 250°C in the final stage. Abundant evidence of boiling was found within and close to the orebody, but not above it: in the phyllic alteration zone above the orebody a temperature gradient of at least 100°C over a vertical distance of 400 meters existed. Some fluid inclusions have as many as 14 daughters, the most common being halite, hematite, and a carbonate. A black, hexagonal, platy daughter which occurs with hematite is probably molybdenite. Inclusions occur in 3 populations: liquid-rich inclusions with salinities ranging from 30 to 60 wt% NaCl, vapor-rich inclusions with salinities between 5 and 20 eq. wt% NaCl, and liquid-rich inclusions <2 eq. wt% NaCl. Halite daughters in the first group commonly dissolve at temperatures more than 100°C higher than the filling temperatures. This requires pressures much greater than any reasonable lithostatic load. It is probable that these high pressures resulted from the evolution of hydrothermal fluid from the crystallizing magmas and caused much of the intense fracturing which resulted in stockwork veining. It is likely that large pressure corrections should be applied to other, less saline, inclusions too. If so, this would make the average temperature of the quartz-molybdenite mineralization at least 500°C. This is a higher temperature than previously proposed for Climax-type deposits and is consistent with a magmatic origin for the molybdenite mineralization. (Author's abstract)

KANDINOV, M. N. and KHARLAMOV, E. S., 1978, Physicochemical conditions for the formation of fluorite from alkali halide melt-brine: Teor. Prakt. Termobarogeokhim., (Dokl. Vses. Soveshch.) 5th 1976, N. P. Ermakov, ed.: Moscow, Izd. Nauka, p. 136-138 (in Russian).

The formation of the fluorite-barite-Fe ore mineralization in East Siberia is considered, based on cryometry, chromatog., and Th of multiphase melt-brine inclusions in fluorite. At 25^{o}, the inclusions have solids 65, soln. 10-15, and liq. CO_2 25%. A small amt. (3 vol.%) of gas phase appears in the inclusions at $<22^{o}$ and is mainly soln. vapor and CO_2. The solid phases are probably carbonates and sulfates of K and Na. The fluorite formed from dense, CO_2-satd. alk. halide-carbonate melt-brines with hydrocarbons and other volatiles, at >700° and 4-6 kbars. (Chem. Abstracts 91: 77042b, 1979)

KARUP-MØLLER, S., 1978, The ore minerals of the Ilímaussaq intrusion: their mode of occurrence and their conditions of formation, Grønlands Geol. Undersøgelse, Bull. No. 127, 51 pp. Author at Miner. Inst., Tech. Univ. Denmark, 2800 Lyngby, Denmark.

On the basis of their chemical composition, the Ilímaussaq ore minerals in pegmatites and hydrothermal veins have been subdivided into the following four associations: I Pb-Zn-Mo, II Cu-Sb (including two subtypes: IIA Cu-Sb and IIB Cu-Sb-S), III Fe-As and IV Fe-Ni-As-Sb.

The accessory ore minerals in the agpaitic rocks crystallized relatively late compared to the silicate minerals. In the augite syenite the original pyrrhotite and associated chalcopyrite crystallized from an immiscible sulphide phase. Correlation between accessory rock-forming ore minerals and bulk chemical composition of the major rocks is severely limited due to the lack of chemical data.

The ore minerals in the rocks, pegmatites and veins crystallized at low sulphur and oxygen fugacities. The log a_{S2} and log f_{02} ranges are semi-quantitatively estimated on the basis of published thermodynamic data. (From the author's abstract)

KARZHAVIN, V. K., LUTTS, B. G. and PETERSIL'E, I. A., 1978, Gas composition of abyssal rocks: Teor. Prakt. Termobarogeokhim., (Dokl. Vses. Soveshch.) 5th 1976, N. P. Ermakov, ed.: Moscow, Izd. Nauka, p. 54-60 (in Russian).

The compn. of the gases in peridotite and eclogite was studied by vacuum thermal degassing. The total amt. of gas sepd. from the rocks varied greatly (16.78-504.78 $cm^3/10$ g), and a general trend is noted of increase in gas content with increase in formational depth of the rocks. The principal volatile component is water. Garnet peridotite is the most water satd. rock variety (2.55 wt.% water). The max. amt. of gas was sepd. at 700°. Numerous hydrocarbons (C_{1-5}) were detected, along with water H, CO_2, N, and CO. (Chem. Abstracts 91: 60543t, 1979)

KAZANSKIY, V. I., LETNIKOV, F. A. and PROKHOROV, K. V., 1978, Fluid regime during emplacement of the Kirovograd-Novoukrainka pluton and fringing faults: Akad. Nauk SSSR, Doklady, v. 243, no. 3, p. 723-726 (in Russian; translated in Doklady Acad. Sci. USSR, Earth Sci. Sects., v. 243, p. 60-63, 1981)

Includes 27 analyses of rocks for H_2O, CO_2, CO, CH_4, H_2, and N_2, by T. A. Shkarupa (method not specified). (E. R.)

KEENAN, J.H., KEYES, F.G., HILL, P.G. and MOORE, J.G., 1978, Steam tables: Thermodynamic properties of water including vapor, liquid, and solid phases: New York, Wiley Interscience Pub., 156 pp.

KEIKO, Hattori, MUEHLENBACHS, Karlis, and MORTON, R.D., 1978, Oxygen isotope geochemistry of uraninites (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 10, no. 7, p. 417.

A preliminary series of $\delta^{18}O$ data for uraninites and associated phases has been obtained. $\delta^{18}O$ values of uraninites are the lowest yet observed in terrestrial minerals; being as low as -30^{o}/oo (SMOW; α-H_2O-CO_2 = 1.0407). Absolute $\delta^{18}O$ values for the uraninites are constantly lower than reported by Hoekstra and Katz (1956); (due to errors in their working standards). Clayton (Univ. of Chicago, found ^{18}O, ^{17}O and ^{16}O values of uraninite from the Oklo core zone to infer that low $^{18}O/^{16}O$ ratios of uraninites are not due to neutron-isotope interactions.

Silicates and carbonates in vein- and metavolcanic hosted-deposits examined have high $\delta^{18}O$ values. Calcite, quartz and uraninite from the vein-type deposit of the Martin Lake mine, N. Sask. have $\delta^{18}O$ values of +16.8, +10.1 and -30 ^{o}/oo respectively. In the Cardiff mine, Ontario, the $\delta^{18}O$ values of calcite, epidote, biotite and uraninite are +16.6, +14.2, +14.4 and -27 ^{o}/oo. In the metavolcanic hosted Kitts deposit, Labrador the $\delta^{18}O$ of calcite is +10^{o}/oo, quartz + Kfeldspar +16^{o}/oo, magnetite -2.0 ^{o}/oo and uraninite -24 ^{o}/oo. The results suggest ore fluids enriched in ^{18}O. As the minerals have not attained isotopic equilibrium, neither the $\delta^{18}O$ of the fluids nor the temperature of formation may be computed. However, the $\delta^{18}O$ of aqueous fluid from inclusions in fluorites of the Cardiff mine was +3.8 ^{o}/oo, precluding genetic involvement of low-^{18}O surficial waters; but the large mineral-water fractionation implies a low temperature of formation (100-200°C). The preliminary nature of results do not permit the solution of whether depleted $\delta^{18}O$ values in uraninites are due to large isotopic fractionation factors, or to later equilibration with low ^{18}O waters.

Silicates from granitoid-hosted uraninite occurrences in N. Sask. exhibit "normal igneous" $\delta^{18}O$ (quartz - 10%, biotite - 4.5%) i.e. inferring high temperatures and no meteoric contributions. (Authors' abstract)

KEKULAWALA, K.R.S.S., PATERSON, M.S. and BOLAND, J.N., 1978, Hydrolytic weakening in quartz: Tectonophysics, v. 46, p. T1-T6. Authors at Research School of Earth Sci., Aust. Nat. Univ., Canberra 2600 Australia.

Natural amethyst of good optical quality is found to be remarkably similar to "wet" synthetic quartz in having a low flow stress at elevated temperatures and in being strengthened by prolonged heating at atmospheric pressure. The low temperature infrared spectra of the crystals also have in common a substantial broad hydroxyl absorption in the region of 340 mm^{-1} wavenumber. The low strength appears to be correlated with this "gel-type" hydroxyl absorption and not with ice bands from molecular water or with very sharp hydroxyl bands from structurally-bound hydroxyl. (Authors' abstract)

KELL, G.S., McLAURIN, G.E. and WHALLEY, E., 1978, The PVT properties of water. IV. Liquid water in the range 150-350^{o}C, from saturation to 1 kbar: Proc. Roy. Soc. London, v. 360, p. 403-425.

KERRICH, R. and ALLISON, I., 1978, Vein geometry and hydrostatics during Yellowknife mineralization: Can. J. Earth Sci., v. 15,

p. 1653-1660. Authors at Dept. Geol., Univ. West. Ont., London, Ont., Canada N6A 5B7.

Three vein systems with distinct geometry and time relations are located within major ductile shear zones at Yellowknife. Gold-bearing quartz veins of metre dimensions are disposed parallel to the schistosity, cross cutting early veins. The shear zones act as conduits for massive fluid discharge; quartz and gold were precipitated from solutions cooling along a temperature-pressure (TP) gradient. Late stage lenticular gold-bearing quartz veins of metre dimensions were emplaced as vertical arrays within the shear zones, oriented normal to schistosity. Consideration of the kinetics of intergranular diffusion, with reference to the required transport distances of gold into a lode deposit, implies that long-range diffusive transport of gold into veins was not significant. (From the authors' abstract)

KERRICK, D.M., and JACOBS, G.K., 1978, Experimental and thermodynamic analysis of decarbonation equilibria in P-T-X_{CO_2} space (abst.): Eos, Trans. Amer. Geophys. Union, v. 59, p. 402.

KESTIN, Joseph, 1978, Viscosity of water and ionic substances (abst.): U.S. Geol. Survey Prof. Paper 1100, Geologic Survey Research 1978, p. 207.

KESTIN, Joseph, SOKOLOV, Mordechai and WAKEHAM, W.A., 1978, Viscosity of liquid water in the range -8°C to 150°C: Jour. Phys. Chem. Ref. Data v. 7, p. 941-948.

KHARLAMOV, Ye. S., 1978, Melt inclusions in minerals of the iron ores and carbonatites of the Kovdor massif: Akad. Nauk SSSR Doklady, v. 239, no. 1, p. 169-172 (in Russian). Author at the Moscow State University.

Early stage in the Kovdor massif produced carbonatites and apatite-magnetite-diopside-forsterite-phlogopite-calcite ores; late stage - forsterite-tetraferriphlogopite-magnetite ores and calcite carbonatites with tetraferriphlogopite. Post-ore parageneses also bear dolomite and later - Fe-dolomite, then calcite-zeolite veins. Inclusions in minerals are 5-80 μm long. Forsterite from all stages bears melt inclusions with 8-10 dms: silicates, carbonates and magnetite, water solution was not observed. Th in melt was 870-895, 760-880, 780-800 and 710-800°C for various parageneses. Apatite bears very similar melt inclusions, but water solution was found by cryometry; Th 680-890°C in melt and ore inclusion bearing L CO_2 + L H_2O + G -530 in G. Also hydrothermal apatite crystallized at 490-50°C and 1.6-0.25 kbar from Cl-CO_3-Na solution of total salt concentration 26-50% by weight. (Abst. by A.K.)

KHAYRETDINOV. I.A., 1977, The regularities of force field structure and main parameters of ore-forming 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, Siberian Branch, v. 3, p. 103 (in Russian).

KHENKINA, S.B., 1978, Liquation products in the Cretaceous-Paleogene rocks of the Okhotsk-Chukotka volcanogenic belt and pecularities of their metalliferous content: Acad. Sci. USSR Doklady, v. 238, no. 2, p. 433-436 (in Russian). Author at the Central Sci.-Research Geol.-Prosp. Inst. of Colour and Precious Metals, Moscow.

In andesites, andesite-diorites, liparites, granites, basalts and andesite-basalts there occur tiny globular accessories, called globulites, with dia. 0.01 to 3 mm, 54 -0.02 g/t, observed in 90% of crushed samples and up to 60% of thin sections). No preferences were observed for any type of rock. X-ray studies of black and dark-gray globulites show them to consist of jacobsite and a mixture of magnetite, wüstite, and yellowish-gray α-iron; extremely rare are transparent yellow-brown globulites of glass ($n = 1.58 \pm 0.02$) with inclusions of wüstite. Globulites, interpreted as immiscibility products, occur in matrix and as inclusions in early phenocrysts of ortho- and clinopyroxenes, and in zoned plagioclases. Paleogene rocks bear almost exclusively massive globulites, whereas Cretaceous ones frequently have hollow globulites. Also chips of hollow thin-walled globulites of a porous substance (magnetite, maghemite, wüstite) seemingly up to 1 cm dia. (sic.) were found. Massive globulites consist of an outer core of magnetite-wüstite and an eccentric inner core of α-iron, the boundary of the core is sharp. Following elements were found in globulites: Ti, Mn, Si, next Au (0.11-172g/t), Cr (57-1300g/t) Sc (traces -6.4g/t), Co (31-390g/t). High content of gold proves that gold ore deposits in this area are connected with primary magmatic specialization. Possible conditions of globulite formation are discussed. (Abst. by A.K.)

KHETCHIKOV, L.N., DOROGOVIN, B.A., SANDOMIRSKAYA, S.A. and POLYANSKIY, Ye.B., 1978, Inclusions of mineral-forming media in minerals grown from melts, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, pp. 20-21 (in Russian). First author at Central Sci.-Research Geol.-Prosp. Inst., Moscow.

Gahnite, eulytite, garnets and other minerals were grown from melt under various conditions, sometimes with added oxides of lead, molybdenum, boron etc. All minerals bear inclusions consisting of a bubble and solid phase. Microprobe analysis revealed changes in composition of solid phase - inclusions consist of variable amounts of components present in crystallization process of host mineral. Th was either close to or very different than T of crystallization (sic.) (Authors' abst., translated by A.K.)

KHITAROV, D. N., 1978, The state of the investigations of the chemical composition of inclusions of mineral-forming fluids (abst.), <u>in</u> International Assoc. Genesis Ore Deposits, 5th Symp., Snowbird, Alta, Utah, 1978, Program and Abstracts: (Alta, Utah), p. 113.

The first group of methods do not require opening the inclusions. The composition of inclusions in this case is determined by measuring the physical characteristics of inclusion contents and by the cryoscopic method. The measurements of the freezing temperatures of inclusion contents permits determinations of the concentration and tentative indications of the composition of the liquid and gas phase. A system for precise regulation of the freezing rate of the sample in the cooling stage, using liquid nitrogen, was worked out in the USSR by E.S.

Kharlamov.

The second group of methods requires opening the inclusions. These methods permit full quantitative analysis of the compositon of gas, liquid and solid phases in the inclusions. In this case we can investigate either the contents of an individual inclusion or the matter extracted from many inclusions. The method of analysis of gas composition of individual inclusions was developed in the USSR by N.A. Shugurova, and of the liquid phase of individual inclusions by I.N. Maslova.

There are two ways of opening inclusions for bulk analysis: mechanical crushing of mineral grains, and heating the inclusions to above the temperature of decrepitation. The investigations specially conducted by us have shown that the first way is preferable for the bulk anlaysis of the liquid phase and the second for the bulk analysis of the gas composition. We extract the gases by heating inclusions in an evacuated glass ampule. Gas analysis is carried out on the chromatograph. With the help of a special mechanism constructed by O. F. Mironova and placed in the chromatograph the ampule is broken and the gases are introduced in the chromatograph. The investigation of the bulk composition of the liquid phase is carried out by means of the method of triple water extracts worked out by us. We have also compared the results of determination of the concentration of inclusion fluids by the triple water extract method with the cryoscopic data and found satisfactory coincidence of the results obtained by the two methods. To estimate the magnitude of ion absorption during the water extraction, we conducted an investigation of the ion absorption of different ions from solutions of various composition and concentration on powders of quartz, fluorite, calcite and barite. This investigation showed that the absorption of certain ions took place only in individual cases but even then it was small and did not change essentially the ion correlations. (Author's abstract)

KHITAROV, D. N., SOKOLOV, S. V., and KHARLAMOV, E. S., 1978, The inclusions in minerals of carbonatite formations (abst.), in International Assoc. Genesis Ore Deposits, 5th Symp., Snowbird, Alta, Utah, 1978, Program and Abstracts: (Alta, Utah), p. 114.

Fluid inclusions in the rock-forming minerals of the polymineralic carbonatites and genetically related rocks of the ultrabasic-alkaline Kovdor massif (Kola peninsula) have been studied by methods of homogenization and cryometry (table).

	Inclusion phase composition, vol%			T homogenization, °C
Mineral	Solid phases	Liquid	Gas	
Stage 1				
Nepheline	S=5-70,C=0-80,X=20	5-20	0-85	930-850
Apatite	X=0-20	55-80	20-40	575-350
Stage 2				
Forsterite	C-10-90,X=0-95	0-15	5-15	890-640
Apatite	X=85-95	0-10	3-5	890,790-690
"	X=0-20	60-85	5-30	480-290
Stage 3				
Apatite	X=90	5	5	760
"		80-90	10-20	365-245
Dolomite	X=80	5	15	>(610-640)
Stage 4				
Zircon	(S+X)=95	5	0	740-720,625
Fe-dolomite	X=80	10	10	>(610-635)

(S-silicates, C-carbonates, X-unidentified phases)

(Continued on next page)

Crystallized and crystal-fluid inclusions homogenize into highly concentrated liquids (melts) which on cooling quench to glass or form microcrystalline phases. Gas-liquid inclusions in apatites, sometimes containing minute daughter crystals of highly soluble salts, homogenize in the liquid phase (i.e., in the aqueous solution). These solutions are characterized by a sodium chloride-carbonate composition and high salt concentrations (over 30 weight percent).

The phase composition of the crystallized inclusions, the processes in them under heating, and the high temperatures of homogenization indicate that highly concentrated liquids (melts), characterized by a complex composition, took part in the formation of carbonatites of the Kovdor massif. The predominance of gas-liquid inclusions in apatite, as well as their homogenization in the liquid phase, suggest that the crystallization of the bulk of this mineral took place from aqueous solution which were similar in their properties to normal hydrothermal solutions. (Authors' abstract)

KHITAROV, D.N., PASHKOV, Yu.N. and NAUMOV, V.B., 1978, Recent state of methods of studies of inclusions of mineral-forming media, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in Geology: Vladivostok, Acad. Sci. USSR, p. 38 (in Russian). First author at the All-Union Inst. of Mineral Raw Material, Moscow.

A review of the methods and devices for fluid inclusion studies yielding data on a series of topics listed in the abstract only by names. (A.K.)

KHITAROV, N.I. and PUGIN, V.A., 1978, Liquation in natural silicate systems: Geokhimiya, 1978, no. 6, p. 803-819 (in Russian with English abstract). Authors at USSR Acad. Sci., Moscow.

The results of three methods of the study of liquation in natural silicate systems (experimental, thermodynamic and petrochemical) are considered. This consideration shows that in resolving the problem of this phenomenon in nature all three methods add to each other. It was shown that the results of experimental and petrologic study can be checked by thermodynamic calculations and on the contrary thermodynamic data can be used to make prognosis on liquation in the given artificial or natural systems. Using thermodynamic tests it was shown that variolitic lavas of Canada and Karelia are the products of liquation. The similar calculations confirm possibility of this phenomenon revealed in some experimental study. The calculations reject some determinations of liquation phenomenon in a number of experimental and petrographic studies. The analysis by another technique confirms that this rejection was correct. The role of water in liquation process was considered. (Authors' abstract)

KHOMICHEV, V.L., KHOMICHEVA, Ye.S., and SOL'TSMAN, A.Ye., 1978, Agaskyr molybdenum deposit (Kuznetskiy Alatau): Geol. Rudn. Mest., v. 20, no. 2, p. 27-39 (in Russian). Authors at the Siberian Sci.-Research Inst. of Geol. and Geochem. of Mineral Raw Materials, Novosibirsk, USSR.

The Th data for three vein Mo deposits: Sorskoe, Ipchul'skoe and Agaskyr, are as follows: pegmatoid quartz of the stock 700-400°C (in G), pegmatoid quartz of veins 680-340°C (in L, sometimes in G), pyrite-feldspar-quartz veinlets 470-260°C (in G and in L), sulfide-quartz veinlets 400-220°C (in L) and quartz-molybdenite veinlets 360-235°C (in L). (A.K.)

KIRILLOVA, E. A., KOLONIN, G. R. and YUSUPOV, T. S., 1977, On solubility and sulphidization of SnO_2 with different degrees of dispersity (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. 3, p. 72-73 (in Russian).

KITYK, V.I. and PETRICHENKO, O.I., 1978, Use of inclusions in minerals to explain the conditions of formation of petroleum and gas deposits: Izv. Visn. Akad. Nauk Ukr. RSR, no. 1, p. 55-60 (in Ukrainian).

Liq. and gaseous inclusions in halite from various locations in the Dnieper-Donets depression were studied to det. the conditions and the history of the formation of oil and gas deposits. Three types of halite are described. Halite with single-phase liq. inclusions contg. aq. solns. of Na and Ca chlorides is the 1st type. The absence of petroleum and internal pressure in these inclusions indicates that they were formed during the sedimentation and an earlier diagenesis. The 2nd type is a recrystd. halite contg. 2- and 3-phase liq.-gaseous inclusions consisting of hydrocarbons, CO_2, N, and aq. salt solns. They are under 200-50 atm pressure and at a partial Th of 100-20°. This type of halite was formed during tectonic dislocations at depths of 2000-500 m. The 3rd type has distinct marks of endogenic (hydrothermal) processes at $>250°$ leading to changes in hydrocarbon compn. of the microinclusions with increasing concn. of CO_2. The liq. phase consists of light petroleum fractions and aq. salt solns. The gaseous phase consists of C_{1-5} alkanes. Inclusions in quartz, fluorite, pyrite, and calcite were also studied. (Chem. Abstracts 88: 194012r)

KIYOSU, Yasuhiro and WADA, Hideki, 1978, Carbon and oxygen isotope compositions of calcite from the Taishu Pb-Zn deposits: Jour. Jap. Assoc. Min., Petrol., and Econ. Geol., v. 73, p. 33-38. (In Japanese with English abstract.)

Carbon and oxygen isotope ratios of calcites from the Taishu Pb-Zn deposits have been investigated. The $\delta^{13}C$ values of the hydrothermal calcites lie within the range -8.9 to -12.3 permil (PDB), while $\delta^{18}O$ values are between +10.7 to +14.1 permit (SMOW). The isotopic composition of carbon ($\delta^{13}C_{\Sigma C}$) in the ore-forming fluid was determined by the physico-chemical conditions of hydrothermal fluids (temperature, pH and fO_2) as well as the $\delta^{13}C$ of hydrothermal calcites. Much of the hydrothermal carbon in the Taishu deposits was probably derived from organic matter in the Taishu formation. Calculated $\delta^{18}O$ values of ore-forming fluid in equilibrium with calcite range from +4.2 to +8.0 permil. These data and the observed δD values of fluid inclusions (Hattori et al., 1976) suggest that the ore-forming fluid of the Taishu deposits were most composed of meteoric water that had undergone isotopic exchange with the granitic magma. (Authors' abstract)

KOGARKO, L.N. and ROMANCHEV, B.P., 1978, Differentiation of alkaline magmatic series of S. Atlantic islands, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, pp. 30-31 (in Russian). Authors at GEOKHI of Acad. Sci. of the USSR, Moscow.

Specimens were collected at the islands: Gran Canaria, St. Helen and Tristan da Cunha. In olivine and Ti-augite from ankaramites partly crystallized inclusions bearing dense CO_2 were found. Density of CO_2 in olivine (by cryometry) from Gran Canaria was 0.725g/cm^3, St. Helen - 0.63g/cm^3, Tristan da Cunha - 0.60g/cm^3, P was, respectively, 5, 3.65 and 3.3 kbar. Series of rocks from Gran Canaria formed during T decrease from 1330-1300°C (ankaramites) through 1310-1270°C (ankaramite-basalts), 1280-1220°C (olivine basalts), 1260-1150°C (alkaline basalts), 1080-980°C (ordanchites) to 960-940°C (phonolites). Series of rocks from St. Helen Island formed at T 1290-1140°C, beginning from ankaramite-basalts through olivine basalts to alkaline basalts. Same tendency was found for the ankaramite-basalts, basalts and trachybasalts in T interval 1300-1130°C at Tristan da Cunha. Th were measured for inclusions in olivine, Ti-augite, plagioclase, apatite, kaersutite and nosean. Two olivine generations differing in Th and chemical composition were revealed, and relations between pyroxene and plagioclase composition and Th and degree of melt differentiation are apparent. By electron microprobe, chemical composition of daughter minerals and homogenized P inclusions in ankaramite minerals were studied. (Authors' abst., translated by A.K.)

KOGARKO, L. N. and ROMANCHEV, B. P., 1978, Use of the complex study of inclusions for the solution of questions about the genesis of alkaline rocks: Teor. Prakt. Termobarogeokhim., (Dokl. Vses. Soveshch.) 5th 1976, N. P. Ermakov, ed.: Moscow, Izd. Nauka, p. 34-38 (in Russian).

Fluid inclusions in apatite (Ap), eudialyte, nepheline, and acmite of agpaitic alk. rock samples from Kola Peninsula massifs had Th 700-1000°. The compn. of the inclusions in Ap from the Khibiny and Lovozero massifs indicates crystn. of Ap from an aluminosilicate melt during differentiation of alk. magma with an anchieutectic compn. Exptl. studies done in conjunction with the fluid inclusion detns. show that agpaitic nepheline syenites crystd. from dry (H_2O-free) melts at $\sim$1000°. The phase relation during melting of mesocratic eudialyte lujavrite indicate eudialyte stability in agpaitic alk. m. 950° under dry conditions or at 770-820° in the presence of 1 kbar H_2O pressure. Early crystn. of eudialyte in the Lovozero massif was caused by satn. of the agpaitic melt with ZrO_2. (Chem. Abstracts 91: 60540q, 1979)

KOGARKO, L. N., and RYABCHIKOV, I. D., 1978, Volatile components in magmatic processes: Geokhimiya, 1978, no. 9, p. 1293-1321 (in Russian, English abst.). First author at Inst. Geochem. and Anal. Chem. of Acad. Sci. of USSR, Moscow.

The paper characterizes the behavior of water, carbon dioxide, fluorine and chlorine in silicate melt, pertinent to gases in fluid inclusions. (A. K.)

KOKORIN, A.M., and KOKORINA, D.K., 1978, Certain features of the formation of a tin-tungsten deposit, <u>in</u> Thermobarogeochemistry of the earth's crust and ore formation, N.P. Ermakov, ed.: Moscow, "Nauka" Press, p. 147-149 (in Russian).

Temp. anal. of the fluid inclusions in vein quartz of the Tsinovets deposit (Czechoslovakia) shows the complex history of its formation with pneumatolytic mixing in the hydrothermal state, of quartz-forming solns. enriched in CO_2 at >300°. Th (287-361°) of the inclusions in fluorite indicate the lower temp. boundary of the Sn-W mineralization. The optimum formational temps. of the sulfides in barite-fluorite veins was $\leq$350°. (Chem. Abstracts 89:166307t)

KOLIKOVSKI, Boris, MELNIKOV, Fedor, and NIKOVSKI, Vassil, 1978, Temperature of mineral formation in the Govedarnika deposit, Central Rhodope Mountains: in "Ore-forming processes and mineral deposits," Bogdan Bogdanov, ed.: Sofia, Bulgarian Acad. Sci., vol. 9, p. 27-38 (in Bulgarian with English summary).

The Govedarnika deposit is a lead-zinc deposit. The mineralizations occur in veins and partly as metasomatic bodies (bed-like bodies formed after marbles). Quartz, sphalerite and galena are the main minerals, and calcite, ankerite, pyrite and chalcopyrite are subordinate; chlorite, epidote, hematite, arsenopyrite and other minerals occur in small amounts. Johannsenite, hedenbergite, bustamite and rhodonite occur widely in the metasomatic bodies. The hypogene mineralization consists of six mineral associations each of which crosscuts or cements the earlier one: skarn, quartz-pyrite, quartz-sphalerite-galena, quartz-ankerite, quartz and calcite associations.

Temperature of mineral formation is studied by the method of homogenization of the fluid inclusions in the minerals. Quartz and partly calcite have been used. Only for the skarn association the data were obtained using the decrepitation technique. A vertical interval of about 350 m has been covered.

Eighty-nine polished quartz platelets and 20 cleavage platelets of calcite have been examined. About 600 fluid inclusions have been homogenized. They were almost invariably two-phase inclusions containing liquid and gas. Carbonic acid and a black-brown filamentous mineral have been seldom found. The larger inclusions are most often of irregular and ellipsoidal shape, and the submicroscopic ones of spheroidal shape. Tubular inclusions and inclusions in the form of "negative crystals" are infrequently found.

Judging from the decrepitation data, the skarn association was formed in a temperature range of 450-350°C. The quartz-sphalerite-galena association filling the veins was formed between 330 and 250°C, but mostly in the 320-280°C range. The maximum temperatures increase in depth by 5-6°C every 100 m. The quartz-sphalerite-galena association from the metasomatic bodies was formed at temperatures ranging from about 300°C to 240-230°C, and probably even at 180°C. The quartz association was formed from about 280°C to about 160°C, and the calcite one from about 200°C to 100°C and lower. (Authors' abstract)

KOL'KOVSKI, B., and PETROV, P., 1977, Temperature formation conditions of some hydrothermal Bulgarian deposits: Probl. Rudoobraz., Simp. Mezhdunar. Assots. Genezisu Rudn. Mestorozhd., B. Bogdanov, ed.: Sofia, Bulg., Izd. BAN, p. 135-140 (in Russian).

The formational temps. of the Madan (Md), Madzharovo (Mz), and Vyrlibrezh (Vy) ore fields were estd. from Th of fluid inclusions in quartz, sphalerite, calcite, and barite. Ore deposits of the Md and Vy fields began to form at 300-10°, the temp. increased to 350-60° and in the final stages of ore formation decreased to $\leq$100°. In the Mz field, ore formation began at 270-80° and ended at $\leq$100°. Development of individual mineral parageneses occurred over a temp. range of 60-170°. Horizontal temp. zoning was recognized in productive parageneses. Sphalerites in the ore deposits contained Fe 4-10%. The temps. indicated by Th and the Kullerud (ZnS-FeS) geothermometer disagreed for sphalerites with ZnS:FeS ratio $>$8. (Chem. Abstracts 90: 154875j)

KOLOMENSKII, V.D., CHUPINA, L.Yu., LAURENT'EV, Yu.G., IVANOVA, G.M. and POSPELOVA, L.N., 1978, Inclusions in olivine of the Bragin pallasite: Akad. Nauk SSSR, Meteoritika, v. 37, p. 140-143 (in Russian).

Inclusions of stanfieldite (a phosphate), Ni-Fe, and troilite are described, and 16 analyses of gases (acid gases and O_2, 0.00 in all; CO_2 30 to 76%; H_2O to 28%; N_2 + rare gases 0 to 58%). (E.R.)

KOLONIN, G. R., 1977, Spectrophotometric method and its potentialities in hydrothermal investigations (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, Acad. Sci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. 3, p. 46-47 (in Russian).

KOLONIN, G. R., 1977, Methods of estimation of redox conditions in 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. 3, p. 86-87 (in Russian).

KOLONIN, G.R., 1978, Acidity-alkalinity of ore-forming solutions and possible forms of metal transfer, in Thermobarogeochemistry of the earth's crust and ore formation, N.P. Ermakov, ed.: Moscow, "Nauka" Press, p. 27-34 (in Russian).

In general ore-forming solns. evolve from a relatively alk. stage at high temp. to an acidic stage at 350-450°, to a nearly neutral stage at 200-300°, and then to back to alk. again. Most of the chalcophile metals passes through the stage of acid leaching and remains in soln.; they probably migrate in the hydrothermal solns. mainly as complex ions. After transition of the ore-forming solns. from a mol. to ionic state most of the metals occur in chloride complexes. Transfer of chalcophile metals to hydrosulfide complexes can occur only after the solns. have undergone cooling. Crystn. of the sulfides can be explained only by low stability of complexes. (Chem. Abstracts 89: 166303p)

KOLTUN, L. I. and PIZNYUR, A. V., 1978, Study of mineral-forming solutions in inclusions for the prospecting and exploration of commercial ore bodies: Teor. Prakt. Termobarogeokhim., (Dokl. Vses. Soveshch.) 5th 1976, N. P. Ermakov, ed.: Moscow, Izd. Nauka, p. 169-172 (in Russian).

The Zhireken Mo deposit formed in 5 stages, each of which is characterized by a mineral assocn. pptd. in a particular sequence during cooling of solns. Based on thermobarogeochem. studies of the fluid inclusions in quartz, the gaseous emanations were a NaCl-CO_2-

H_2O mixt., with CO_2 sepd. as the principal gas phase, and were heated to >510-30° at >200 atm. Early, disseminated molybdenite ores in the central part of the deposit formed under conditions favorable for soln. filtration; later galena-sphalerite stockworks formed by pptn. from solns. in rock fissures. Discharge of the productive vein filling solns., at the level of the mine adits, occurred mainly at 350-420°. Formation of intraore fissures caused a drop in pressure, boiling of the solns., migration of the liq. phase, and crystn. of ore minerals. (Chem. Abstracts 91: 77043c, 1979)

KOMOV, I. L., 1978, The contemporaneous use of ionizing radiation and thermobarometry for recognition of the endogene mineral-formation, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 170-171 (in Russian). Author at All-Union Sci. Research Inst. of Synthesis of Artificial Mineral Raw Materials, Alexandrov, USSR.

Gamma-radiation helps to distinguish chloride dms on the basis of their coloring. (A.K.)

KONEV, A. A. and BEKMAN, I. K., 1978, On the nature of gases released during calcination of rocks (as indicated by the nepheline syenite of Pribaikal'ye): Geokhimiya, No. 3, p. 390-397 (in Russian, English abst.). Authors at Inst. Earth's Crust of Siberian Branch of the Acad. Sci. of USSR, Irkutsk.

Gases released during calcination of rocks under inert atmosphere are not the gas components of parent fluid of the rocks. H_2O and CO_2 are mostly formed due to mineral decomposition, and H_2 - due to oxidation of iron in hydrous minerals. (From the authors' abst.; pertinent to studies of gases in fluid inclusions, A. K.)

KONNERUP-MADSEN, J., LARSEN, E. and ROSE-HANSEN, J., 1978, Hydrocarbon-rich fluid inclusions in minerals from the alkaline Ilímaussaq intrusion, South Greenland, in Société Francaise de Minéralogie et Cristallographie, Colloque "Minéraux et Minérais," Nancy, 26-29 Sept. 1978 -- Programme et Resumes des Communications: (Nancy), p. 65. First author at Inst. for Pet., Øster Voldgade 10, 1350 København K, Denmark.

Fluid inclusions in minerals from agpaitic nepheline syenites and hydrothermal veins from the alkaline Ilímaussaq intrusion in South Greenland are very rich in reduced gases such as hydrocarbons (predominantly methane) whereas the contents of CO_2 and CO are insignificant. The hydrocarbon-rich gases are thought to be of inorganic origin and to reflect very low oxygen fugacities during crystallization. It is proposed that they have been trapped as immiscible droplets of hydrocarbon-rich fluids in highly saline (33 to 46 equivalent weight per cent NaCl) aqueous solutions. Isolated hydrocarbon-rich inclusions suggest conditions of entrapment at temperatures from 800 to 500°C and pressures from 1.4 to 0.8 kb. (Authors' abstract)

KONOVALOV, I.V., 1978, Metamorphic paleotemperature zoning of quartz vein fields of gold ore mineralization, (Abst.): Abstracts of the Sixth All-union Meeting, Vladivostok, Sept. 15-18, 1978, v. II, Thermobarogeochemistry and ore genesis: Vladivostok, Acad. Sci. USSR, p. 33-34 (in Russian). Author at Siberian Branch of Acad. Sci. USSR, Irkutsk.

Quartz from Alpine-type veins bears fluid inclusions $\leq 5\mu m$ dia., L 50-70%, Td 400-600°C. The second stage metamorphic veins bear quartz with fluid inclusions 1-20 μm in size, filled by two or three phases (LCO_2+LH_2O+G), Td have peaks at 150-200 and 400-600°C. Gold-bearing veins yielded Td 160-220°C. (From the author's abst.)

KONOVALOV, I. V., BELEVTSEV, Ya. N. and BUKHAREV, V. P., 1977, Temperature-controlled zoning and conditions of formation of gold ore mineral associations, in Metamorfogennoye Rudoobrazovaniye: Moscow, Izdat. "Nauka," p. 164-173 (in Russian).

KOROBEYNIKOV, A.F., 1976, Geochemical behavior of gold in contact-metasomatic processes in granitoid intrusions: Akad. Nauk SSSR, Doklady, v. 227, no. 5, p. 1224-1227 (in Russian; translated in Doklady Acad. Sci. U.S.S.R., Earth Sci. Sect., v. 227, p. 213-216, 1977).

Abstracted in Fluid Inclusion Research -- Proc. of COFFI, v. 9, p. 70, 1976. (E.R.)

KOROBEYNIKOV, A.F. and CHERNYAEV, Ye.V., 1978, Prospecting and evaluation of endogene gold deposits by thermobarogeochemical methods, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. II, Thermobarogeochemistry and ore genesis: Vladivostok, Acad. Sci. USSR, p. 18-19 (in Russian). Authors at Tomsk Polytechnical Inst., Tomsk, USSR.

Gold deposits (names not given) develop decrepitation haloes of activity exceeding 7-80 times the local background. The largest radius of detectable decrepitation haloes (at T 360-70°C), confirmed also by Au and other element haloes, reach 70-100m, especially above ore body. Post-ore dikes cutting the ore zones cause a distinct decrease in decrepitation activity due to earlier natural decrepitation of inclusions. Water leachates detected a zoning of hydrothermal haloes, especially the ratios: K/Na, NH_4/K, SO_4/HCO_3, HCO_3/Cl, which are highest in the intensively mineralized zones and decrease at their margins. Au concentration in ore is positively correlated with Au content in G/L inclusions. In upper zones of some deposits contents of SO_4, NH_4 and NO_2 increase but Cl, K - decrease. The above features may be used for prospecting. (Abst. by A.K.)

KORYTOV, F.Ya., BYAMBA, Zh., ARAKELYANTS, M.M., KHASIN, R.A., KHRAPOV, A.A. and KANDINOV, M.N., New data on the age of fluorite mineralization in Mongolia: Akad. Nauk SSSR Doklady v. 241, no. 5, pp. 1151-1153 (in Russian). First author at Sci.-Research Lab. of Geol. of Foreign Countries, Moscow.

Fluorite from microcline-quartz-cleavelandite-topaz-lepidolite-rubellite-beryl-cassiterite pegmatites in Khukh-Del-Uda yielded Th 215-245°C; from pegmatite Gorikho - 260-320°C; from unspecified rare metal (phenakite) deposits - 90-250°C, from quartz-fluorite formations - 150-200°C. (A.K.)

KORYTOV, F.Ya. and KANDINOV, M.N., 1978, Zoning in the fluorite deposits in Mongolia, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. II, Thermobarogeochemistry and ore genesis: Vladivostok. Acad. Sci. USSR, p. 32-33 (in Russian). Authors at Sci.-Res.

Lab. of Foreign Geol., Moscow, USSR.

Mongolian fluorite deposits usually are polystage. Th varies from 270-60°C; commercial fluorite formed in the Berkhe deposit at Th 170-140°C, Khavt-Gay - 220-160°C, Dzun-Tsagan-Del'- 145-125°C, Khamros - 200-130°C, Khar-Aygar - 195-130°C, Tsagan-Del' - 210-160°C etc. Zoning is seen in Th, mineral composition, ore textures and structures, trace Be, Ba etc. content in fluorite etc. Vertical Th zoning is often "reverse", i.e. the deeper level, the lower the Th. (From the authors' abst.)

KORYTOV, F.Ya., KHRAPOV, A.A. and KANDINOV, M.N., 1978, On the phenakite-fluorite mineralization in Mongolia: Akad. Nauk SSSR Doklady, v. 242, no. 1, p. 190-191 (in Russian). Authors at Sci.-Research Lab. of Foreign Country Geol., Moscow.

One of over 500 fluorite deposits in Mongolia (name not given) occurs in the periphery of an early Cretaceous massif of subalkaline granite located in the center of a ring structure of 30-35 km diameter. This deposit bears Be-F type mineralization (with phenakite). Th of two-phase P inclusions in fluorite and phenakite are 90-250°C, but mostly >200°C. (Abst. by A.K.)

KORYTOV, F.Ya. and SHILIN, N.L., 1978, Gold content in fluorites from several deposits: Izv. Vyssh. Uchebn. Zaved., Geol. Razved., v. 21, no. 6, p. 156-157 (in Russian).

The fluorite deposits occur in ring-structured volcanic terrains. Based on Th of gas-liq. inclusions, the fluorites were formed at 120-250°C. The Au content in fluorites is 2.7-140.0 ppb. Max. Au content is characteristic of fluorites assocd. with pyrite and marcasite. With increasing crystn. temp. of fluorite, the Au content increases. Intensely colored (green and violet) fluorites with an octahedral habit have a high Au content. (Chem. Abstracts 89: 77885n)

KOSALS, Ya.A., 1978, Temperature conditions of crystallization of granitoid magma and its rare-metal ore capacity, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 75-77 (in Russian) Author at Inst. Geol. Geophys. of Siberian Branch of Acad. Sci. of the USSR, Novosibirsk-90.

Considerations based on published melt inclusion data. (A.K.)

KOSUKHIN, O.N., 1978, On the fluid pressure in the formation of pegmatites: Akad. Nauk SSSR, Sibirsk. Otdel., Geol. Geofiz., v. 19, no. 2, p. 148-151 (in Russian; translated in Soviet Geol. and Geophys., v. 19, no. 2, p. 124-126).

A study of the inclusions of mineral-forming substances in the quartz from the early structural-material zones of chambered pegmatites indicates that the fluid pressure in the pegmatite-forming melt considerably exceeded the lithostatic pressure corresponding to the depth at which the chambered-pegmatite bodies were formed. Thus such low-temperature pegmatite magmas were evidently crystallized under conditions closely resembling those of a closed system. (Author's abstract)

KOSUKHIN, O.N., 1978, On certain peculiarities of processes of chamber pegmatite formation, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in Geology: Vladivostok, Acad. Sci. USSR, p. 50-51 (in Russian). Author at Inst. Geol. Geophys. of Siberian Branch of Acad. Sci. of the USSR, Novosibirsk.

P inclusions were studied in quartz of chamber pegmatites from granitoid massifs: Dzhel'tau (Golodnaya Step', Kazakhstan), Dungalinshiy (E.Kazakhstan), Kyrin (E.Transbaikalia), Bektau-Ata (N.Pribalkhash'ye, Kazakhstan), & Kaib (Golodnaya Step', Kazakhstan). Two P inclusion types in quartz were studied: crystallized melt and G/L.

Results of studies of crystallized melt inclusions proves that pegmatoid-granite, aplite, classic graphic and certain other graphic and pegmatoid aggregates of pegmatites crystallized from silicate melt. Distribution of inclusions in host quartz proves the absence of postmagmatic recrystallization of quartz of those pegmatitic zones in significant ranges. Presence of aggregates of coarse quartz and feldspar in graphic and other early zones cannot be used as evidence of recrystallization processes. Results of studies of melt inclusions proves that those agglomerations are not „porphyroblasts" and „metacrysts", but porphyroid phenocrysts.

Crystallization of the studied chamber pegmatites from silicate melt developed at 660-540°C. Intervals of T of magmatic crystallization vary somewhat for pegmatites from various regions.

Studies of P inclusions in quartz showed enrichment of pegmatitic magma in water. The evidences are:

1. Fluid phase of melt inclusions consists of a dense solution plus gas.
2. Presence of P dense G/L inclusions, coeval with melt inclusions, with Th 220-280°C (in L phase) in the Kyrin and Dzhel'tau massifs.

The pressure of fluid in pegmatitic magma at the moment of trapping of P G/L inclusions in graphic quartz was 3.6-3.8kbar. This P for chamber pegmatites exceeds lithostatic overload, which proves the existence of the autoclave effect, i.e. crystallization under conditions similar to a closed system. Low-T remnant pegmatitic magmas form in those parts of granite plutons where separation of volatiles from crystallizing magma was difficult.

Presence of P G/L inclusions in graphic quartz suggests that at the stage of graphic aggregate crystallization, saturation of the magma with fluid may be reached. Finding of melt inclusions in the root parts of quartz crystals from some types of chambers proves that this excess fluid may accumulate, forming chambers (cavities) with commercial mineralization. Such chambers should be distinguished from cavities formed in post-magmatic stage due to opening of pegmatitic system and influx of the outside solutions. (Author's abst., translated by A.K.)

KOVAL', V. B., 1978, Thermobarogeochemical conditions of formation of ore-extracting systems, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 138 (in Russian). Author at Inst. Geochem. and Physics of Minerals of Acad. Sci. of the Ukrainian SSR, Kiev.

Ore-forming solutions extract K at T>400°C, Na at 400-300°C, Ca, Mg and Fe at T<300°C; most of U is extracted at T<400°C. Potassium metasomatism develops at 395-300°C, sodium metasomatism at 290-210°C, carbonate metasomatism at 250-200°C. (From the author's abst.)

KOVAL', V. B. and LITOVCHENKO, Ye. I., 1978, Fluid-accumulating systems in rocks of the Ukrainian shield, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 130-131 (in Russian). Authors at the Inst. of Geochem. and Physics of Minerals of Acad. Sci. of Ukrainian SSR, Kiev.

Certain varieties of metamorphic rocks of the Ukrainian shield, that bear anomalously high contents of fluid inclusions, are named a fluid-accumulating system. It forms under conditions of amphibolite and granulite facies in fissures formed when rocks were plastic (boudinage formation), P of fluid was 5-7 kbar; its main component was CO_2. Quartz, kyanite and feldspar from pegmatites and their wall-rocks (gneisses, migmatites) bear inclusions of dense CO_2 with heterogenization temperatures from -39 to -11°C. Pyroxenes contain polyphase inclusions (L H_2O+L CO_2+solids) with Th 680-720°C. Large fluid-accumulating systems are in deep-seated fault zones. In aplite granites in such zones high-T melt inclusions and secondary two-phase inclusions (Th 700 -450°) occur. (From the authors' abst.)

KOVALENKO, V.I., ANTIPIN, V.S., NAUMOV, V.B., IVANOVA, G.F., and VLADYKIN, N.V., 1978, Mineralogical evidence on the rare-metal ores connection with the acid magmatism (abst.): XI General meeting International Mineralogical Association, Abstracts, v. 1, p. 164 (in English).

The problem of the connection of the rare-metal ores with acid magmas is considered on the base of: a - studying of the distribution coefficients of the elements between phenocrysts and matrix (glass) of acid effusives and ongonites; b - studying of melt and fluid inclusions; c - studying of the composition and structure of typomorphic minerals.

The distribution coefficients of Li, F, Sn, W, Ta, Nb are less than that in the ongonites. The increase of concentrations of these elements up to economic values in the residual acid melts is shown. Thus the formation of the rare-metal ores from the magmatic glasses and other rocks is possible. Be, Li, F, W can be extracted by the fluid and can be precipitated during the hydrothermal stage (greisens and quartz veins).

Inclusion studies of the minerals show that the temperatures of the rare-metal ores (rare-metal granites, pegmatites, greisens, quartz veins) varies from 1000 to 50°C; the character of mineralizing medium changes from the melts with the decreasing viscosity through concentrated solutions (80-50 wt% of salt) to less concentrated solutions (10-5 wt% of salt) with decreasing temperature. The temperature interval of the coexistence of the melts and solutions is 750-550°C.

The mineralogical and geochemical aspects of the connection between the rare-metal ores and the geochemical types of the acid rocks are considered. (Authors' abstract)

KOWALSKI, W., KARWOWSKI, L., ŚMIETAŃSKA, I., and DO VAN PHI, 1978, Ore mineralization of the Stara Kamienica schist zone in the Izera

Mountains: Prace Naukowe Univ. Slaskiego No. 243, Geologia, v. 3, p. 7-90 (in Polish with English abstract). First author at the Instytut Geochemii, Mineralogii i Petrografii, Wydzial Geologii, Uniwersytet Warszawski, 02-089 Warszawa, al Zwirki i Wigury 93, Poland.

T_D of cassiterite, by some authors supposed to be of metasedimentary, clastic origin and by the others--of hydrothermal mineralization in mica-chlorite-garnet schists, was 380-360°C. (Abst. by A.K.)

KOZLOV, E. D. and MASALOVITCH, A. M., 1977, Antimonite solubility in a part of the system Sb_2S_3-NaCl-HCl-H_2O at elevated temperatures (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. 3, p. 44-45 (in Russian; abstract courtesy Dr. A. P. Berzina).

Antimonite solubility at 180°C in 0.034, 0.110, 0.220M HCl and 2M NaCl is 0.27, 0.77, 1.15 g/kgH_2O respectively and increases up to 10.70, 18.32, 26.17 g/kgH_2O at 475°C. In 2M NaCl at 225°C the solubility is about 0.43 g/kg and increases up to 10.84 g/kg at 467°C. A high antimonite solubility is observed in pure water. The estimation of composition of antimony chloride complexes is carried out (this is not in the abstract). The mean ligand number changes from 2.46 to 5.0 with decrease in temperature.

KOZLOV, V. K. and GONCHAROV, V. I., 1977, The use of voltamperometry for study of solutions at elevated temperatures and pressures (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. 3, p. 25-26 (in Russian).

KOZLOWSKI, Andrzej, 1978, Pneumatolytic and hydrothermal activity in the Karkonosze-Izera block: Acta Geologica Polonica, v. 28, p. 171-22 (in English, with 38 plates and Polish summary). Author at Inst. Geochemistry, Mineralogy, and Petrography, Warsaw University., Al. Zwirki i Wigury 93, 02-089 Warszawa, Poland.

The Karkonosze-Izera block in the Sudetes Mts (Southern Poland), consisting of the Karkonosze granite massif and its gneiss-schist cover, named the Izera area, bears numerous pegmatites and pneumatolytic-hydrothermal bodies: veins, silicified cataclastic zones, and metasomatites (leucogranites, greisens and tourmaline nests). A scheme of the formation of early zones of pegmatites by metasomatic recrystallization of aplite under pneumatolytic conditions is presented, being established on textural features. The mode of crystallization of the individual types of veins depended on the type of fracture and the changes of temperature during the fracture filling with minerals. Both pegmatites and veins from Karkonosze formed originally under action of pneumatolytic, and subsequently of hydrothermal fluids, contrary to veins and metasomatites in the Izera area, formed by an activity of essentially hydrothermal fluids. Measurements of temperatures of the homogenization of fluid inclusions and evaluation of the pressure permitted a discussion of real temperatures of the crystallization of hydrothermal mineral assemblages. Geochemistry of major elements in the inclusion fillings i.e. sodium, potassium, calcium, magnesium, aluminum, iron, and chlorine, was characterized. High fluorine content in inclusions, expressed as atomic ratio 1000F/Cl, is typical of metasomatites and ore-bearing rocks in the Izera area, being a possible prospecting tool. Minor and trace elements in inclusion fluids, especially Li, Be and B, have characteristic regional distribution. Bromine content in inclusions gives some genetic suggestions on the origin of mineral-forming solutions. Discussed are also possible relations between diverse hydrothermal deposits in the metamorphic Izera cover and the Karkonosze granite massif. (Author's abstract)

Editor's note: The above author's abstract does not adequately cover this work, which is Kozlowski's doctorate. Numerous rock analyses, and an extensive study of the textures and fluid inclusions in the various stages of quartz growth (and replacement) are presented. Th of various stages in the Karkonosze pegmatites range from 80-580°C, and other areas (Izera, Garby, Izerskie) cover parts of this range. Forty-two leach analyses for up to 14 constituents (Li, Na, K, Be, Mg, Ca, Sr, Ba, Al, Mn, Fe, B , F, Cl are presented and discussed. 123 refs. (ER)

KRASNOVA, N.I. and YAKOVLEVA, T.B., 1978, Comparative evaluation of conditions of ore formation from the Kovdor apatite-magnetite deposit, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok. Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 67-69 (in Russian). Authors at the Leningrad State Univ.

A complex apatite-magnetite deposit occurs in the SW part of central type alkaline-ultrabasic intrusive, Kola Peninsula. The deposit is a pipe-like body of concentric zonal structure. Outer zone consists of early apatite-forsterite rocks, and inner zones of the various magnetite ores cut by calcite carbonatite veins; the youngest ones are francolite-bearing rocks. Inclusions occur in forsterite and apatite of all types of rocks.

Forsterite from apatite-forsterite rocks, in central parts of crystals, bears only P inclusions, up to 5 µm dia., consisting of apatite with minute magnetic dms. Forsterite of magnetite ores bears crystallized PS inclusions (dms: apatite, calcite, magnetite, phlogopite and undetermined). Forsterite from carbonatites bears inclusions that are round calcite aggregates.

Apatite from all types of ores bears many various inclusions of different degrees of filling, Th, etc. In P incs. F is 60-70%, Th 560-800°C (apatite-forsterite ores), or they are filled with G, L + 1-3 dms, one of which is halite (apatite-magnetite ores.) Carbonatite apatite bears G/L incs. occasionally with 1-2 dms, Th from 240-380 to 400-500°C; same inclusions occur in apatite from francolite-bearing rocks.

Forsterite crystallized from solution-melts poor in fluids, and apatite from media rich in fluid. (From the authors' abst, by A.K.)

KRAVTCHUK, K. G. and VALYASHKO, B.M., 1977, Phase equilibria in the system SiO_2 - Na_2O-H_2O at elevated temperatures and pressures (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. 3, p. 48 (in Russian).

KREJCI-GRAF, Karl, 1978, Data on the geochemistry of oil field waters: Geol. Jb. v. 25, p. 3-174, plus 153 tables. Author at Senckenberg-Anlage 32, D-6000 Frankfurt/Main., F.R.G.

The greatest part of interstitial water in sediments as well as in larger cavities of organisms, is soon compacted out. The main phase of oil genesis occurs at about 100 ± 50°C at depths of several thousand metres where the porosity of pelites has sunk below 10%. Organisms consist mainly of water, marine plankton of more than 90%. Such water is partly a free component of cells or tissues, partly bound, e.g. in colloids; it is liberated at putrefaction. More water is generated at the transformation of organic compounds. The dry organic substance from plankton contains 30-40% oxygen, while primary oil contains no oxygen; oxygen is used up in the formation of water. About 40% of the organic substances are transformed into water; under favorable conditions 1-4% may become oil. The main part of interstitial water has been lost when the discharge from tissues and cell components starts; still later the new formation of water begins; thus the remaining water is derived mainly from organic substances. This water contains substances which had been concentrated in organisms, or have been extracted from sea water by sedimenting organic substances. Of diagnostic importance are substances which are independent of chemical conditions in the sedimentary environment. To exclude the influence of differing concentrations, everything is referred to standard elements. Thus, a low Cl: I ratio characterizes marine organic origin if there is no salt in the neighborhood. Some conspicuous components are formed at diagenesis, e.g. H_2S and elementary sulphur when sulphates come in contact with oil, or naphthenic acids in reactions of oil with oxygen or carbonates; while fatty acids occur in most oil field waters. (Author's abstract)

KROL', O.F., KARABANOV, V.A., CHERNOV, V.I., NAYDENOV, B.M., POLYVYANNY, E.Ya., LYAPICKEVA, A.A., 1978, Contribution to the nature of paleowaters in endogene ore formation: Acad. Sci. USSR Doklady, v. 238, no. 3, p. 678-680 (in Russian). Authors at the Kazakh Sci.-Research Inst. of Mineral Raw Materials, Alma-Ata.

Bogutinskoe scheelite vein-stockwork deposit occurs in E. Zailiyskiy Alatau, in terrigeous-sedimentary Cambrian-Ordovician and Carboniferous rocks plus Caledonian granites. Bogutinskoe leucocratic granites and the deposit, are of Upper Siluran-Lower Devononian age. Solutions in fluid inclusions in ore quartz bear Na>>K, Ca, Mg, HCO_3, SO_4, Cl, H_2S, F, T_D 220-360°C. P inclusions in quartz of granite bear Ar of which 60-90 % is atmospheric component, suggesting strong influence of modified vadose waters on granite origin. (Abst. by A.K.)

KROL, O.F., KARABANOV, V.A., CHERNOV, V.I., Naidenov, B.M., Polyvyannyi, E.Ya., and Lyapicheva, A.A., 1978, Nature of paleothermal solutions involved in endogenic ore formation, in Thermobarogeochemistry of the earth's crust and ore formation, N.P. Ermakov, ed.: Moscow, "Nauka" Press, p. 170-173 (in Russian).

See previous item (E.R.)

KRYLOVA, G.I., KHETCHIKOV, L.N., and ANUFRIYEV, Yu.N., 1978, Peculiarities of genesis and their interpretation for evaluation of the erosion of deposits of rock crystal in the Southern Urals: Geol. Rudn. Mest.,

v. 20, no. 5, p. 112-120 (in Russian). First author at All-Union Sci.-Research Inst. of Synthesis of Mineral Raw Material, Alexandrov, USSR.

Three deposits (names not given) were studied. In all regions of the USSR, the vertical extent of rock crystal mineralization reaches 1.5-2 km, but commercial raw material occurs in the range 400-500 m. The minimum formation depth (in the Pamirs) was about 600 m. High-quality rock crystals crystallize usually from weakly-alkaline solutions at T 160-200 to 360-380°C and P 120-1000 atm (i.e., depth 0.5-3.5 km). Deposit I: wall-rocks are crystalline schists with garnet, staurolite and kyanite of epidote-amphibole facies. Corrected T of formation of vein quartz were 400-430°C, rock crystal 400-350°C, final amethyst 200-220°C, P-600-1000 atm down to 400 atm at the amethyst stage. Deposit II: wall-rocks are andesite-porphyrite metavolcanites with extensive metasomatism, G/L incs commonly bear CO_2 in late stages, corrected T from 280-340°C (rock crystal growth) to 360-380°C, P from 600 ± 85 atm to 500-400 atm. Deposit III: wall-rocks are porphyrytoids and schists of andesite-basalt composition, solutions in inclusions are very rich in SO_4 ion, T of vein quartz growth (corrected) 320-300°C, rock crystals--250-160°C, P 330 to 220-170°C. Depth of the deposit formation was evaluated essentially on the basis of metamorphic facies. The paper also details literature data on G in fluid inclusions. (Abst. by A.K.)

KRYLOVA, G. I. and OSTAPENKO, G. T., 1978, Parameters of epidote-amphibolite metamorphic facies in metapelites of the Svetlyi saddle structure (southern Urals): Teor. Prakt. Termobarogeokhim., (Dokl. Vses. Soveshch.) 5th 1976, N. P. Ermakov, ed.: Moscow, Izd. Nauka, p. 75-79 (in Russian).

The physicochem. conditions of metamorphism of the metapelites were assessed from Th of primary inclusions (fluid and fluid-salt) in cordierite, kyanite, andalusite, and acicular sillimanite. The solid phase in gas-liq.-solid inclusions contg. 40-90% solid remained undissolved at ≤700°. Widespread gas-liq. and water-salt inclusions, contg. 20-25% soln., had Th 485-540°. Th for fluid-inclusions contg. 60-80% CO_2 in the gas phase was 200-80°. The temp. of metamorphism was 460-520 and 540-620° for staurolite muscovite and sillimanite-muscovite subfacies, resp. The pressure varied during the multiphase metamorphism. from a min. of 1-3 to a max. of 5-6 kbars. (Chem. Abstracts 91: 60605q, 1979)

KRYUKOV, P.A., STAROSTINA, L.I., LARIONOV, E.G., 1977, Electrochemical methods of investigation of solutions at high temperatures and pressures (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. 3, p. 27-28 (in Russian).

KUCHER, M.I.; BATYRMURZAEV, A.Sh; MATSAPULIN, V.U., and UMAKHANOV, E.M., 1977, Evaluation of diffusion effect on the preservation of inclusions and on the analysis of gases in them: Probl. Rudoobraz., Simp. Mezhdunar. Assots. Genezisu Rudn. Mestorozhd., 4th, B. Bogdanov, ed.: Sofia, Bulg. Izd. BAN, p. 141-146 (in Russian).

Diffusion parameters were detd. on quartz (Q) samples from a polymetallic ore occurrence. Thermometric app. was connected to a mass spectrometer for detn. of the CO_2, N_2, H_2O, H_2, O_2, Cl_2, H_2S, CH_4, Ar, and NH_3 contents released during heating of the samples. The greatest vol. of gas released from fluid inclusions in Q heated for 1 h, was at 400-50°; gases from the crystal lattice were sepd. by heating ≥ 1 h at 600-1000°. The diffusion coeffs. (in cm^2/s) and activation energies (kcal/mol) of gases in the crystal lattice were H_2O 3×10^{-8} and 34, CO_2 1.45×10^{-7} and 46, N_2 7.7×10^{-9} and 34.2, H_2 3×10^{-10} and 44, and CH_4 5.5×10^{-8} and 36. At the normal temps. of stratified rocks and orebodies the coeff. of diffusion of gases is low enough so that almost no gas will be lost from vacuoles over millions of years. Prolonged heating as a result of metamorphism or intrusive activity could alter the compn. of the gases in Q. (Chem. Abstracts 91: 7414a)

KUCHERENKO, Ye. V., 1978, Determination of microquantities of fluoride-ion in water leachates and rocks by paper chromatography, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 158 (in Russian). Author at Inst. Geochem. and Physics of Minerals of Acad. Sci. of Ukrainian SSR, Kiev.

Microquantities of fluorine were determined by paper chromatographic method joined with luminescent method: fluoride ion diminishes luminescence of aluminum-quercitine complex. Also sorption of F by ground mineral at various pH values of leaching solution was studied. The proposed merhod is simple, sensitivity 5 $\mu g/ml$, relative error 2.5%. Quartz sample of 5g or 100 ml of leachate was used for determination. (From the author's abst.)

KUDRIN, A. V., REKHARSKY, V. I. and KHODAKOVSKY, I. L., 1977, On MoO_2 solubility in aqueous solutions at elevated temperatures (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. 3, p. 49 (in Russian; abstract courtesy Dr. A. P. Berzina).

With pH increase in acid solutions at 200-250°C, MoO_2 solubility falls on account of Mo(IV) cation formation in acid media.

KURSHAKOVA, L.D., 1976, Physico-chemical conditions of formation of skarn-boron-silicate deposits: Moscow, "Nauka" Pub. House, 274 pp. (in Russian).

The book is divided into three parts (A.K.):

Part I - Geological-mineralogical characteristics of the lime-ferriferous skarns with overlapped boron-silicate ores

Part II - Experimental study of redox mineral equilibria in the lime-iron skarns

Part III - Conditions of the boron-silicate mineralization based on the experimental and calculation data

KUSHEV, V.G. and MIRONOV, A.G., 1978, Significance of fluid flow of reduced gases in mantle for formation of alkaline melts: Akad. Nauk SSSR Doklady, v. 240, no. 2, p. 431-433 (in Russian). Authors at Geol. Inst. of Buryat Division of Siberian Branch of Acad. Sci. USSR, Ulan-Ude.

Pertinent to melt-gas inclusion studies. (A.K.)

KUZNETSOV, A.G., 1978, Application of thermobarogeochemical methods for detailed prospecting and exploitation of polymetallic deposits in the Northern Caucasus, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. II, Thermobarogeochemistry and ore genesis: Vladivostok, Acad. Sci. USSR, p. 6-7 (in Russian). Author at the Simferopol' Geological Office, USSR.

The studies were performed on the deposits in N. Osetia: Zgid, Arkhon, and Sadon. Samples (quartz, calcite, Mn-calcite, sphalerite, pyrite, wall-rock granites and albitophyres) were collected in ore bodies and at 5, 25, 50, 75 and 100 m from their boundaries. Ores formed at 380-50°C (Th and Td^{2}. - A.K.). Ore bodies develop decrepitation maxima, especially at Td 225-375°C, and CO_2 content maxima, as compared with the background for the wall-rocks. (From the author's abst.)

KUZNETSOVA, S.V., 1978, Thermobarogeochemical characteristics of quartz veins as prospecting criteria for alkaline metasomatic zones with rare-metal mineralization, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. II, Thermobarogeochemistry and ore genesis: Vladivostok, Acad. Sci. USSR, p. 17-18 (in Russian). Author at Inst. Geol. and Phys. of Minerals of Acad. Sci. of Ukrainian SSR, Kiev.

In Precambrian rare-metal apogranitic, apomigmatitic and apogneissic Na-metasomatites quartz veins occur (no location given). The veins bear large numbers of tiny (1-10μm) fluid inclusions with weak decrepitation activity, Th 370-100°C, mostly 270-150°C, filled by $Cl-HCO_3$, Ca-K-Na (+ some F and SO_4) solutions with a total salt concentration ≤10%. The features are typical of rare-metal mineralization. (From the author's abst.)

KUZNETSOVA, S. Ya. and KRIGMAN, L. D., 1978, Solubility of sulfur in silicate melts - models of natural magmas: Geokhimiya, 1978, No. 2, p. 238-247 (in Russian, English abst.) Authors at the Inst. Geochem. and Anal. Chem. of Acad. Sci. USSR, Moscow.

Relations between sulfur and artificial melts of "granite" (S solubility 0.014%) "nepheline syenite" (0.029%) and "agpaitic nepheline syenite" (0.76%) at 1200°C and 1 atm. are pertinent to melt inclusion silicate-sulfide immiscibility. (A. K.)

KWAK, T.A.P., 1978a, The conditions of formation of the King Island scheelite contact skarn, King Island, Tasmania, Australia: Am. Jour. Sci., v. 278, p. 969-999. Author at Dept. Geology, La Trobe Univ., Bundoora, 3083, Victoria, Australia.

At the King Island Scheelite deposit (King Island, Tasmania, Australia) 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, wollastonite, and finally marble. Superimposed on and largely subsequent to this is the tungsten-bearing skarn in the still 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 occurs, while between the hornfels and the pyroxene rock there is a hornblende-rich hornfels. Case (1) occurs where the volumetric hornfels/skarn ratio in the immediate area is large, whereas in case (2) 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 cases (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), whereas the reverse is true in case (2). This is due to Al being retained as grossularite garnet at the periphery of the skarns 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 (sic.) 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° to 510° ± 20°C at the edge. Salinities at the core are low ($\lesssim$5 wt. percent equivalent NaCl), whereas at the 370°C ± 20°C temperature they rise dramatically to nearly 30 wt. 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. Pyrrhotite in the skarn is always rimmed by pyrite suggesting, 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 mol percent) which falls abruptly (to < 1 mol percent) at a distance of half the radius of the crystals. Using pertinent thermodynamic data and the reactions involving (A) andradite-hedenbergite, (B) wollastonite-quartz-calcite, (C) powellite-scheelite-molybdenite-tungstenite, and finally (D) pyrite-pyrrhotite the following semi-quantitative values are suggested. The skarn began to form at T = 350° ± 20°C, $f_{O_2} < 10^{-42}$, $f_{CO_2} < 10^{-0.5}$, and $f_{S_2} < 10^{-10}$ from a relatively dilute solution. At the interpreted faulting period T = 370° ± 20°C, $f_{O_2} \lesssim 10^{-41}$, $f_{CO_2} \lesssim 10^{-0.5}$, and $f_{S_2} \gtrsim 10^{-0.5}$ with the solution becoming fairly saline. Near the termination of the episode T = 505° to 510° ± 20°C, $f_{O_2} \gtrsim 10^{-25}$, $f_{CO_2} \cong 10^{-12}$, and $f_{S_2} \gtrsim 10^{-5.5}$. 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)

KWAK, T.A.P., 1978b, Mass balance relationships and skarn-forming processes at the King Island scheelite deposit, King Island, Tasmania, Australia: Am. Jour. Sci., v. 278, p. 943-968.

KWAK, T.A.P., 1978c, Justification of the use of fluid inclusion data--relation of fluid inclusion results to observed ore-forming fluids, in Notes for Workshop on Fluid Inclusions: Melbourne, Dept. Geology, La Trobe Univ. (unpaginated, mimeographed).

A 7-page review. (E.R.)

KWAK, T.A.P., 1978d, Analysis of daughter minerals by SEM, in Notes for Workshop on Fluid Inclusions: Melbourne, Dept. Geology, La Trobe Univ. (unpaginated, mimeographed).

A brief review (11 pages) including photomicrographs from Metzger et al. (1977; Fluid Inclusion Research--Proceedings of COFFI, v. 10, p. 177, 1977). (E.R.)

KYLE, J.R., 1977, Development of sulfide-hosting structures and mineralization, Pine Point, Northwest Territories: Ph.D. dissertation, Univ. of Western Ontario; London, Ont.; Can.

Includes some study of fluid inclusions but text unavailable at present. (E.R.)

LAGACHE, M., 1978, Cation exchange equilibria between aqueous chloride solution and ternary feldspars (Ab, An, Or) from 400°C to 700°C and 1 to 2 kbar (abst.): XI General Meeting of International Mineralogical Association, Novosibirsk, Abstracts, v. 1, p. 174-175 (in English).

LAPTEV, Yu. V. and KOLONIN, G. R., 1977, Study of Bi_2O_3 solubility at elevated temperatures (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. 3, p. 50 (in Russian; abstract courtesy Dr. A. P. Berzina).

The rise of Bi_2O_3 solubility in H_2O with temperature increase from 10^{-6}mol at 25°C to 10^{-4}mol at 75°C and to 10^{-3}mol at 300°C is established. In solutions acidified by $HClO_4$ the increase of bismuth concentration is due to the formation of bismuth cations. In alkaline solutions (up to $2 \cdot 10^{-3}$mol at pH=12) the increase of Bi_2O_3 solubility at 300°C is observed due to existence of a bismuth anion.

LARIONOV, E.G., 1977, On calculation of electrolyte diffusion coefficients at temperatures up to 150 C and pressures up to 8000kg/cm^2 (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. 3, p. 29-30 (in Russian).

LATTANZI, P. and TANELLI, G., 1978, Speculations on cotunnite genesis in the pyrite deposit of Niccioleta, Tuscany: Rendiconti Soc. Ital. Mineral. Petrol., v. 34, p. 37-44 (in Italian, emended abstract courtesy P. Lattanzi).

Crystals of cotunnite, $PbCl_2$, have been found in vug association with euhedral pyrite, sphalerite and galena in the pyrite deposit of Niccioleta (Tuscany, Italy). The mode of occurrence, the lack of evidence for sulphide alteration, as well as the lack of supergene minerals (phosgenite, anglesite, etc.), which always accompany cotunnite in all known occurrences in ores, suggest that at Niccioleta cotunnite is a primary, rather than a secondary, mineral, namely the last crystallization product of the same environment in which the associated sulphides were formed. The observed paragenesis, in agreement with Fe content in sphalerite and sulphur isotope fractionation between sphalerite and pyrite, suggests an environment of formation characterized by low temperature (possibly below 100°C), moderately low pH and Eh, high Cl and low S contents. These features reflect those of a typical ore-forming brine. (Authors' abstract, emended).

LAZARENKO, E.A., KOZLOV, I.T., KOZLOVSKIY, L.M., KUTSEVOL, L.I. and SHUKAYLO, L.G., 1978, Temperature of crystallization of minerals of magmatic and postmagmatic stages of formation of liparite in Carpathians, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 107-109 (in Russian). Authors at Dnepropetrovsk Geol. Inst., Dnepropetrovsk, USSR.

Post Miocene liparite formation occurs in large area of Inner Carpathians and consists of three levels of liparite tuffs and ignimbrites with few late liparite extrusions. Thermometric studies were made using samples from the Beregovo region. Melt inclusions (G+glass) in the inner parts of quartz phenocrysts have Th 148°C (sic; probably a misprint for 1480°C? - A.K.), suggesting the beginning of crystallization of quartz from magma poor in water. Intruding magma probably then absorbed water from wall rocks. Th of melt inclusions in apatite was 1300°C. Tridymite in lenticular aggregates bears pneumatolytic inclusions with Th 550-600°C. G/L inclusions in barite homogenized at 360-410°C in L, in later quartz and barite (secondary quartzite) - at 150-280°C, in the latest barite - at 50-60°C; vein alunite bears one-phase L H_2O inclusions. (Authors' abst., translated by A.K.)

LAZARENKO, Ye. Ye., 1978, Post-magmatic fluids of the Lower-Proterozoic rocks of the Belaya Tserkov' region in the Ukrainian shield, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 132-133 (in Russian). Author at Inst. Geochem. and Physics of Minerals of Acad. Sci. of the Ukrainian SSR, Kiev.

Feldspars and quartz from migmatites, vein granites and pegmatoid veins in biotite-amphibolite schists were studied. Migmatites bear only low-T S heterogeneous inclusions. Inclusions in pegmatoids (up to 10 μm long) are filled by L (60-90%) + (G, homogenizing in L, essentially by G, and by L H_2O + L CO_2 + G; Th of most of inclusions is 180-300°C; only part has Th 450° in microcline and 525°C in quartz (both in L). Low T has total salt concentration (by cryometry) of 30-35% NaCl. P equiv was 3-5 kbar and T during metamorphism was at least 500-700°C, and then quartz-microcline substrate was melted. (From the author's abst.)

LAZUTKINA, L.N., KOGARKO, L.N. and ROMANCHEV, B.L., 1978, Conditions of crystallization of eudialite from the Lovozero massif, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 56-58 (in Russian). Authors at G.I.N. B.F., Sib. Branch of Acad. of Sci., USSR, Ulan-Ude.

The studied eudialite specimens were from agpaitic nepheline syenites of the Lovozero massif, namely from eudialite luiavrites and eudialitites (60-80% of eudialite). By electron microprobe following dms in inclusions in eudialite were found: nepheline, K-spar, eudialite, pyroxene and lamprophyllite. Th of inclusions 800-860°C; (only eudialite phenocrysts in porphyric luiavrites are somewhat higher-870-900°C.) Published data on Th of inclusions in other minerals of the same rocks are in the same ranges: 800-860°C. (From the authors' abst., by A.K.)

LEEMAN, W.P., 1978, Distribution of Mg^{2+} between olivine and silicate melt, and its implications regarding melt structure: Geoch. Cosmo. Acta, v. 42, p. 789-800.

LEEMAN, W.P. and LINDSTROM, D.J., 1978, Partitioning of Ni^{2+} between basaltic and synthetic melts and olivines - An experimental study: Geoch. Cosmo. Acta, v. 42, p. 801-816.

LEMMLEIN, G.G., 1952, Migration of liquid inclusions in a crystal toward a source of heat: Akad. Nauk SSSR Doklady, v. 85, no. 2, p. 325-328 (in Russian). Author at the Inst. of Crystallography of the Acad. Sci. of the USSR, Moscow. (See translations)

LENNIKOV, A.M., MOISEENKO, V.G. and MALAKHOV, V.V., 1978, Gaseous phase of plagioclases of the Dzhugdzhur anorthosites: Acad. Sci. USSR Doklady, v. 238, no. 3, p. 684-686 (in Russian). Authors at the Far East Geol. Inst. of the Far-East Sci. Center, Vladivostok.

Plagioclases of the Dzhugdzhur massif bear tiny (0.5-1μm) G inclusions and much rarer crystallized melt inclusions up to 8-10μm. Opened by heating, inclusions were analysed by gas chromatography. Water occupies 36-94 vol. % of total G, CO_2 4-45%, CO 1-15%, CH_4 0.2-3.0%, H_2O 0.8-28%, N_2 0.2-5%, total gases 1300-3800 cm^3/kg of sample (0.12-0.31 wt%). Possible influence of those H_2O-rich fluids on anorthosite formation is discussed. (Abst. by A.K.)

LEROY, Jacques, 1978, Contribution to the evaluation of internal pressure in fluid inclusions when they decrepitate, in Société Francaise de Minéralogie et Cristallographie, Colloque "Minéraux et Minérais," Nancy, 26-29 Sept. 1978 -- Programme et Resumes des Communications: (Nancy), p. 51. Author at Equipe de Recherche sur les Equilibres entre Fluides et Minéraux, E.N.S.G., B.P. 452, 54001 - Nancy et C.R.P.G., C.O. n^{o}1, 54500 - Vandoeuvre-les-Nancy, France.

The pressure inside a fluid inclusion increases with temperature. When this pressure exceeds the strength of the walls of the host mineral, the inclusion decrepitates. Previous data on synthetic or natural quartz crystals, obtained either by decrepitometry or by microthermometry lead to variable values of this decrepitation pressure. The size of the inclusions is one of the factors some times considered as responsible for the variations of the pressure.

New values have been obtained by microthermometry on two-phase inclusions from synthetic quartz crystals. The thickness of the plates is 0.2 mm. For inclusions larger than 35 micrometers, the decrepitation pressure is 850 ± 50 bars, as previously determined by Naumov et al.(1966). When inclusions are smaller, the pressure increases up to 1200 bars for a size of 12-13 micrometers. For inclusions smaller than 12 micrometers pressures up to 2.7 kbar were obtained without any decrepitation. (Author's abstract)

LEROY, Jacques, 1978, Metallogenesis of the uranium deposits of the La Crouzille district (COGEMA - Nord Limousin - France): Sci. de la Terre, Memoires, no. 36, 276 pp. (In French with English abstract.)

This is the full paper (276 pp.) corresponding to the next item. It has a long chapter V on inclusion studies (p. 137-172), and on their interpretation (Chapt. VI). (E.R.)

LEROY, Jacques, 1978, The Margnac and Fanay uranium deposits of the La Crouzille district (Western Massif Central, France): Geologic and fluid inclusion studies: Econ. Geol., v. 73, p. 1611-1634. Author at Equipe de Recherche Sur Les Equilibres Entre Fluides et Minéraux, Centre de Recherches Pétrographiques et Géochimiques, Case Officielle No. 1, 54500 Vandoeuvre-Les-Nancy, France.

The uranium deposits are located in the Saint-Sylvestre granitic plutonic complex. The existence of two granitic facies (Brame and Saint-Sylvestre) is due to magmatic and deuteric processes (muscovitization, albitization) operating within the same plutonic complex. These phenomena obliterated the primary features and caused a reequilibration of the initial catazonal paragenesis (sillimanite-orthoclase) to mesozonal conditions (muscovite-biotite).

Lamprophyric magmatic activity produced localized hot spots. This heat flux caused the reheating of the cold waters which impregnated the plutonic complex and produced a convective fluid circulation as in modern geothermal systems. The fluids were channeled into faults and fractures of the east-west-north-south fracture system causing the micaceous episyenitization of the granite (dissolution of quartz, total muscovitization of plagioclase and biotite, and partial replacement of orthoclase). An earlier type of episyenite (feldspathic episyenite produced by quartz dissolution, chloritization of biotite, and feldspathization of muscovite) is considered to have been produced during the plastic P_4 deformation which folded the Saint-Sylvestre plutonic complex into an anticlinorium (NNE to NE fold axes).

Pitchblende and pyrite mineralization immediately followed the emplacement of the lamprophyres and the micaceous episyenitization of the granite. The mineralization was precipitated from a CO_2-rich fluid by the unmixing of complex CO_2-H_2O mixtures following a drop in pressure. The temperature of the solutions in the 132 episyenite column of the Margnac mine was approximately 345°C.

After pitchblende deposition, the fluid became progressively more water-rich during the precipitation of microcrystalline quartz and hematization of pyrite. The deposition of quartz plus marcasite and the transformation of pitchblende to coffinite took place during falling temperatures (330° to 140°C) related to the progressive decay of the geothermal system. The formation of the deposit ended with the deposition of fluorite, barite, and calcite, beginning at 135°C and continuing to a lower temperature. (From the author's abstract)

LETNIKOV, F. A., 1978, Problem of trapping of fluid components in metamorphic and magmatic rocks, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 129-130 (in Russian). Author at Inst. Earth's Crust of Siberian Branch of Acad. Sci. of USSR, Irkutsk.

Trapping of fluids by minerals occurs by several mechanisms, but mostly by sorption. The sorbed molecules of fluid during "aging" of crystal and ordering of its structure form visible fluid inclusions of various composition, separated into defects in the crystal. This does not exclude the formation of primary inclusions, but that rare phenomenon appears only during presence of fluid phase during crystallization of magmatic rocks. Because most rocks crystallizes from melt undersaturated by volatiles, a fluid phase is trapped by the sorption mechanism. In each rock, the minerals have selective abilities to trap fluids, depending on acid-alkaline properties of faces of growing crystal, composition and P-T of fluid. Strong preference of fluid in partitioning of chlorine between fluid and melt is observed. Author suggests an increase in the NaCl and KCl content in fluid inclusions after trapping, whereas salt concentration in fluid in equilibirum with melt was 2-3 orders lower. Thus, composition of G/L inclusions does not reflect the composition of fluid in equilibrium with melt (experimental data). Extraction of the whole amount of volatiles from all minerals may help in recognition of the former fluid composition. (From the author's abst.)

LETNIKOV, F.A., MEDVEDEV, V.Ya., and IVANOVA, L.A., 1978, Interaction of granitic melt with carbonates and silicates: Novosibirsk, Siberian Branch of the "Nauka" Publishing House, 151 pp. (in Russian). Authors at the Inst. of the Earth's Crust of Acad. Sci. USSR, Irkutsk.

The book contains descriptions of experiments on interaction of granitic melt and carbonate in water-free systems, including runs with $CaCO_3$ and $MgCO_3$ under 1 atm, and with calcite or dolomite under P 1000-4000 atm. The next topic is the system water-granitic melt-carbonate and problems of migration of water through granite melt under total $P>PH_2O$, i.e., so-called "transmagmatic streaming." Special attention is paid to the partitioning of elements between phases in the studied systems. The last chapters describe reactions between granitic melt and silicates under $P_{tot.} = PCO_2$, $P_{tot.} = PH_2O+CO_2$, & $P_{tot} = PH_2O$, evolution of silicate melts due to their structural and kinetic peculiarities and problems of reactions of mineral-formation in connection with acid-alkaline features of the compounds. The book is pertinent to the forming of melt inclusions and course of their homogenization as well as to the homogeneity problem. In granitic glass from the runs fluid inclusions were found with: 1) G 8% + L 92%, 2) G 5-8% + L 45-82% + dms (halite and sylvite) 10-50%, 3) L 75% + dms 25%, no G phase (vol.%). Size of inclusions ranges from 0.04 to 0.05 mm. Since halides were not added in the reagents used, NaCl and KCl should be extracted by water phase from the mineral substance. (Abst. by A.K.)

LEVITSKIY, V.V., DEMIN, B.G., KHRENOV, P.M. and POPIVNYAK, I.V., 1978, Physico-chemical conditions of formation of sulfide-quartz dispersed veinlets and vein zones of the Baykal area: Akad. Nauk SSSR Doklady v. 241, no. 5, pp. 1190-1192 (in Russian). Authors at the East-Siberian Sci.-Research Inst. Geol., Geophys, and Min. Raw Mat., Irkutsk, USSR.

A number of deposits (presumably native gold ore; AK) of the Baykal and Lena areas were studied (deposit regions Varalon, Uryakh, Severnyi, Irokinda, Berikul', Bestyube, Basil'kovsko, Arkharly, S. Kuder). Th of the ore stage inclusions is 190-320°C or 200-240°C, heterogeneous CO_2-H_2O solutions are common. P ranges from 1300 to 30 atm. CO_2 is the main G in fluid inclusions, (5-89 vol.%), the second one is N_2 (5-77 vol.%), moreover H_2, CH_4, O_2 and "acid gases" (total NH_3 SO_2, SO_3, HF, HCl) are present. (Abst. by A.K.)

LIKHATCHEV, A. P., KOZHEVNIKOVA, L. I. and POLENKOV, A. I., 1977, On conditions of solubility, transport and precipitation of chemical elements by aqueous 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. 3, p. 74 (in Russian).

LIKHOYDOV, G.G., 1978, Stability of association aegirine+quartz+hematite according to experimental data: Akad. Nauk SSSR Doklady, v. 242, no. 3, p. 704-706 (in Russian). Author at the Inst. Exper. Mineral. of Acad. Sci. USSR, Chernogolovak.

Experiments were carried in pure water and NaCl solution up to 0.5 molal, T up to 500°C, P up to 6 kbar; pertinent to fluid inclusion studies. (A.K.)

LINDBLOM, S., 1978a, Variations in the environment of sphalerite deposition in Laisvall revealed by color zoning and fluid inclusion data: Org. 78, Annual Report of the Ore Research Group, Stockholm Univ., p. 38-55.

Color zoning in sphalerite has been observed for the first time in Laisvall. Relict open pores in coarse-grained sandstone have been found. They have the appearance of minute crystal-lined vugs. Modal fluid inclusion temperatures were distinct for different crystals. The results show that very small variations in depositional environment may be worked out and correlated throughout the mineralization. At least three stages of sphalerite deposition may have occurred. (Author's abstract)

LINDBLÖM, Sten, 1978b, Fluid inclusion studies of the lead-zinc-bearing arenaceous sediments at Laisvall, Sweden, in Société Francaise de Minéralogie et Cristallographie, Colloque "Mineraux et Minerais", Nancy, 26-29 Sept., 1978--Programme et Résumés des Communications: (Nancy), p. 67. Author at Geol. Inst., Kungstensgatan 45, Box 6801, 113 86 Stockholm, Sweden.

Laisvall is the largest of several lead-zinc sandstone deposits along the eastern margin of the Scandinavian Caledonian mountain range. The ore occurs as interstitial filling between sandgrains in an Eocambrian suite of quartzitic sandstones. The deposit has apparently been very little affected by metamorphism. For this reason most of the fluid inclusions found are thought to reflect the original nature of the ore-forming fluids. Fluid inclusions in sphalerite, calcite, fluorite and quartz have been measured with respect to melting and homogenization temperatures. T_f (i.e., Tm ice; Ed.) was found to vary between -16.5 and -27.8°C for sphalerite with a modal value around -22°C. T_f in calcite ranged from - 9.5 to -31.2°C, showing two separate groupings below -20°C and above -15°C. Th ranged from 135.3 to 177.5 for sphalerite showing a clear mode around 155°C in the Upper Sandstone and 165°C in the Lower Sandstone. Calcite showed a larger spread from 105.9 to 209.2°C and two maxima may be discovered at 145°C and 180°C. Fluorite and quartz measurements are fewer but the results agree with the sphalerite and calcite measurements. Several textural relationships testify against any major recrystallization of pore minerals and strengthen the conclusion that the ore was deposited from a slowly moving solution of high salinity at 150 - 160°C. Part of the calcite may have been deposited at a later phase of this event or from a different solution altogether. (Author's abstract)

LINDSTROM, D.J. and WEILL, D.F., 1978, Partitioning of transition metals between diopside and coexisting silicate liquids. I. Nickel, cobalt, and manganese: Geoch. Cosmo. Acta, v. 42, p. 817-831.

LISITSYN, A. E. and RUDIEV, V. V., 1978, Some physicochemical conditions for the formation of borosilicates in skarns: Teor. Prakt. Termobarogeokhim., (Dokl. Vses. Soveshch.) 5th 1976, N. P. Ermakov, ed.: Moscow, Izd. Nauka, p. 139-142 (in Russian).

Datolite, danburite, quartz assocd. with these 2 minerals, calcite and apophyllite have 1-, 2-, and multi-phase fluid inclusions. Minerals trapped in the inclusions include calcite, quartz, datolite, and halite. Based on homogenization characteristics of the inclusions the temps. of formation are: danburite 310-420, datolite 270-420, quartz 265-400, and calcite 165-365°. The apophyllite formed from cold aq. solns. The solns. in the inclusions contain 8-30 wt.% dissolved solids. The inclusions in post-ore quartz have high B concn. (Chem. Abstracts 91: 60606r, 1979)

LONGINELLI, A., DONGARRA', G, and RICCHIUTO, T.E., 1978, Isotope geochemistry of two evaporite formations, Sicily. Rendiconti Soc. Ital. Mineral. Petrol. v 34, p. 153-160 (In Italian with English abstract). First author at Ist. Mineral., Petro., Geochim. - Univ. di Palermo, via Archirafi 36, 90123 Palermo, Italy.

Isotopic measurements have been carried out on gypsum and marl samples from the Upper Messinian sequence of Eraclea Minoa (Agrigento) with the purpose of obtaining information on the environmental conditions of deposition of the evaporitic sediments. Oxygen and sulfur isotopic composition of sulfate, oxygen isotopic composition of the water of crystallization of gypsum and oxygen and carbon isotopic composition of carbonate have been measured on about 50 samples. From the results obtained the following conclusions can be drawn: 1) large contributions of fresh water affected the basin during the deposition of the evaporites (chaotic gypsum, gypsarenite, and balatino) which form the lower part of the Eraclea Minoa section; 2) gypsum is often of secondary origin in the sense that it underwent at least one cycle of dissolution and reprecipitation (mainly in fresh or brackish water) before its final deposition. Selenitic gypsum itself, whose conditions of precipitation can be referred to rather homogeneous conditions of evaporating marine brines, shows δ_O^{18} values of the water of crystallization consistently more negative than the values which can be measured nowadays in the brines of salinas; 3) the isotopic composition of carbonate in the marls (both oxygen and carbon) is close to that of normal marine carbonate with a moderate shift towards more negative values. This proves that the studied carbonaceous sediments were never deposited from evaporated sea water. They were probably precipitated either from normal sea water or from a mixture of evaporated sea water and meteoric water; 4) very negative δ_O^{18} and δ_S^{34} are found in the non-selenitic gypsum from the seventh cyclothem. These values strongly suggest that the basin was filled over a relatively long time by meteoric water which extensively re-dissolved and re-precipitated older evaporites. Biological metabolic processes probably affected the dissolved sulfate causing the striking enrichment in light isotopes of these samples. (Authors' abstract)

LONGINELLI, A. and RICCHIUTO, T.E., 1977, The role of meteoric waters in the Messinian salinity crisis: Boll. Soc. Geol. Ital. v. 96, p. 423-428. (In Italian, with English abstract). First author at Ist. Mineral., Petrog. e Geochim., Univ. di Palermo, via Archirafi 36, 90123 Palermo, Italy.

The oxygen isotopic composition of the water of crystallization of gypsum samples can provide information on the conditions of precipitation of evaporites. $\delta_{O}18(H_2O)$ measurements have been carried out on gypsum samples from Northern Italy (Santerno Valley and Brisighella), Tuscany (Badia), Sicily (Palermo and Agrigento provinces) and DSDP cores (Sites 374, 376 and 378A). The samples studied show no evidence of dehydration and rehydration during their geological history. Processes of isotopic exchange between the water of crystallization and meteoric water are considered rather improbable because of the good preservation of the samples, their age (5-6 M.Y.) and the results of a comparative examination of the data obtained with the isotopic composition of sulfates and carbonates from the same formations. The results obtained suggest that the addition of relatively large amount of meteoric water to the evaporating basins was characteristic of the Messinian environment in both Eastern and Western Mediterranean. Such an assumption if of importance as regards the conditions of deposition of evaporites, the duration of the salinity crisis, the sedimentation rates and the desiccation model itself. However, further measurements, which are now being carried out, are needed to obtain more detailed information in this direction. (Authors' abstract)

LU, Huanzhang, YU, Cimei, and SHI, Jixi,1978, Inclusions in the Jilin meteorite: characteristics, temperatures of formation and implications: Geochemica, 1978, no. 1, p. 41-45 (in Chinese with English abstract).

Glass and gas inclusions have been observed in olivine and other minerals in 30 doubly polished thin sections of the Jilin* meteorite, indicating that there must have been melting and condensation stages during the process of meteorite formation. Temperatures of formation have been determined by quenching and homogenization runs, giving 1050-1200°C and 502°C for glass and gas-rich inclusions respectively. Meanwhile, the fibrous radial crystals of pyroxene have been noticed to grow when heated over 800°C. These observations are in general agreement with the available experimental data and theoretical calculations regarding meteorites. (Authors' abstract)

*Ed. notes: This was previously transliterated Kirin. The nature of the liquid phase in the gas-rich inclusions is unstated. (ER)

LUCKSCHEITER, B., and PAREKH, P., 1977, A new method to analyse fluid inclusions in minerals (abst.): 7. Seminar, AKTIVIERUNGSANALYSE, Geesthacht, 7. und 8. November 1977, Kurzfassung der Vorträge, GKSS Forschungszentrum Geesthacht, p. 5 (in German).

No other information available at this time. (E.R.)

LUDDEN, J.N., 1978, Fractionation trends defined by residual glasses in the lavas and xenoliths of Piton de la Fournaise, Reunion Island: Canadian Mineralogist v. 16, p. 265-276. Author at Dept. Geol., The University, Manchester M13 9PL U.K.

Microprobe analyses of glass which occurs as late-stage segregations in gabbroic xenoliths included within the olivine basaltic lavas of Piton de la Fournaise, Reunion Island, are used to define the closed-system, low-pressure evolutionary trend for the basaltic liquids. Glass of a trachytic composition located in a doleritic sample associated with recent scoria activity on Fournaise and hawaiitic vein segregations in an olivine basalt lava lake follow low-pressure evolutionary trends similar to those defined by the glass in the gabbroic xenoliths. Using fractional crystallization models, the Fournaise evolutionary trend has been compared to that of the adjacent volcanic centre, Piton des Neiges, which displays a sequence of lavas ranging from ne-normative hawaiite to qz-normative trachyte. This comparison shows that the chemical variation within both the Piton des Neiges Differentiated Series lavas and the Piton de la Fournaise glasses may be accounted for by low-pressure fractionation of mineral assemblages comprising olivine + clinopyroxene + plagioclase + magnetite. Rare occurrences of highly oxidized glass of a rhyodacite composition as vesicle infillings in some lavas are interpreted to have formed as a result of local development of high $P(O)_2$ conditions, possibly by inclusion of groundwater in the basaltic melt. Alkaline glass ($Na_2O + K_2O = 10.8$ wt. %) occurs as primary inclusions within the olivines of a dunite xenolith; these compositions may provide evidence for immiscibility between alkali-rich and basaltic liquids in the low-pressure magma reservoir. (Author's abstract)

LUDINGTON, Steve, 1978, The biotite-apatite geothermometer revisited: Amer. Min. v. 63, p. 551-553. Author at U.S. Geol. Survey, Reston, VA 22092.

The proposed biotite-apatite geothermometer of Stormer and Carmichael (1971) is refined by taking the effect of octahedral cation substitution in biotite into account and by incorporating some new thermochemical data for the phases involved. For the reaction, biotite (F) + apatite(OH) $\rightleftharpoons$ biotite(OH) + apatite(F), it is proposed that T(Kelvins) = 1100/log K*, where log K* = log $[X_F/X_{OH}]_{ap} + \log [X_{OH}/X_F]_{bio} - 1.107 (X_{annite}) - 1.444 (X_{siderophyllite})$. These revisions lead to higher calculated temperatures. (Author's abstract)

LYAKHOV, Yu.V., 1973, Errors in determining pressure of mineralization from gas-fluid inclusions with halite, their causes and ways of eliminating them: Zapiski Vses. Mineral. Obsh., v. 102, no. 4, p. 385-393 (in Russian; see translation section).

LYAKHOV, Yu.V., 1978, Changes of composition of mineral-forming solutions in process of formation of gold ore fields: Mineral. Sborn., v. 32, no. 2, p. 72-86 (in Russian). Author at the L'vov Univ., Ukrainian SSR.

The general scheme of ore-forming process in gold ore deposits may be presented as follows: 1) quartz-molybdenite stage (>450-280°C, 1200×10^5-1000×10^5 Pa), 2) tourmaline-quartz stage (>430-280°C, 1200×10^5-800×10^5 Pa), 3) early sulfide stage (>450-260°C, 1000×10^5-520×10^5 Pa), 4) gold-sulfoantimonite-polymetal stage, i.e., commercial stage (335-170°C, 950×10^5-600×10^5 Pa), 5) quartz-carbonate stage (230-40°C, 430×10^5-200×10^5 Pa); upper range of salt concentrations as NaCl equiv. is 38-48% for stage 1, 32-50% for 2, 25-43% for 3, 29-35% for 4;

most common values range from 2 to 44%. For various deposits L CO_2 in inclusions appears in any stage. Ion composition in solutions change from formula Cl, $HSiO_3$(?), Na through $HSiO_3$(?), HCO_3, Na, Ca, Mg; HCO_3, $HSiO_3$(?), Ca, Mg to HCO_3, Ca, sometimes with F. Gas composition is: $CO_2 + H_2S$ 1-99%, O_2 0-5%, H_2 0-21%, C_nH_{2n+2} 1-68%, N_2 + rare gases 0-96%. (Abst. by A.K.)

LYAKHOV, Yu. V. and POPIVNYAK, I. V., 1977, Physicochemical conditions of development of gold mineralization in Northern Buryatia: Akad. Nauk SSSR Izvestiya, 1977, no. 6, p. 5-18 (in Russian; translated in Intern. Geol. Review, 1978, v. 20, no. 8, p. 955-967).

This is apparently the full paper corresponding to an abstract with similar title in COFFI, v. 10, p. 163-164 (1977). (ER)

LYASHCHENKO, A. K., 1977, State of water in aqueous salt systems and temperature effect on salt solubility (abst.) in Main parameters of natural processes of endogenetic ore formation (Abstracts of papers of the All-Union Meeting, Novosibirsk, 1977): Novosibirsk, Acad. Aci. U.S.S.R., Sci. Council on Ore Formation, Siberian Branch, v. 3, p. 51-52 (in Russian).

McLACHLAN, D., Jr., 1978, Progress in crystal-growth theory: Canadian Mineral., v. 16, p. 415-425.

Pertinent to studies of fluid inclusion trapping processes. (ER)

McSWEEN, H. Y., JR. and STOLPER, E., 1978, Shergottite meteorites, In Mineralogy and Petrography: Lunar and Planetary Science IX, Houston, the Lunar and Plan. Inst., p. 742-734.

Elongated glass inclusions occur in whitlockite, oriented normal to the plane of foliation, often contain small crystals of opaque minerals concentrated at the same ends, suggesting accumulation in a gravity field. (From the authors' abstract).

MAKAGON, V.M., TAUSON, L.S. and KUZ'MINA, T.M., 1978, Physicochemical conditions of pegmatite formation with different ore specialization in E. Siberia, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 54-55 (in Russian). Authors at the Geochem. Inst. of Siberian Branch of Acad. Sci. of the USSR, Irkutsk.

Minerals in muscovite pegmatites bear inclusions consisting of melt, liquid, or G/L. Melt inclusions sometimes bear water solution or L CO_2. Those inclusions occur in pegmatoid zones and, seemingly, formed under rapid P decrease and heterogenization of the melt-solution. Th of water solution and L CO_2 is 250-330°C; complete homogenization was not achieved. Formation of those minerals was at 500-350°C and P 4-1.4kbar. In L phase $K > Na$, and HCO_3 is the main anion. Inclusions of melt-solution were found in spodumene of spodumene-microcline-albite pegmatites: crystallized silicates, water solution and CO_2; complete homogenization was not achieved. G/L inclusions in late pollucite homogenized at 510-390°C, P 4-4.5 kbar in the beginning and then rapidly decreases. The unstable tectonic regime played a large role in process of pegmatite formation, causing rapid P decrease and escape of CO_2 from the fluid. L phase contains high concentrations of Na, Cl and Li.

Veins of microcline-albite pegmatites crystallize at T 700-270°C, with a variable T at the start. Great role of H_2O, F, B and P was revealed; Na and Cl are common, HCO_3 is low. These pegmatites formed under low P. (Authors' abst., translated by A.K.)

MAKHSIMOVA, V. V., ed., 1977, Prognosis of estimation of the ore-bearing capacity of volcanogenic formations: Moscow, "Nedra" Press, 296 pp. (in Russian).

Contains several chapters with data on melt inclusions that are separately cited in this volume of COFFI. (E.R.)

MÄKIPÄÄ, Heikki, 1978, Petrological relations in some Icelandic basaltic hyaloclastites: Bull. Geol. Soc. Finland, v. 50, pt. 1-2, p. 81-112. Author at Nordic Volc. Inst., Univ. Iceland, 101 Reykjavik, Iceland.

Analyses of a number of subglacially formed basaltic hyaloclastites are used to evaluate various properties of the magmas on eruption. Glass inclusions in olivine and plagioclase crystals have similar composition as the surrounding glass and crystals are therefore true phenocrysts. These data combined with simplified experimental systems can be used to show that crystallization of the lavas studied took place under varying water pressure conditions. The maximum total pressure did not exceed 2 kb. Mineral liquid calculations show that variation between samples from any single area can be explained by fractionation less than 20% olivine and plagioclase. (Author's abstract)

MAKRYGINA, V. A. and GLAZUNOVA, A. D., 1978, Co, Ni, Cr, V and Sc in processes of metamorphism, granitization and pegmatite formation under moderate pressure: Geokhimiya, 1978, No. 2, p. 185-198 (in Russian with English abst.). Authors at Inst. Geochem., Irkutsk, USSR.

The paper bears some P, T and fluid composition data from inclusions cited from literature. (A.K.)

MAKSIMOV, A. P., KADIK, A. A., KOROVUSHKINA, Ye. Ye. and IVANOV, B. V., 1978, Andesite melt crystallization under water concentration and pressure up to 12 kbar: Geokhimiya, No. 5, p. 669-679 (in Russian, English abst.). First author at Inst. Volcanol. of Far-East Sci. Center of Acad. Sci. USSR, Petropavlo-Kamchatskiy.

Pertinent to melt inclusion studies. (A. K.)

MAKSIMOV, S.O. and EFIMOV, V.V., 1978, Temperatures of crystallization of magmatic rocks from the crest Badzhal, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 100-101 (in Russian). Authors at Far-East Geol. Inst. of Far-East. Sci. Center of Acad. Sci. of the USSR, Vladivostok.

Petrological peculiarities prove the distinctly reducing conditions of formation and crystallization of magmas: absence of magmatic magnetite, presence of ilmenite, iron sulfides and moissanite, ortho- and clinopyroxenes, and biotite are extremely ferruginous varieties. Also almandine occurring in lavas and intrusives is a variety stable only under low oxygen fugacity. Temperature data are given in the table: (Continued on next page) (From the authors' abst., by A.K.)

Sample	Type of inclusions. Mineral	Th of P melt inclusions, °C	T from two-pyroxene thermometer, °C
M-1326, two-pyroxene andesite	Crystallized inclusions, Plagioclase.	1130	1110
M-882, two-pyroxene andesite	Two-phase: G+glass, sometimes partly crystallized, Plagioclase.	1250	1070
M-1356, garnet dacite	Two-phase glass, round shape, sometimes partly crystallized. Plagioclase.	1230	
M-1339, garnet liparite	Partly crystallized, Quartz.	1120	
M-881, two-pyroxene dacite	Two-phase glass, Plagioclase.	1100	1100
M-810 biotite granite	Round two-phase crystallized. Quartz.	620	
M-668 hypersthene granite-porphyry	Round two-phase crystallized. Quartz.	970	

MALDARESCU, Ioan, 1977, A possibility of estimating the depth of formation of hydrothermal vein ores: An. Univ. Bucuresti, Geol. 1977, p. 26, 37-44 (in French). Author at Fac. Geol. Goegr., Bucharest, Rom.

Empirical relations detd. for (1) the temp. and equil. vapor pressure of pure water systems (Nenitescu, C. D., 1963) and (2) the temp. and hydrostatic pressure of natural hydrothermal systems were compared with the variation of fluid inclusion homogenization temps. in quartz sampled from various vein depths in the Bais Sprie and Suior areas of Romania. A tentative relation between fluid inclusion homogenization temps. and depth of vein formation, is proposed for the study region. (Chem. Abstracts 91: 60448r, 1979).

MALEEV, M., 1978, Electron-microscope study of the phase heterogeneity of sphalerite from the Kenan Dere deposit. Geokhim. Mineral. Petrol., 1978, no. 9, p. 39-46 (in Russian). Author at Sofia Univ., 1000 Sofia, Bulg.

Electron microscope replica method was used to study the nature of microinclusions of diverse form and size, in grains of sphalerite. The mineral phases identified were gypsum, halite, sylvite, NH_4Cl, kainite, etc. The water-sol. salts in sphalerite were derived by the crystn. of fluid inclusions. (Chem. Abstracts 91: 7431d, 1979)

MALENKOV, G.G., DYAKONOVA, L.P., 1977, Structure and thermodynamics of water and aqueous solutions by computer experiments (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. 3, p. 13-14 (in Russian).

MALININ, S. D., 1978, CO_2 solubility in aqueous solutions of electrolytes (problems of salting out): Geokhimiya, 1978, no. 10, p. 1452-1465 (in Russian). Author at Vernadsky Inst. Geochem. USSR Acad. of Sci., Moscow.

Based on equation of equilibrium in binary systems gas - liquid (Krichevsky - Il'inskaya equation) applied to the system CO_2-H_2O-NaCl and $CaCl_2$ the generalized equation of CO_2 salting out was deduced. This equation besides electrolyte concentration (Sechenov equation) takes also into account the pressure and concentration of CO_2 dissolved. Sechenov equation represents the limiting case of this generalized equation. As a result of treatment of available experimental data on CO_2 solubility in water and electrolyte solutions the coefficients of salting out for aqueous solutions of chlorides in broad interval of temperature (25-300°) and chloride concentration (up to 5-7 moles per litre) were calculated and tabulated. The coefficients should be recommended for calculations of CO_2 equilibrium with natural waters within the interval of concentrations from diluted solutions to brines. (Author's abstract)

MAL'KOV, B.A. and ASKHABOV, A.M., 1978, Crystalline inclusions with octahedral habit (negative crystals) - proofs of the xenogene origin of diamonds in kimberlites: Acad. Sci. USSR Doklady, v. 238, no. 3, p. 695-697 (in Russian). First author at the Ukhta Industrial Inst., Ukhta, USSR.

Authors suggest that octahedral inclusions in diamonds filled with garnet, olivine, pyroxene and chromite, formerly were inclusions with various shapes of accidentally trapped random aggregates of those minerals. Next inclusion habit changed due to recrystallization of host diamond; time of recrystallization to octahedral habit was evaluated at 10^7 years. Presumably this duration of high P and T was possible under upper mantle conditions rather than in relatively short-lived kimberlite magma chamber, thus kimberlite should be considered only the transporting medium for diamonds, not the parent rock. (Abst. by A.K.)

MAMCHUR, G.P., 1978, Isotope analysis of carbon in determination of genesis of carbon-bearing minerals: Mineralog. Sborn. v. 32, No. 1, p. 65-68 (in Russian). Author at the Inst. Geol. Geochem. of Mineral Fuels of Acad. Sci. of the Ukrainian SSR, L'vov.

The value of $\delta^{13}C$ from fluid inclusions in pegmatites in the Korostenskiy pluton ranges from -20 to -10‰. (A.K.)

MARCHANT, J. W. and KLOPPER, B. C., 1978, Microgram metal contamination of water/nitric acid after four years in linear polyethylene containers: Jour. Geoch. Expl., v. 9, p. 103-107.

Pertinent to the problems of analysis of the heavy metals in fluid inclusions. (ER)

MARCHENKO, Ye. Ya., GUROV, Ye. P., GUROVA, Ye. P. and GONCHAROVA, Ye. I., 1978, Typomorphism of cryolite from alkaline-halide metasomatites: Akad. Sci. USSR Doklady, v. 240, no. 3, p. 710-713 (in Russian). First author at Inst. Geol. Sci. of Acad. Sci. of Ukraina, Kiev.

Cryolite occurring in alkaline-halide metasomatites from biotite granitoids (age 1,200-1,000 m.y.) of the marginal zone of the Ukrainian shield bears G/L inclusions with Th 540-490°C. Cryolite is very well characterized in this paper. (A.K.)

MAR'IN, A. A. and BALITSKY, V. S., 1977, On pressure determination in hydrothermal systems investigated in Teflon-lined autoclaves (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. 3, p. 75 (in Russian).

MARTYNOV, Yu.A. and EFIMOV, V.V., 1978, Evaluation of temperatures of crystallization of volcanogenic rocks of the Kolchan effusive-extrusive complex (Southern Priamur'ye), (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 101-102 (in Russian). Authors at the Far-East Sci. Center of Acad. Sci. of the USSR, Vladivostok.

Rocks of the studied area have variable composition, from dacites to subalkaline plagioliparites; they crop out in small areas. Plagioclase of plagioclase-pyroxene andesite has Th 1260-1280°C, plagioclase of pyroxene-amphibole-plagioclase dacite - 1390-1410°C, plagioclase of biotite-plagioclase liparite - 1150-1170°C. Dacites have unusually high Th. (From the authors' abst, by A.K.)

MARUTANI, Masaharu and TAKENOUCHI, Sukune, 1978, Fluid inclusion study of stockwork siliceous orebodies of Kuroko deposits at the Kosaka mine, Akita, Japan: Mining Geology, v. 28, p. 349-360.

Filling temperatures and salinities of fluid inclusions in quartz from the bedded and stockwork siliceous orebodies of Uwamuki No. 4 Orebody and No. 7 Stockwork Orebody of Uchinotai Western Deposit of the Kosaka mine were studied. Filling temperatures in quartz were in a range of 260°-310°C for the bedded orebodies, and 280°-320°C for the stockwork orebodies. The temperature range of sphalerite was 200°-240°C for the bedded siliceous orebodies and 235°-280°C for the stockwork orebodies, and apparently lower than those of associated quartz. Thermal gradients in the stockwork orebodies were fairly gentle and most of temperatures concentrated around 300°C, but the data obtained from drilling cores indicate a tendency of increase in temperature at deeper levels. Salinities range from 2.5 wt.% to 5.5 wt.% and slightly increase at lower levels. From the data on fluid inclusions, it is inferred that the depth of sea floor was deeper than 1,000 m at the Kuroko mineralization. (Authors' abstract)

MASLENNIKOV, V.V. and MANUCHARYANTS, B.O., 1975, Some characteristics of the formation of antimony-mercury ores of northern Verkhoyansk region): Sov. Geol., no. 11, p. 143-146 (in Russian).

Th for inclusions in early stage, 325-250°C, pressure 1270-1040 bars; late stage 225-150°C, pressure 1020-630 bars. (E.R.)

MASSARE, Dominique, CHAIGNEAU, Marcel and CLOCCHIATTI, Robert, 1978, Chemical composition (major elements and volatiles) of glass inclusions of phenocrysts contained in the rhyolitic pumices of the islands of Kos (Aegean arc): petrogenetic significance: C. R. Somm. Soc. Geol. Fr., 1978, pt. 5, p. 246-249 (in French).

Optical and thermo-optical studies, chemical analyses of trapped glass by electron microanalyser and mass spectrometer have made it evident that the different mineral phases have crystallised at temperatures between 860 and 750°C; that plagioclase crystallisation took place before quartz, biotite and K feldspar crystallisation; that the percentage of volatiles in deep magma was 8.5% ± 2%, out of which 88% was H_2O, approximately 10% carbon, there were also traces of chlorine, sulphur compounds and hydrocarbons. According to data, the origin of these pumices is discussed. (Authors' abstract)

MATSUBAYA, Osamu and SAKAI, Hitoshi, 1978, D/H and $^{18}O/^{16}O$ fractionation factors in evaporation of water at 60 and 80°C: Geochemical Journal, v. 12, p. 121-126. Authors at Inst. for Thermal Spring Research, Okayama Univ., Misasa, Tottori-Ken, 682-02 Japan.

The isotopic fractionation factors in evaporation of water at 60° and 80°C were determined from the isotopic ratios of water under steady-state balance between inflow and evaporation. The results at 60° and 80° are 1.0501 ± 0.0029 and 1.0431 ± 0.0022 for H_2O/HDO and 1.0176 ± 0.0010 and 1.0156 ± 0.0008 for $H_2\,^{18}O$, respectively. Oyunuma, isotopically the heaviest geothermal pond in Japan, is enriched by 40.3‰ in D/H and by 16.5‰ in $^{18}O/^{16}O$, respectively, relative to its meteoric inflow and may be a natural example of such steady-state evaporation pans. (Authors' abstract)

MATSUHISA, Yukihiro, GOLDSMITH, J. R. and CLAYTON, R. N., 1978, Mechanisms of hydrothermal crystallization of quartz at 250°C and 15 kbar, Geoch. Cosmo. Acta, v. 42, p. 173-182. Authors at Univ. Chicago, Chicago, IL 60637.

Oxygen isotopic exchange between quartz and water, using a novel technique in which both $^{18}O/^{16}O$ and $^{17}O/^{16}O$ fractionations were measured, yielded an equilibrium fractionation $\Delta^{18}=9.0$ at 250°C and 15 kbar. The reaction proceeds predominantly by solution of fine grains and growth of larger grains. Exchange by solid-state diffusion is immeasurably slow at this temperature. Under the same experimental conditions, cristobalite behaves quite differently, becoming transformed to sub-micron quartz crystals in a few minutes. The phase transformation is accompanied by a kinetic isotope effect yielding quartz in isotopic disequilibrium with water. It is possible that such disequilibrium products are also formed in other experiments involving phase transitions or mineral syntheses. (Authors' abstract).

MATVEEVA, E. S., TOLSTIKHIN, I. N. and YAKUTSENI, V. P., 1978, Helium isotope criterion in the origin of gases and in detection of neotectonic zones (example of Caucasus): Geokhimiya, No. 3, p. 307-317 (in Russian, English abst.). Authors at the Inst. of Geol. and Geochronol. of Precambrian of Acad. Sci. of the USSR, Leningrad.

Pertinent to the gas studies in fluid inclusions. (A.K.)

MAYSKIY, Yu. G. and USHAK, A. T., 1978, Quantitative decrepitometric analysis of minerals, rocks and ores, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR,

p. 176 (in Russian). Authors at the Rostov State Univ., Rostov-on-Don, USSR.

The vacuum-decrepitometric method with periodic change of P in the decrepitation chamber and differential recording, was proposed. The method may be used for quantitative evaluation of decrepitation effects. (From the authors' abst.)

MAZOR, Emanuel, 1978a, Noble and active gases in the Larderello Geothermal Field in Italy (abst.): U.S. Geol. Survey Prof. Paper 1100, Geologic Survey Research 1978, p. 202-203.

MAZOR, Emanuel, 1978b, Noble gases and dissolved ions in geothermal exploration (Lassen Volcanic National Park) (abst.): U.S. Geol. Survey Prof. Paper 1100, Geologic Survey Research 1978, p. 205.

MEADOWS, J. W. T., SMITH, C. F., COLES, D. G., MAYNARD, L., and DELLIS, J., 1978, Sampling natural waters: are filtered samples true solutions?: Environmental Chemistry and Cycling Processes. Edited by D. C. Adriano and I. Lehr Brisbin, Jr.: Published by Technical Information Center, U. S. Department of Energy, Conf. 760429, p. 253-264.

Of pertinence to analysis of trace metals in inclusions. (ER)

MEDENBACH, O. and SCHREYER, W., 1978, CO_2 - rich fluid inclusions in the basement rocks of the Vredefort structure, South Africa - a hint to its endogenic origin?, in Société Francaise de Minéralogie et Cristallographie, Colloque "Mineraux et Minerais", Nancy, 26-29 Sept., 1978--Programme et Résumés des Communications: (Nancy)

See Schreyer et al., Fluid Inclusion Research--Proc. of COFFI, v. 10, 1977, p. 247-248.

MEDVEDEV, A. Ya. and AL'MUKHAMEDOV, A. I., 1978, Partitioning of chalcophile elements between sulfide and silicate melts (experimental data): Akad. Nauk SSSR Doklady, v. 240, no. 3, p. 718-721 (in Russian). Authors at the Inst. Geochem. of Siberian Branch of Acad. Sci. of the USSR, Irkutsk.

Pertinent to melt inclusions with silicate-sulfide immiscibility. (A.K.)

MEL'NIK, Yu. P., 1978, Thermodynamic properties of carbonic oxide and methane under high temperature and pressure - New correlation based on principle of corresponding states: Geokhimiya, 1978, no. 11, p. 1677-1691 (in Russian). Author at Inst. Geochem. and Physics of Minerals, Ukrainian SSR Acad. of Sci., Kiev.

A modified form of expression of principle of corresponding states for determining of approximate values of molar volumes ($V=V_{ideal}+\alpha$) and fugacity coefficients (γ) of some gases under high scaled pressures (π) and temperatures (τ) is suggested. Generalized diagrams $\alpha-\pi$ under $\pi=200\div600$ and $\tau=2\div12$ have been prepared. Calculated values V and γ of carbonic oxide and methane under P as high as 15 kbar and T=400—1500°K are in a good accordance with experimental data. (Author's abstract)

MEL'NIKOV, F.P., 1978a, Endogenous mineral formation and hydrocarbons (abst.), in International Assoc. Genesis Ore Deposits, 5th Symp., Snowbird, Alta, Utah, 1978, Program and Abstracts: (Alta, Utah), p. 125.

Ore-forming and oil- and gas-forming processes used to be regarded as independent, isolated natural phenomena, irrespective of their relationship. Moreover some kind of barrier has been created between these two specific phenomena. The fact of a genetic relationship between hydrocarbons and mineral deposits hasn't received serious consideration, and this relation was believed to be merely incidental. However, the facts of such relationships are so numerous and various that they are difficult to understand from any single process.

The closest relationship is evident in the hydrocarbon inclusions present in minerals of endogenic deposits. Inclusions found in quartz, topaz, fluorite and other cyrstals contain various hydrocarbons, both liquid and gaseous, as well as liquid oil and the solid products from metamorphism of oil.

It has been established that the variety of hydrocarbon phases in primary inclusions of oil and bitumen indicates the common association of mineral-forming solutions and hydrocarbons under deep-seated conditions, and also is a sure sign of hydrocarbons participating directly in the processes endogencic mineral formation.

Another aspect is that in additon to sulphur, oxygen and nitrogen present in oil, various metals such as iron, calcium, magnesium, aluminum, copper, sodium, tin, cobalt, chromium, germanium, lead, mercury and others occur in oil. It has been established that some particular metals characteristically occur in particular types of oil. These metals are not present as mechanical admixtures but are inherent to the oil itself. It is thus becoming evident that oil and gas formation and endogenic minmineral-forming processes are not to be regarded as isolated phenomena but as parts of a single process of formation and transformation of substance on the Earth.

Investigations on hydrocarbon inclusions in endogenic minerals under both high and low temperatures open new possibilities in understanding the thermobarogeochemistry of endogenic mineral- and ore-forming processes. The inclusions themselves are a connecting link between two natural phenomena and hence their investigation provides new information about the close linkage of these phenomena.

The realization of such a r lationship requires a new approach to both endogenic ore-forming processes and to oil- and gas-forming processes. Experiments involving phase transformations in hydrocarbon inclusions while heated and cooled have been filmed.(Author's abstract)

MEL'NIKOV, F. P., 1978b, Hydrocarbons in endogenous mineral formations (abst.): XI General Meeting of International Mineralogical Association, Novosibirsk, Abstracts, v. 2, p. 74 (in English).

A review of previously published work. (E.R.)

MEL'NIKOV, F.P., 1978c, Methodological problems of thermobarogeochemistry, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept.

15-18, 1978, v. 1, Thermobarogeochemistry in Geology: Vladivostok, Acad. Sci. USSR, p. 39 (in Russian). Author at the Moscow State Univ., Moscow.

A review. (A.K.)

MEL'NIKOV, F.P., 1978a, Phase alterations of hydrocarbons in inclusions in endogene minerals, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in Geology: Vladivostok, Acad. Sci. USSR, p. 37-38 (in Russian). Author at the Moscow State Univ., Moscow.

Brief characterization of the contents of inclusions bearing organic matter. Includes description of phase changes on heating (Th+53°C) and on freezing (crystallization of liquid, first and second condensation of two different gases). Also an outline of the behavior of polyphase inclusions is given. (Abstract by A.K.).

MEL'NIKOV, I.V., KOTOV, Ye.I., TIMOFEEV, A.V., SHTEYNSHNEYDER, T.L. and GORBUNOV, V.YU., 1978, Thermobarogeochemistry of uranium deposits in the Phanerozoic folded areas, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 19-20 (in Russian). Authors at the Vernadskiy Inst. of Geochem. and Anal. Chemistry of Acad. Sci. of the USSR, Moscow.

U deposits of Devonian to Paleogene age are connected essentially with new tectonic activity in the old central massifs. Mineral formation developed in one of three ways: a. albitization → berezitization → quartz + carbonate + hydromicas → quartz + sulfides + carbonate → U ores → quartz + fluorite + sulfides; b. albitization → quartz + carbonate + hydromicas → quartz + sulfides + carbonate → U ores → quartz + fluorite + calcite; c. K-spar → argillitization → quartz + carbonate → U ores. T of mineral-formation changed, sometimes rapidly, from 400-370 to 100°C. Albitization (early alkaline stage) developed at 400-370°C, berezitization at 350-300°C, argillitization and quartz + carbonate + hydromicas at 300-280°C, quartz + sulfide + carbonate or quartz + carbonate at 270-220°C, U ores at 220-180°C, quartz-fluorite-calcite or quartz-calcite-190-100°C. P ranged from 800 to 300 atm. Three essential types of hydrothermal solutions occur: Cl-HCO_3, HCO_3, and F-HCO_3. All processes began with the action of solutions rich in Na and Cl and they finished with solutions rich in Ca and HCO_3. During U ore stage T $\leq$220°C, Cl concentration decreased whereas HCO_3 concentration increased, and Eh decreased rapidly. (Authors' abst., translated by A.K.)

MEL'NIKOV, I. V., ZHUKOVA, T. B., TIMOFEEV, A. V. and SHTEINSHNEIDER, T. L., 1978, Some characteristics of the change of the chemical composition of solutions during the formation of hydrothermal uranium deposits: Teor. Prakt. Termobarogeokhim., (Dokl. Vses. Soveshch.) 5th 1976, N. P. Ermakov, ed.: Moscow, Izd. Nauka, p. 107-115 (in Russian).

The compn. of the fluid inclusions in vein minerals of U-Mo deposits was detd. by triple leaching of inclusions with aq. exts. In the deposits with quartz-carbonate-hydromica wall-rock alteration, the solns. obtained by the leaching method have a F^--HCO_3^- compn. with moderate Cl^- and SO_4^{2-} concns. The relative contents of HCO_3^- and

Ca^{2+}, in general, increase during mineral formation, but with decrease in their contents at the beginning of each stage of ore formation. The Cl- and alkali metals show inverse tendencies of geochem. behavior in the solns. For deposits with wall-rock beresitization, solns. with a Cl^--HCO_3- compn. and predominance of alk. earths over alkali metals were characteristic. (Chem. Abstracts 91: 77038e, 1979)

MEL'NIKOV, V. D., 1978, Thermobarogeochemical peculiarities hydrothermal bodies of quartz in Priamurie, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 148 (in Russian). Author at ITiG of Far-East Sci. Center of Acad. Sci. of USSR, Khabarovsk, USSR.

In geosynclinal complexes of the Mongolian-Okhotsk belt, formations of quartz hydrothermal bodies form three groups: metasomatic quartzites, Alpine-type veins without haloes and quartz veins with silicification haloes. Metasomatic quartzites are widely developed in the Yankan zone, where they are associated with sulfide formation, and in Selemdzhinskaya ore zone. T (Th?) in quartzites is 345-360°C, in Alpine-type veins - 200-240°C (+ typical HCO_3-Na solutions in inclusions) in the Dzhagda area. The third type of quartz veins occurs in the whole area of geosynclinal complexes) of Priamurie. Quartz from rocks in the Tukuringrskaya zone is rich in G (up to 2829 g per kg of H_2O -sic.), with 84 vol. % of G= CO_2 and 15 vol. % =N_2. Quartz rocks from the Selemdzhinskaya zone yield Th 160-360°C and low P (not given by the author, A.V.). In orogenic volcanic complexes of the Lower-Amur zone quartz metasomatites of propylite and secondary quartzite formations yield Th 180-400°C and HCO_3-Na and HCO_3-Na-K composition of melt (sic; probably should be "solution") in inclusions. In orogenic complexes of the Gonzhin horst G content is 415-95 g per kg of H_2O. (Author's abst.)

MELTON, D.C., Jr., 1978, Base metal mineralization in south central Missouri: M.S. thesis, Univ. Missouri-Rolla, 138 pp.

A number of small base metal mineral deposits in Paleozoic carbonate rocks are present in a four-county study area in south central Missouri, intermediate to the Tri-State district of Missouri, Kansas and Oklahoma and the Southeast Missouri Lead district.

The studied mineral deposits are of simple mineralogy, dominated by sphalerite and galena. Major host rock alteration is absent. Gangue minerals include pyrite, marcasite, calcite, dolomite, and quartz. The paragenesis of mineral deposition was typically initiated by the introduction of sphalerite, followed closely by galena, then the iron sulfides. Calcite usually terminated the sequence. Fluid inclusions in sphalerite from the Pierson Creek district, the Star mine, the Mansfield district, and the Ozark Lead Co. Sweetwater Mine (Viburnum trend) yielded homogenization temperatures that range from 61° to 161°C, with the bulk in the 70° to 110°C group.

The deposits exhibit similarity to the Tri-State ore bodies in respect to stratigraphy, ore control, mineralogy and paragenesis but show little similarity to the Southeast Missouri Lead district. (Modified, from the author's abstract)

MEYER, P. S. and SIGURDSSON, Haraldur, 1978, Interstitial acid glass and chlorophaeite in Iceland basalts: Lithos, v. 11, p. 231-241.

It is concluded that chlorophaeite globules in interstitial rhyolitic glass in Tertiary basaltic dikes are not from immiscibility. (ER)

MICHEL, J. P., 1977, Various aspects and applications of electron microscopy: Cahiers Geologiques, No. 93, p. 190-194 (in French).

Techniques of electron microscopy of minerals, after a determined treatment, give many data about their genesis especially observations of liquid intracrystalline cavities in gypsum and of quartz inclusions. Exoscopy provides many details of the evolution of quartz grains, owing to their successive environments (fluviatile, marine, etc...). Inclusion study has more and more sedimentological, and petrographic applications. (Author's abstract).

MILOVSKIY, G. A., ZLENKO, B. F. and GUBANOV, A. M., 1978, Conditions of formation of scheelite ores in the Chorukh Dayron ore field (as indicated by fluid inclusion studies): Geokhimiya, 1978, No. 7, p. 79-86 (in Russian with English abstract). First author at the Inst. Geochem. and Analyt. Chem.

In the Chorukh-Dayron ore field three ore deposits: Chorukh Dayron, Shurale and Southern Yangikan occur in skarns formed in alumosilicate rocks without visible connection with carbonates. Chorukh-Dayron and Shurale bear scheelite ores, S. Yangikan - mostly chalcopyrite-molybdenite ores. All deposits formed in several stages. Scheelite ores consist of scheelite, diopside, andradite, scapolite and apatite or of scheelite, scapolite, feldspar and quartz. Scheelite bears fluid inclusions occasionally with 1-3 solid phases (up to 20% of inclusion volume), Th 240-475°C (Pincs) and 100-159°C (Sincs), quartz - with Th 217-475°C (Pincs), calcite - with Th 198-265°C (Pincs). Total chloride concentration was up to 50-60 wt. %. P determined by use of P-V-T plot of 30% NaCl solution for scheelite was 800-1650 atm, for quartz - 250-1250 atm and for calcite 300-400 atm. (Abst. by A. K.)

MIRONOVA, O. F. and NAUMOV, G. B., 1978, Sources of methane and other hydrocarbons during the analysis of gas-liquid inclusions: Teor. Prakt. Termobarogeokhim., (Dokl. Vses. Soveshch.) 5th 1976, N. P. Ermakov, ed.: Moscow, Izd. Nauka, p. 241-243 (in Russian).

Chromatographs of gases sepd. from black fluorite (Ft) heated at 400° for 1 h showed peaks for N_2, CO, CH_4, CO_2, and H_2O. When the heating time was increased to 1.5 h, peaks for C_2H_2 and traces of unidentified components appeared; heating for 2 h caused the C_2H_2 peak to disappear, the CH_4 peak to increase, and the peaks of the trace components to grow stronger. Chromatographs of ground black Ft, heated in the same way as the unground Ft, showed the presence of the same components with C, H, and O; as the heating time was increased new peaks appeared and the peaks for CO_2, H_2O, etc. decreased or disappeared. The gases released from the Ft were from carbonaceous (org.) matter as well as from fluid inclusions. (Chem. Abstracts 91: 60365m, 1979)

MIRONOVA, O. F., SALAZKIN, A. N., SAVEL'YEVA, N. I. and KOPNEVA,

L. A., 1978, Methods and apparatus for geochemical mapping of endogene processes, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 172 (in Russian). First author at Moscow Geol. Prosp. Inst., Moscow, USSR.

The proposed method is a refinement of the decrepitophonic procedure of Ermakov. The first modification involves the measurement of volume of water converted to hydrogen (reaction with calcium hydride) plus total volume of other gases in fluid inclusions after decrepitation under atmospheric pressure. Analysis time 20 min. The second modification applies liquid manometer and adsorption units for CO_2 and H_2O; analysis time 10 min. The method may yield the curve of G release vs. T. Sensitivity of both varieties is $4 \cdot 10^{-3}$ -$5 \cdot 10^{-3}$ ml of gas from ~500 mg of mineral. Mineral after heating may be leached by water and used for salt analysis of inclusion filling. Also both methods were tested in field prospection, where alteration halos were detected, and morphologically similar rocks were distinguished. (From the authors' abst.)

MITCHELL, R. H., 1978, Mineralogy of the Elwin Bay kimberlite, Somerset Island, N.W.T., Canada: Amer. Min., v. 63, p. 47-51.

Calcite and primary serpentine-filled ocelli are considered to represent separation of a late-stage immiscible carbonate fluid. (From the author's abstract).

MITIN, S.N. and MEL'NIKOV, F.P., 1978, New data on Upper Jurassic evaporite formations from the Northern Forecaucasian area, obtained by studies of gas-liquid inclusions in halite: Akad. Nauk SSSR Doklady, v. 241, no. 2, pp. 463-466 (in Russian). Authors at the Moscow State Univ.

The specimens came from the E. Kuban' and Chernoles depressions. The E. Kuban' evaporite formation is a giant lenticular body, dipping from S. outcrops to the depth of 5 km to the north. Its length is 150km and area over 6000km^2. The formation consists of anhydrite, halite, marls, limestones, clays, and more rarely, gypsum. The Chernoles formation occurs at the depth 3.4-4.5km, its composition is similar. Grain size of the almost completely recrystallized halite ranges from 5 to 20mm. Over 800 preparations, made from 70 specimens, were studied. Following inclusions were found in halite: 1) one phase, L and G; 2) two-phase G (up to 5 vol.%)-L; 3) three-phase (sic), with one or more trapped minerals and G up to 5 vol.%. Th of types 2) and 3) 50-90°C for halite from E. Kuban' and 75-100°C for halite from Chernoles. The above temperatures (200 determinations) should be connected with recrystallization of halite. P of G phase in inclusions range from 50 to 100 atm (determination method not mentioned). The authors suppose that recrystallization of halite mostly occurred at the depth 600-1000m due to appearance of water released from dehydrating gypsum, which thus ought to be the primary sedimentary mineral. (Abst. by A.K.)

MIYAZAWA, T. and PARK, H. I. 1978, Fluid inclusions in minerals from the Chichibu mine, Japan (abst.), in International Assoc. Genesis Ore Deposits, 5th Symp,. Snowbird, Alta, Utah, 1978, Program and Abstracts: (Alta, Utah), p. 127.

Contact-metasomatic deposits of the Chichibu mine were formed in close association with the intrusion of Tertiary quartz dioritic magma and are mined for iron, copper, lead, zinc, gold and manganese. The deposits can be classified into two major types; an earlier stage that belongs to the contact-metasomatic type in the strict sense, and a later stage that belongs to the hydrothermal replacement and vein type. The earlier deposits are subclassified into the Early I and Early II deposits, and occupy a generally lower horizon than the later deposits, but they are often closedly associated with each other spatially.

Primary fluid inclusins are found in various minerals in the deposits. The inclusions consist mainly of two-phase inclusions of gas and liquid, but polyphase inclusions are not always rare. Polyphase inclusions contain three kinds of solid phases, one being halite. Polyphase inclusions are found in the skarn minerals such as axinite and clinopyroxene. Two-phase inclusions are found in garnet, quartz, manganoan ankerite and calcite, as well as in axinite and clinopyroxene.

Two-phase inclusions are also found in calcite of limestone adjacent to the altered zone. Such inclusions are very important in that they represent the last stage of the ore-forming fluids.

Homogenization temperature and salinity of the fluid inclusions in the minerals are shown in the table. (Author's abstract)

Ore deposits	Minerals	Locality	Homogenization temperature (° C)	Salinity (wt.% NaCl)
Early I	Axinite	Wanaba	334-375	more than 35 at maximum
	Skarn minerals	Akaiwa	287-355	
Early II	Quartz	Akaiwa	238-296	2.0-13.0
Later stage	Quartz	Akaiwa	204-260	2.2- 7.8

MOGAROVSKII, V.V., FAIZIEV, A.R., ALIDODOV, B.A., 1978, Bitumen inclusions in minerals of some hydrothermal deposits of southern Tien Shan and the Pamin (Tadzhikistan), <u>in</u> Carbon and its compounds in endogene processes of mineral formation, G.N. Dolenko, ed.: Kiev, "Naukova Dumka" Pub. House, p. 148-153 (in Russian)

Hydrocarbon-contg. inclusions in quartz, scheelite, orthoclase, scapolite, calcite, fluorite, barite, celestite, and galena were studied, by use of luminescent microscope and bitumenol. anal. Hydrocarbons were present in the ore-forming solns. and were preserved in the minerals in small amt. (<0.1%). The bitumen inclusions were captured by most of the minerals during late stages of crystal growth. The bitumen concn. in the minerals does not depend on the type of country rocks; the max. concn. is in granitic and metamorphic rocks rather than sedimentary rocks. (Chem. Abstracts 90: 9156w)

MOISEENKO, V.G., 1978, Metallogeny of the Circumpacific ore belt (physico-chemical parameters); (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 12-13 (in Russian). Author at the Far-East Geol. Inst. of the Far-East Sci. Center of the Acad. Sci.

USSR, Vladivostok.

In the Circumpacific ore belt alkaline-halide hydrotherms are connected with granitoids, alkaline earth-bicarbonate and alkaline earth-sulfide ones with volcanites of intermediate composition and with deep-seated solutions. Hydrotherms of the inner part of the belt connected with island arc volcanites are rich in sulfur, whereas those of the outer part of the volcanites are poor in S, and HCO_3 ion prevails; however, plutonic rocks in the same outer part generate Cl-Na type hydrotherms. S-rich hydrotherms formed deposits of Cu, S and alunite, and those of alkaline earth-HCO_3 type-formed Au-Ag deposits. Internal zones of the belt typically have Au, Sn and W deposits formed by Cl-Na hydrotherms. (Abst. by A.K.)

MOISEENKO, V. G., FAT'YANOV, I. I. and MALAKHOV, V. V., 1976, Change in hydrothermal solutions in time and space during formation of the Amur River gold deposits: Mikroelem. Miner., 1976, p. 36-40 (in Russian).

See Fluid Inclusion Research--Proceedings of COFFI, v. 10, p. 182 (1977).

MOISEENKO, V. G., SAKHNO, V. G. and MALAKHOV, V. V., 1978, Role of abyssal fluids in the evolution of magmatism and mineralization of the Pacific Ocean mobile zone: Teor. Prakt. Termobarogeokhim., (Dokl. Vses. Soveshch.) 5th 1976, N. P. Ermakov, ed.: Moscow, Izd. Nauka, p. 44-53 (in Russian).

The mol. and elemental compns. are given of the gas inclusions in basic to acidic lavas of the different structural zones occurring in the transition from the eastern Soviet Asian continent to the open Pacific Ocean. In the basalts of the oceanic rift zone, the fluid inclusions contain 80-90 vol.% water. The dominant gas in the inclusions in general is CO_2; H is the dominant reduced gas. The inclusions in continental basalts and tholeiites have a higher proportion of oxidized gases and lower H content than do the inclusions in the basalts of the oceanic islands. During differentiation of volcanic rocks of the Kurile-Kamchatka arc, where change is obsd. from basaltic to acidic rocks, the concn. of reduced forms of C increased, with increase in H concn., esp. in extrusive rocks. Interaction of fluids with magmas had a significant effect on the evolution of volcanism. (Chem. Abstracts 91: 60542s, 1979)

MOISEENKO, V.G., STEPANOV, G.N., MALAKHOV, V.V., 1978, Role of carbon compounds in the formation of ore deposits in the eastern USSR, in Carbon and its compounds in endogene processes of mineral formation, G.N. Dolenko, ed.: Kiev, "Naukova Dumka" Pub. House, p. 95-99 (in Russian).

This is full paper corresponding to abstract given in COFFI v. 8, p. 123, 1975 (ER)

MOORE, J.G., CUNNINGHAM, C.G., and BATCHELDER, J.N., 1978, Carbon dioxide-filled vesicles in deep-sea basalt (abst.): U.S. Geol. Survey

Prof. Paper 1100, Geologic Survey Research 1978, p. 184.

Essentially the same as Moore, Batchelder, and Cunningham, 1977a, Fluid Inclusion Research -- Proceedings of COFFI, v. 10, p. 184. (ER)

MORGAN, B. A., 1978, Metamorphic forsterite and diopside from the ultramafic complex at the Tuolumne River, California: Jour. Research U.S. Geol. Survey, v. 6, p. 73-80. Author at U. S. Geol. Survey, Reston, VA 22092.

Stratigraphic reconstruction indicates that the total load pressures probably did not exceed 3 kilobars. At these pressures, the formation of forsterite and diopside should take place between 400° and 500°C with a fluid composition ranging from nearly pure H_2O to less than 5 mole percent CO_2. The restriction of forsterite and forsterite+diopside to shear zones may be attributed to the presence of carbonate in the rock prior to metamorphism and to the dilution of a CO_2-bearing fluid phase by water coming from outside the area of the reaction. (From the author's abstract).

MORI, Y. H., 1978, Configurations of gas-liquid two-phase bubbles in immiscible liquid media: Int. J. Multiphase Flow, v. 4, p. 383-396. Author at Depart. Mech. Eng., Keio Univ., 3-14-1 Hiyoshi, Kohoku-ku, Yokohama 223, Japan.

The configuration of a "two-phase bubble" constituted of a gas phase and a liquid phase in an immiscible liquid medium is classified into three types: complete engulfing of a gas bubble inside a liquid shell, partial coalescence of a gas bubble and a liquid drop forming a three-phase contact line, and non-coalescence whereby a gas bubble and a liquid drop remain separated. Simple criteria have been presented by which the favorable type of configuration in a given system is predicted from the values of the spreading coefficients characterizing the system. Experiments using some combination of liquids as well as air suggest the general validity of the criteria. (Author's abstract).

MOROZOV, S.A.; ALIDODOV, B.A.; ISHAN-SHO, G.A., and GRIGOR'EVA, E.P., 1978, Thermobarogeochemical conditions of the formation of rare metal deposits in Tadzhikistan: Izv. Akad. Nauk Tadzh. SSR, Otd. Fiz.-Mat. Geol.-Khim. Nauk, no. 4, p. 76-81 (in Russian).

Ore deposits of Sb, Hg, W, Mo, Sn, Ag, Au, and Bi in the Zeravshan-Gissar region occur in the Paleogene-Neogene formations. Th was detd. for quartz, dolomite, calcite, barite, etc. The ore deposits were formed from liq. hydrothermal solns. at moderate pressures (0.3-0.8 kbars) at 2 temp. intervals (300-450 and 300-340°). The ore forming solns. contained Na, K, Ca, and Mg chlorides-bicarbonates. (Chem. Abstracts 91: 77046f)

MORTEANI, G. and FRIEDRICHSEN, H., 1978, Pressure and temperature determination of the hematite mineralisation from the Gleisinger Felsen (Fichtelgebirge/Bayern) as deduced from microthermometry on fluid inclusions and $^{18}O/^{16}O$ data: N. Jb. Miner. Abh., v. 134, p. 15-23 (in

German).

As indicated by $^{18}O/^{16}O$-data the quartz-hematite veins from the Gleisinger Felsen (Fichtelgebirge, Bavaria) formed at about 300°C. Fluid inclusion microthermometry suggests a pressure of 2.4 kb during ore deposition. Combining $^{18}O/^{16}O$-data, microthermometric data and consideration of mineral equilibria in the granites the uplift after the mineralisation was between 0.06 and 0.25 mm/year. (Authors' abstract).

MORTON, R. D. and BECK, L. S., 1978, The origins of the uranium deposits of the Athabasca region, Saskatchewan, Canada (abst.): Econ. Geol., v. 73, p. 1408.

Polygenetic U deposits in the Athabasca region are reviewed. Multiple remobilization of U (and partly of Ni, Co, Bi, Cu, Mo, V, As, Se, and Te) formerly residing in late Archean crust or in early Aphebian supracrustals caused emplacement of veins and disseminated deposits. Mobilization and concentration of U was effected by hydrothermal pulses coeval with the Hudsonian and Grenville orogenies, (∿1,750 and ∿1,000 m.y.). Lithological controls of the deposit are analagous to others in North America and Australia within unmetamorphosed and metamorphosed sequences. Premetamorphic, sedimentary-diagenetic facies may have localized the deposits; organic-rich pelites, arkosic arenites, and carbonates being of prime importance. These may have been either sites of synsedimentary or diagenetic deposition or might have acted as selective receptors of U during later hydrothermal activity. In the light of fluid inclusions evidence (showing temperatures of 80° to 400°C for the Beaverlodge deposits and 160° to 225°C for the Rabbit Lake deposit) and of recent geochronologic data (showing the Athabasca Formation to have been deposited 1,350±50 m.y. ago), the thesis that the U deposits were generated by supergene activity during Helikian times is refuted. The only supergene effects recognizable are probably of Mesozoic or Cenozoic age. The concept of "unconformity type" deposits is still a valid exploration model, if localized U deposition at or near the Helikian cover-basement contact was caused by the emergence of ascending hydrothermal fluids into contrasting physiochemical regimes at the interface of the unconformity. (Authors' abstract)

MOTTL, M. J. and HOLLAND, H. D., 1978, Chemical exchange during hydrothermal alteration of basalt by seawater--I. experimental results for major and minor components of seawater: Geoch. Cosmo. Acta., v. 42, p. 1103-1115.

MURCK, B.W., and BURRUSS, R.C., 1978, Phase equilibria in CO_2-rich fluid inclusions in ultramafic xenoliths (abst.): Amer. Geophy. Union, Trans; v. 59, no. 4, p. 226.

We have determined density and composition of over 200 individual fluid inclusions from four dunite, peridotite and pyroxenite xenoliths in basaltic volcanic rocks from Red Hill, Arizona; Salt Lake Crater and Hualalai, Hawaii, and Dreiser Weiher, Germany. Fluid inclusions in two samples were described by Roedder (1965). Based on temperatures of final melting of CO_2 solid and of liquid-vapor homogenization, we find that inclusions from all but one sample contain essentially pure CO_2 (i.e., <2 mole % additional components). H_2O is notably absent. The exception, a dunite xenolith from the 1801, Kapulehu lava flow, Hualalai, Hawaii, contains inclusions in olivine with a small amount (∿5 mole %) of a sulfur-bearing component, either SO_2, H_2S, or COS. Pure CO_2 fluids with densities as high as 1.14 gm/cm^3 occur in inclusions in clinopyroxene in the Salt Lake Crater pyroxenite (Oahu, Hawaii). If these fluids were entrapped at about 1200°C, their densities require confining pressures of more than 10 kbar at the time of entrapment. The highest observed fluid densities in the other samples require confining pressures at 1200°C of 1.4 kbar for the Dreiser Weiher peridotite, 3.4 kbar for the Hualalai dunite, and 8.5 kbar for the Red Hill pyroxenite.

The CO_2-rich fluid inclusions in the Dreiser Weiher peridotite and the Red Hill pyroxenite contain 2-5 μm thick glass rims which we have analyzed with an energy dispersive electron microprobe. Allowing for crystallization of the host mineral, the glasses are basaltic, We interpret the occurrence of a dense CO_2-rich fluid and a basaltic glass in these inclusions as evidence of the coexistence, at depth, of a CO_2 rich fluid phase with a melt phase. (Authors' abstract)

MURCK, B. W., BURRUSS, R. C. and HOLLISTER, L. S., 1978, Phase equilibria in fluid inclusions in ultramafic xenoliths: Amer. Min., v. 63, p. 40-46. Authors at Dept. Geol. and Geophy. Sciences, Princeton Univ., Princeton, New Jersey 08540.

Over 200 fluid inclusions in five dunite, peridotite, and pyroxenite xenoliths associated with basaltic rocks from Arizona, Hawaii, and Germany were examined using a petrographic microscope equipped for cooling to -140°C.

The temperatures of phase changes observed in individual fluid inclusions are interpreted according to published, experimentally determined phase equilibria as follows:

(1) Most inclusions contain nearly pure CO_2 and, in some cases, a small amount (on the order of 0.05 to 0.10 mole fraction) of SO_2, H_2S, or COS. Only one inclusion contains a possible aqueous phase.

(2) The CO_2 fluid densities range from 0.34 to 1.14 gm/cm^3. Assuming a temperature of entrapment of 1200°C, this implies confining pressures of more than 10 kilobars at the time of entrapment of the densest inclusions.

The presence of glass linings on some of the inclusion walls suggests coexistence at depth of a CO_2-rich volatile phase with a melt phase at the time of entrapment of the two fluids in the host minerals. Compositions of the glass linings of two samples, Dreiser Wehier, Germany, and Red Hill, Arizona, most closely match high-alumina andesite and high-alumina basalt, respectively. (Authors' abstract)

MYSEN, B. O. and POPP, R. K., 1978, Solubility of sulfur in silicate melts as a function of f_{S_2} and silicate bulk composition at high pressures: Carnegie Inst. Wash. Yearbook, 1977-1978, p. 709-713.

From experimental studies, primary melts in the upper mantle may contain >1%S. Extrusive basalt and andesite contain on the order of 0.1 wt% S. It appears that sulfur is exsolved, most likely as an immiscible liquid, from silicate melts during ascent of the magma. Because of the large values of the sulfide melt-silicate melt partition coefficients for transition metals (>200), separation of less than 1 wt% sulfide melt will lower the transition metal content (Ni, Cu, and Co) of the silicate melt by more than 50% without significantly affecting its major element composition. (ER)

NAMBU, Masateru, HARA, Kenichi and HAYAKAWA, Norihisa, 1978, Fluid inclusion study of Inari copper vein, Ani mine, Akita Perfecture: Mining Geology (Japan), v. 28, p. 25-34 (in Japanese with English abstract). First author at Dept. Mining and Mineral Eng., Tohoku Univ., Sendai, Japan.

Fluid inclusions in quartz from the Inari copper vein group of the Ani mine, Akita perfecture were studied. The filling and freezing temperatures of fluid inclusions were measured in a silicone oil cell of a dual-purpose device which was designed by authors and found to be useful for both heating and freezing measurements of the same inclusion in a single operation. The heating rate was controlled by a program controller.

To obtain the relationship among the freezing temperature, heating rate and size of inclusion, the melting temperature of ice of distilled water enclosed in glass capillaries having various diameters were measured. The result show that the deviations from the true melting temperature of ice caused by various heating rates and sizes of inclusion should not be ignored. In the present study, the heating rate was 0.3°C/min. in which the deviation of melting temperature is almost unaffected by the size of inclusion.

Filling temperatures of fluid inclusions in quartz and adularia from the ore veins, and in quartz from diorite and dacite, were within the range from 150°C to 300°C. These results agree approximately with those obtained from various vein type deposits in Japan. On the other hand, salinities of most inclusions were within the range from 18 to 22 wt.% NaCl equivalent concentration. With the exception of only one vein in the Taishu mine, these highly saline inclusions have not been reported previously in the vein-type deposits in Japan. It is assumed from the occurrence of highly saline inclusions in vein quartz and the geological setting of the Ani mine that the formation of the ore solution was genetically related to the granitic rocks intruded into the Tertiary systems in the Ani mineralised area. (Authors' abstract).

NASEDKIN, V.V. and BOYARSKAYA, R.V., 1978, Studies of solid inclusions in vacuoles of volcanic glasses by scanning electron microscopy, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok. Acad. Sci. USSR, p. 113-115 (in Russian). Authors at IGEM of Acad. Sci. of the USSR, Moscow.

Samples of perlite and obsidian were collected from the extrusive domes and lava flows of the Early Quaternary of Arteni volcano, Armenia. Following minerals were found:

- a) native iron globules 2-5 μm in dia.
- b) globules consisting of Ca and S - probably oldhamite.
- c) cubic crystals of compositions: Fe; Fe+Ti+Mn; Fe+Mn+Zn, probably magnetite and spinels.
- d) druses of acicular crystals bearing K, Al, Si, Ca, Mg, probably amphibole.

Glass adjacent to vacuoles bearing minerals have higher than background content of Cl and S. (From the authors' abst., by A.K.)

NAUMOV, G. B., 1978, Principles of the physico-chemical model of uranium ore formation, 216 pp., "Atomizdat" Publishing House, Moscow (in Russian).

The book contains a chapter presenting methods of study of fluid inclusions in minerals (p. 25-31) and discusses results of such studies of minerals from uranium deposits (p. 32-48, in part p. 49-83, and p. 161-164, 171-173, 185-186). Minerals of metasomatic deposits with uraninite yielded Th 225-155°C; vein and metasomatic with brannerite - 320-170°C; vein pitchblende-carbonate - 170-91 (Td of pitchblende 180-50°C); pitchblende-molybdenite with hydromicas - 170-85°C (Td of pitchblende 145-100°C); pitchblende-arsenide - 156-110°C (Td of pitchblende 100°C); calcite veinlets with pitchblende - 60-35°C (inclusions in calcite; Td of pitchblende 70-50°C). Examples of detailed study of Th in several deposits of the U-Mo type are given (Table 3.2, p. 35). P determined by use of syngenetic inclusions of CO_2 and H_2O, anomalous decrepitation of pitchblende, three-phase inclusions with L CO_2 and inclusions with dms, was as follows: alkaline-metasomatic type of deposit - 2300-1250 atm; vein pitchblende-carbonate -2400-1200 atm; pitchblende-sulfide of the moderate depth >500 atm; pitchblende-Mo of the low depth - 800-1200 atm. In the ore-forming solutions one of the most important components is CO_2; its concentration is not lower than 2 g/kg H_2O, usually ranges from 5 to 130 g/kg H_2O. (Abst. by A. K.)

NAUMOV, G.B., 1978, Basis for a physico-chemical model of uranium ore formation: Moscow, Atomizdat Publ. House, 213 pp. (in Russian).

Includes, in addition to a discussion of the physical chemistry of uranium ore deposition, a short discussion (p. 29-31) on fluid inclusion data. (E.R.)

NAUMOV, G.B., MIRONOVA, O.F., SAVELYEVA, H.I., 1977, Some problems in the analysis of mineral-forming fluids (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. 3, p. 98-99 (in Russian; abstract courtesy Dr. A.P. Berzina).

The analysis of probable errors of composition of fluid inclusions shows that most are connected not with the analytical methods used but with the technical conditions of extraction from the sample. When used for study of salt composition of inclusions the mechanical method of opening can give somewhat high results due to extraction from solid inclusions, structural defects, intergrain films etc. The phenomenon of sorbtion of cations and gas components on pulverized simple surfaces can result in losses. The decrepitometric method of inclusion opening permits obtaining, by means of water extracts, values of salt composition which are similar to data from cryometric study of the inclusions. But when gases are studied, the main shortcoming is change of ratio of gas components on heating inclusions, especially in the presence of hydrocarbon complexes.

NAUMOV, G.B., MOTORINA, Z.M. and NIKITIN, A.A., 1978, Use of fluid inclusions for reconstruction of development of ore territories, (Abst): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 36 (in Russian). Authors at GEOKHI OF Acad. Sci. of the USSR, Moscow.

Calculations based on data obtained from fluid inclusion studies may characterize direction of movement of hydrothermal solutions, geochemical specialization of individual ore territories and space and temporal anisotropy of hydrothermal systems. (From the authors' abst., by A.K.)

NAUMOV, V.B. and FIN'KO, V.I., 1976, Conditions for crystallization of phenocrysts in Cenozoic alkaline pumices of Primor'ye: Akad. Nauk SSSR, Izvest., Ser. Geol., 1976, no. 12, p. 91-95 (in Russian; translated in Internat. Geol. Rev., v. 19, no, 11, p. 1326-1330). Abstract in Fluid Inclusion Research -- Proceedings of COFFI v. 10, p. 192.

NAUMOV, V.B. and KHODAKOVSKIY, I.L., 1978, Hydrothermal mineral formation from thermobarogeochemistry and thermodynamic data, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 23-25 (in Russian). Authors at GEOKHI of Acad. Sci. of the USSR, Moscow.

The paper consists of analysis of over 7000 determinations of temperature from 1500 deposits of the world, characteristics of the general T interval of hydrothermal process and best T conditions for crystallization of various minerals etc., and all data on P in endogene processes (about 600 determinations). Thermodynamic equilibria typical of deposits of iron sulfide, Sn, Mo, Pb, Zn, Hg, Sb, As and Bi in the T interval 25-350°C are presented, as well as metal complexes suitable for migration. (From the authors' abst., by A.K.)

NAUMOV, V. B. and SHAPENKO, V. V., 1978, Iron concentration in high-temperature chloride solutions as determined by fluid inclusion studies (abst.), in International Assoc. Genesis Ore Deposits, 5th Symp., Snowbird, Alta, Utah, 1978, Program and Abstracts: (Alta, Utah), p. 132.

Analysis of published data from experimental studies on the solubility of iron in chloride solutions and on fluid inclusions in minerals indicates that iron concentrations in high-temperature (>400°C) chloride solutions may be relatively high. Magnetite, hematite, hydrated ferrous chloride, and other iron-bearing solids, together with halite and sylvite, were observed by many investigators in quartz, fluorite and cassiterite (N.P. Ermakov, V. F. Lesnyak, Yu. V. Lyakhov, Wm. C. Kelly and F.S. Turneaure, E. Roedder and others). However, during the heating of these inclusions, the dissolution of magnetite or hematite was not observed.

More than 200 primary multiphase inclusions containing magnetite as one of the solid phases have been studied in fluorite from pyroxene-garnet skarns of Tyrnyauz deposit (Northern Caucasus). The inclusions studied range from several to 175 μm, and contain (vol. % at 25° C): gas 20 ± 1; solution 32 ± 4; solid (halite, sylvite and unknown minerals) 45 ± 5; and magnetite 3 ± 0.6. On heating, sylvite dissolves completely at 190-200° C: halite at 435-455°C; the gas phase homogenizes at 615-

645° C, and magnetite dissolves completely in 5 to 10 minutes at 625-650° C. However, heating for two hours at 600° C does not result in complete dissolution of magnetite. The magnetic properties of magnetite were observed up to 450-470° C. When cooled at 5° C/minute, one or two separate crystals of magnetite reappeared at 450-400° C in the inclusions.

The density of the mineral-forming fluid was calculated to be 1.5 ± 0.2 g/cm^3, chloride concentration in it to be 60 wt.%, and the iron concentration - 7.3 ± 2.1 wt.% . These data agree well with the results obtained by E. Roedder on multiphase inclusions containing hematite in quartz from the Cu-Mo deposit at Bingham, Utah. He reported a density of the fluid 1.1-1.3 g/cm^3, a chloride concentration of 35-55 wt.%, and an iron concentration of 0.3-0.8 wt.% . In contrast with the behavior of our samples, however, he was not able to observe dissolution of the hematite crystals of reheating. This difference in solubility might be attributable to the auto-oxidation of the inclusion contents by hydrogen diffusion through the host quartz that he suggested may have occurred in the Bingham samples. (Authors' abstract)

NAYDENOV, B. M., POLYVYANNYI, E. Ya. and BOGOLEPOV, V. G., 1978, The present state and perspectives of studies of variations of isotope composition of argon in gas-liquid inclusions in minerals: Geokhimiya, 1978, no. 12, p. 1866-1882 (in Russian). Authors at Kazakh Sci. Research Inst. of Mineral Raw Materials, Alma-Ata.

On the basis of mostly literature sources, the reasons for natural variations of argon isotope composition are discussed, especially in fluid filling G/L inclusions. (The amount of total argon ranges from 0.01 to 273.9 X 10^{-4} mm^3 per g of sample; admixture of atmospheric Ar is 0.5 - 90% of total argon in pegmatites and veins from Volhyn', Karalia, Ural and Kazakhstan. The isotope composition of Ar in atmosphere and lithosphere are different. Content of atmospheric Ar in fluid inclusions may be successfully used for determination of ratio of vadose and juvenile water solutions during mineral formation. (Abst. by A. K.)

NEDACHI, Munetomo, TAKEUCHI, Tsunehiko, YAMAOKA, Kazuo and TANIGUCHI, Masahiro, 1973, Bi-Ag-Pb-S Minerals from Agenosawa Mine, Akita Prefecture, Northeastern Japan: Sci. Repts. Tohoku Univ., Series III, V. 12, no. 1, p. 69-80 (in English).

Presumably secondary inclusions in late quartz (deposited after bismuth) have Th = 87-142°C. After (presumed pressure) correction, these yielded Tt of 192-241°C. (ER)

NEDASHKOVSKII, P.G.; VATUTINA, T.G.; and MALAKHOV, V.V., 1978, Composition of liquid-gas inclusions in quartz from granites of different origin: Geol. Magmat. Rudogenez Zony Perekhoda Kont. Okeanu, G.B. Levashev, ed.: Vladivostok, USSR, Dal'nevost. Geol. Inst, p 161-162 (in Russian).

In aq. exts. from the quartz (Q) in granites of differentiated intrusions of the Far East (USSR), Mg^{2+} and Ca^{2+} are the predominant cations, whereas HCO_3^- and SO_4^{2-} are the principal anions and the gas phase of the fluid inclusions is enriched in CH_4. The aq. exts. from the Q of sialic granites and pegmatites have Na^+ and Cl^- and F^- as the predominant anions, the gas phase of the fluid inclusions is enriched in CO_2 and H_2O vapor. The fluid inclusions in the Q formed from differentiated subcrustal magma have a more basic, less acidic, liq. compn. and reduced gases in comparison to the inclusions in the Q of crustal granites. (Chem. Abstracts 91: 178479e)

NEHRING, N.L. and TRUESDELL, A.H., 1978, Organic gases in geothermal fluids (abst.): U.S. Geol. Survey Prof. Paper 1100, Geologic Survey Research 1978, p. 201.

Three end member patterns can be distinguished for organic gases in geothermal and volcanic steam samples:

A volcanic pattern with relatively little total hydrocarbons, little methane, more unsaturated than saturated C_2 and C_3 hydrocarbons, a large amount of an unidentified C_4 and C_5 gas and no benzine. This pattern was found in Kilauea, Hawaii, St. Augustine, Alaska, and Mount Hood, Oreg., fumarole gases.

A volcanic-geothermal pattern where a geothermal system is developed in volcanic or crystalline rocks. In this pattern more total hydrocarbons, about 10 times more methane than in the volcanic pattern, and variable amounts of benzine are found with saturated C_2 and C_3 hydrocarbons predominant over unsaturated hydrocarbons. This pattern was found at Lassen Park, Calif., the eastern part of Yellowstone National Park, Wyo., Steamboat Springs, Nev., and Roosevelt Hot Springs, Utah.

A sedimentary-geothermal pattern characterized by a relatively large amount of total hydrocarbons, near absence of unsaturated hydrocarbons other than benzine, and the appearance of numerous branched hydrocarbons in large amounts. Patterns of this type, found at The Geysers, Calif., Lardarello, Italy, and Cero Prieto, Mexico, are nearly identical despite large differences in sedimentary rock type and geothermal character. Some gases from western Yellowstone also approach this type. (Authors' abstract)

NEHRING, N.L. and TRUESDELL, A.H., 1978, Hydrocarbon gases in some volcanic and geothermal systems: Geothermal Resources Council, Trans. v. 2, p. 483-486. Authors at U.S. Geol. Survey, Menlo Park, CA 94025.

Reports on the analysis of C-1 to C-6 hydrocarbons, including normal and branched alkanes, alkenes, and cyclic compounds, from a variety of volcanic and geothermal systems. (ER)

NEIKUR. T.L. and DEMINA, N.E., 1977, Some data on the composition of quartz-forming fluids of hydrothermal halos of the Dzhabyk-Karagai granitic massif: Izv. Ezheg., Inst. Geol. Geokhim., Akad. Nauk SSSR, Ural. Nauchn. Tsentr, p. 74-75 (in Russian).

Fluid inclusions in different types of vein quartz of pegmatites and granites were studied. The quartz-forming solns. were predominantly sodic with a high content of alkalies and a high Na^+/K^+ ratio. The HCO_3- ion was predominant in the solns. of the quartz inclusions from hydrothermal haloes. Inverse correlation exists between the F- and Cl- contents of the solns. The tectonic setting and the lithol. of the country rocks played an important role in the evolution of these fluids. (Chem. Abstracts 90: 140257x)

NEKRASOV, I.Ya. and GORBACHEV, N.S., 1978, Possible mechanism of formation of kimberlites: Akad. Nauk SSSR Doklady, v. 240 no. 1, p. 181-184 (in Russian). Authors at Inst. Exper. Mineral. of the Acad. Sci. USSR, Chernogslovka, USSR.

NENOW, D. and GUELEVA, S., 1978, Influence of the morphology of voids in lithium fluoride on the kinetics of their disappearance: Kristall und Technik, v. 13, no. 4, p. 429-433. (in English)

NESBITT, B. E. and KELLY, W. C., 1978, Application of scanning electron microscopy to inclusions in carbonatites: Proc. Ann. Conf. Microbeam Anal. Soc., v. 13, no. 95, 5 pp.

See same authors, 1977, in Fluid Inclusion Research--Proc. of COFFI, v. 10, 1977, p. 195-196. (ER)

NESBITT, H.W., 1978, (The system CO_2-H_2O), in Notes for Workshop on Fluid Inclusions: Melbourne, Dept. Geology, La Trobe Univ. (unpaginated, mimeographed).

A pair of P-X plots, with pressure linear or logarithmic, made from the literature. (ER)

NESTERENKO, V.S., 1978, Main features of the geological structure and problems of genesis of the Gai copper-sulfide deposit in the Southern Urals: Geol. Rudn. Mest., v. 20, no. 3, p. 24-35 (in Russian). Author at the Gai Mining-Dressing Combine, USSR.

Td of inclusions in quartz, barite and sphalerite ranged from 400-390 to 60-55°C, P calculated from inclusion data -- 685-560 atm. (A.K.)

NIKOLAEVA, N.M., 1977, Potentialities of some physico-chemical methods of investigation of equilibria of complex-forming reactions and of hydrolysis in aqueous solutions at elevated temperatures and pressures (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. 3, p. 31-32 (in Russian).

NORMAN, D. I., 1978, Analysis of Rb, Sr and Sr isotopes in fluid inclusion waters (abst.), in International Assoc. Genesis Ore Deposits, 5th Symp., Snowbird, Alta, Utah, 1978, Program and Abstracts: (Alta, Utah), p. 135.

Methods of liberating fluids from inclusions for Rb-Sr analysis are being investigated. The most successful methods are thermal decrepitation in a quartz test tube, and crushing the sample under vacuum in 304 stainless-steel tubing. Blank levels for these methods are slightly below the general laboratory blank. Analyses have been successfully done on fluids from inclusions in quartz (hydrothermal, igneous, metamorphic, and sedimentary), wolframite, pyrite, galena, and sphalerite. Rb and Sr concentrations are measured by isotope dilution using standard techniques. Sr isotope ratios are measured by running the leachates without separation by cation exchange.

Sr isotopic measurements are reproducible within experimental error for splits of selected material. Equal recovery of Rb and Sr during the leaching process is indicated by analyses of fluid inclusion waters in quartz crystals from miarolytic cavities in the Drammen granite, Norway. The data, ^{87}Sr/^{86}Sr=0.9647± .0001, ^{87}Rb/^{86}Sr=65.9±0.1, plot directly on the published isochron for the granite, age=284± 13 mill.y., intial ^{87}Sr/^{86}Sr= 0.7033± .0011.

Levels of Rb and Sr in the inclusion fluids are ∼300ppm; Rb/Sr increases exponentially with inclusion filling temperature. Fluid inclusion waters are quite inhomogeneous in Rb/Sr and ^{87}Sr/^{86}Sr. Hence changes in sample preparation and fluid extraction methods may affect the analysis by changing the population of inclusions sampled. An isochron age of 289 ± 14 mill.y. has been obtained from fluid inclusion waters in quartz from miarolytic cavities in granites near Oslo, Norway. This compares well with the published composite ages of 276 m.y. for the Oslo area igneous rocks and 288 m.y. for the Oslo granites alone. Dating of ore deposits, however, has proven nearly impossible because of the variable initial Sr isotopic composition of the mineralizing fluids. These variations reflect multiple sources for Sr in hydrothermal fluids, and may prove a valuable tool in understanding the genesis of some deposits. (Author's abstract)

NORMAN, D. I. and EVANS, A. M., 1978, Analysis of Rb, Sr, and Sr isotopes in fluid inclusion waters (abst): Inst. Min. Metall., Trans., Sect. B, Feb 1978, v. 87, p. 34-35 (see previous item).

NORMAN, D.I., and SEGALSTAD, T.V., 1978, Genesis of fluorite deposits associated with the Oslo paleorift, Norway (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 10, no. 7, p. 464.

Fluorite deposits occur in fractures in Precambrian metamorphics along the western boundary of the Permian-aged, Oslo paleorift. Although K-Ar dating indicates the fluorite deposits are contemporaneous with Permian rifting, the lack of association with significant volumes of Permian igneous or volcanic rocks raises questions concerning the genesis of the deposits.

Fluid inclusion studies on the Skien deposit indicate mineralization by boiling fluids with salinities of 46-11 eq. wt.% NaCl and temperatures of 400°-325°C. Strontium isotopic studies of the Skien deposit show the fluorites have an ^{87}Sr/^{86}Sr = 0.714-.774, whereas the granitic gneisses have an ^{87}Sr/^{86}Sr = 0.876-.961 (= 0.838-.912 during Permian time). REE abundances for Skien fluorites indicate fluorites with ^{87}Sr/^{86}Sr<0.722 are enriched in the heavy rare earths whereas fluorites whose ^{87}Sr/^{86}Sr >0.750 have similar REE abundances as the gneisses.

The REE and Sr data indicate the ore fluid at Skien originated in a different rock than the granitic gneisses and was reacting with gneiss during fluorite deposition thereby becoming equilibrated with the gneiss in regards to the REE and strontium isotopes. The enrichment in heavy REE suggests a late stage differentiate. Taken together, the data suggest either the dissolved solids in the mineralizing waters were derived from an underlying Permian biotite granite, or the fluids themselves were a residual phase in the cooling of a Permian granite.

The results of similar studies on fluorite from the Lassedalen deposit and Kongsberg silver mine indicate a similar genesis at the Skien deposits although the fluorites were deposited by cooler solutions which had equilibrated to a greater degree with the country rock. (Authors' abstract)

NORTON, Denis, 1978, Sourcelines, sourceregions, and pathlines for fluids in hydrothermal systems related to cooling plutons: Econ. Geol., v. 73, p. 21-28.

Simulation of hydrothermal systems by numerical methods permits computation of the initial position (sources) of all fluids in the system. The locus of these positions, which are sourcelines, defines an essential link between the theories of irreversible mass transfer and those of thermally driven fluid flow. The concept of a fluid sourceline is introduced to facilitate the quantitative description of the initial composition of fluids which ultimately circulate through rocks in the vicinity of hot plutons.

The mathematical definition of fluid sourcelines and pathlines for hydrothermal systems permits the quantitative prediction of the initial position and, hence, initial compositions of all fluids which circulate through rocks in the vicinity of an igneous intrusion and the variations in temperature, pressure, and rock type along flow paths and, hence, the changes in composition of the fluid as it flows from its source to a position of interest in the system.

Examples of fluid sourcelines, sourceregions, and pathlines defined for inert fluids in an idealized hydrothermal system indicate the predominant source of fluids flowing through permeable hot plutons is from host rock environments adjacent to and above the pluton. These sourceregions in two dimensions include rocks from a 50-km^2 region as far as 5.5 km away from a 2.7-km-wide and 4.5-km-tall pluton. (Author's abstract).

NORTON, D., 1978, Transport phenomena in hydrothermal systems: the redistribution of chemical components around cooling magmas, in Société Francaise de Minéralogie et Cristallographie, Colloque "Mineraux et Minerais", Nancy, 26-29 Sept., 1978--Programme et Résumés des Communications: (Nancy), p. 198.

See Norton and Knapp, and Norton and Knight, Fluid Inclusion Research--Proc. of COFFI, v. 10, 1977, p. 198. (E.R.)

NOSIK, L.P.; DOLOMANOVA, E.I.; ROZHDESTVENSKAYA, I.V., 1978, Characteristics of the formation of tin ore deposits in relation to data on the isotopic compositions of carbon, oxygen, and sulfur in gas-liquid inclusions in minerals, in Thermobarogeochemistry of the earth's crust and ore formation, N.P. Ermakov, ed.: Moscow, "Nauka" Press, p. 135-147 (in Russian.)

The quantities (mm Hg·cm^3) of CO_2, SO_2, and H_2O released during heating of fluid inclusions in cassiterite, quartz, etc. from Sn deposits in the USSR and the $\delta^{34}S$, $\delta^{13}C$, and $\delta^{18}O$ values detd. by mass spectrometric anal. of gases from the inclusions are tabulated and considered. The CO_2 concn. in water of the inclusions decreases from the high- to low-temp. minerals. The C isotope compn. varies in relation to the degree of interaction of hydrothermal solns. with country rocks and the physicochem. conditions of mineral crystn. The $\delta^{13}C$ values are -3.30 to 4.07 and -3.30 to 12.5%, for syngenetic cassiterite and quartz, resp.; and the $\delta^{18}O$ values are -2.40 to 0.91 and -2.60 to 0.83 for the 2 minerals, resp. The C and S were enriched in the light isotope and O in the heavy isotope, with increasing involvement of endogenic over exogenic processes in mineral formation. (Chem. Abstracts 89: 200546g)

NUTI, S. and D'AMORE, F., 1977, Considerations on the Radon-222 content in geothermal fluids: Boll. Soc. Geol. Ital., v. 96, p. 279-289 (in Italian). Authors at Instituto Internazionale di Ricerche Geotermiche, via del Buongusto 1, 56100 PISA, Italy.

On the basis of prospecting to establish the quantity of Radon-222 present in the geothermal fluids of Larderello field made in 1976, an attempt has been made to reconstruct the borderlines between the steam-dominated and the water-dominated areas of the field. Previous data suggest that these borderlines move with time. A possible mechanism for the enrichment of the radon-222 in the gaseous phase of the geothermal fluid is also described. Finally, the possible correlations between radon-222 and radiogenic argon, the oxygen-18 of the condensated waters and the gas/steam ratio are all considered. (Authors' abstract).

NYAMBOK, I. O., 1978, Mineralogy and paragenesis of the fluorite deposits from the Kerio Valley, Kenya: Geologiska Foreningens i Stockholm Forhandlingar, v. 100, pt. 2, p. 221-223 (in English). Author at Univ. of Nairobi, Dept. Geol., Box 30197, Nairobi, Kenya.

Investigation of the mineralogy and paragenesis of the fluorite from the Kerio Valley shows that the mineralization resulted from residual magmatic solutions, which also led to the replacement of the crystalline limestone. Two types of inclusions--primary and secondary--are recognised. Four varieties of fluorite occur in the area. They are paragenetically related in the following order: white and yellow-brown varieties mineralized first, then the dark-grey variety and lastly the violet one. (Author's abstract).

OKRUGIN, V. M., GARANIN, V. K., KUDRYAVTSEVA, G. P. and SOKOLOVA, V. N., 1978, First results of a study of ore minerals in products of the South outbreak of the Tolbachik volcano eruption. Geol. Geofiz. Dannye Dol'shom Treshchinnom Tolbachinskom Izverzhenii 1975-1976, p. 106-111 (in Russian). Edited by S. A. Fedotov and E. K. Markhinin., Izd. Nauka: Moscow, USSR.

Plagioclase phenocrysts from the southern eruption of Tolbachik in 1975-76 contain inclusions. Solidified magma in plagioclase phenocrysts had a homogenization temp. of 1080-1260°. (From abstract in Chem. Abstracts 91: 60366n).

OPENSHAW, R., PAGEL, M. and POTY, B., 1978, Fluid inclusions associated with the diagenesis, tectonic movements, and nuclear reactions in the Oklo deposit (Republic of Gabon) (abst.), in International Assoc. Genesis Ore Deposits, 5th Symp., Snowbird, Alta, Utah, 1978, Program and Abstracts: (Alta, Utah), p. 138 - 139.

Centre de Recherches Pétrographiques et Géochimiques, Equipe de Recherche sur les Equilibres entre Fluides et Minéraux, case officielle no. 1, 54500 - Vandoeuvre-les-Nancy (France).

In 1972 it was discovered that several areas of high grade uranium ore in the Oklo deposit were the sites of a nuclear chain reaction. The most probable agent for moderating the chain reaction and preventing it from becoming an explosion was considered to be circulating groundwater. A study of the fluid inclusions associated with the Oklo deposit has been made with the aim of verifiying the existence of such a fluid moderator and more generally to understand the geologic history that led up to this unique phenomenon.

Fluid inclusions associated with the silica diagenesis of the sandstones have homogenization temperatures (T_H) higher than 150°C indicating that the diagenesis occurred at considerable depth. The temperatures of melting of ice (T_F) decrease with depth indicating a salinity increase with depth (3.3 to 8.8 weight equivalent NaCl over 800 m). Late carbonate diagenesis is associated with a highly saline fluid (mean T_F of - 32.4° C) and which has a mean T_H of + 110 C.

Many quartz ± carbonates ± sulfides (mainly pyrite) ± chlorite veins occur in the area. The associated fluid inclusions have mean T_H's from + 110°C to + 150°C and mean T_F's from - 3.8°C to - 1.4°C. The characteristics of the fluid inclusions associated with the carbonate are essentially the same as for the carbonate diagenesis. In one case hydrocarbon inclusions were observed.

In and around the reaction zones are aqueous inclusions, the majority of which have T_H's from 340°C to 460°C and variable but low salinity. Homogenization occurred in both the vapor and liquid phases and necking down was observed to be a widespread phenomenon. There were slight differences from one fracture to another and from one reaction zone to another. In particular the fluid inclusions associated with zone II a much greater variability of T_H's and T_F's and many inclusions had significantly higher T_H than the other zones.

The microthermometric data were supplemented by ion analysis and Raman spectroscopy.

All these results have been used to reconstruct the geologic conditions leading up to and prevailing during the functioning of the natural nuclear reactors. The most important result is the characterization of a fluid in the neighborhood of the reaction zones which was heated to at least 400°C. It is probable that the variation of the density of this fluid on being heated was responsible for moderating the chain reaction. (Authors' abstract)

OPENSHAW, R., PAGEL, M., and POTY, B., 1978, Fluid phases contemporaneous with sandstone diagenesis, tectonic movements and functioning of the Oklo nuclear reactors (Gabon): React. Fission Nat., Cr. R. Reun. Cum. Tech. 1977 (pub. 1978), p. 267-296 (IAEA, Vienna) (in French with English abstract).

See preceding abstract. (ER)

OSIPOV, P.V., and KLIMOVITSKAYA, E.F., 1977, Conditions for the formation of the chrysoprase in the Sarykulboldy deposit of central Kazakhstan: Namet.

Polezn. Iskop. Kory Vyvetrivaniya, V.P. Petrov; P.P. Smolin, ed.: Moscow, USSR, Izd. Nauka, p. 153-164 (in Russian).

Chrysoprase mineralization occurs in serpentinized ultrabasic rocks and is controlled by tectonic fault zones. The fluid inclusions contained gas (5-30) and liq. (70-95%) phases with Th 48-244°. Aq. exts. of gas-liq. inclusions contained Na^+, K^+, Mg^{2+}, Ca^{2+}, HCO_3, (Fe^{2+} + Fe^{3+}), and Cl-, and SO_4^{2-}. Concns. were detd. of Be, Co, Cu, Mn, Pb, Sn, Ni, Zn, Ca, Ti, Cr, Al, Mg, Nb, Fe, Zr, Y, Sr, Mo, Ge, B, and Hg in chrysoprase. Origin is attributed to hypergene processes. (Chem Abstracts 91: 24221c)

OSKVAREK, J.D., and OHMOTO, Hiroshi, 1978, Oxygen isotope exchange in the system muscovite-H_2O-CO_2 (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 10, no. 7, p. 466.

OVCHINNIKOV, L.N. and BANSHCHIKOVA, I.V., 1978, Conditions of metamorphism of volcanogenic-sedimentary rocks of the Pechenga structure (fluid inclusion studies), (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 25-28 (in Russian). Authors at Inst. Geochem. Mineral. of Rare Elements, Moscow.

1. Deep levels of the rocks of the N part of Pechenga structure were metamorphosed in the epidote-amphibolite facies with partial microclinization), and upper levels in the prehnite-pumpellyite facies.

2. Studied specimens were taken from the Kola deep borehole; fluid inclusions were found only in metamorphic veins. Inclusions 1-3 µm dia. were filled by water plus various salts, water-NaCl, CO_2, CO_2-water and dilute water solutions. Methods of homogenization, freezing, differential and total gas chromatography and microspectral analysis were used.

3. Five types of veins were distinguished: isofacial with metamorphic rocks (coeval with folding); early diaphthoric (coeval with folding); overlapping high-T hydrothermal; late diaphthoric; and alpine, in zones of young faulting.

(...)6. The third type of veins (quartz, quartz-feldspar) formed under action of CO_2-rich solutions connected with granitization of underlying Archean rocks; P_{CO_2} at the depth 6100m was 5.2 to 5.8 kbar.

Data obtained from fluid inclusions are listed in the table.

Zone of metamorphism (facies, subfacies)	Thickness, m (from-to)	Phase state of solutions	Salt concentration, wt.%	Th, °C	T gradient °C/km
Prehnite-pumpellyite	1300 (0-1300)	liquid	≤30	300	
Chlorite	800 (1300-2100)	liquid	≥30	300-400	90-100
Actinolite	1700 (2100-3800)	liquid	≥30	400-505	70
	1400 (3800-5200)	gaseous	>>30	500-580	60

The composition of the solutions in all was water-salt; in G phase CH_4 35-80 mol/1000 g of solution, light hydrocarbons, nitrogen, and oxygen. (From the authors' abst., by A.K.)

OVCHINNOKOV, L.N., BANSHCHIKOVA, I.V. and VASIL'YEV, Ye.V., 1978, Inclusions of melts and solutions in acid differentiates of ore regions in Kunashir, (Abst.): Abstracts of the Sixth All-Union Meeting, Valdivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 98-99 (in Russian). Authors at IMGRE, Moscow.

Early-Quaternary andesite-basalts and Holocene dacites of volcano Mendeleev were studied. Inclusions in plagioclase and olivine phenocrysts from andesites and dacites have Th 1390-1380°C; Pb, Zn and Cu contents are lower than clark values for andesites, total (Pb+Zn+Cu): Na = 1:100. More shallow melts in early inclusions in quartz phenocrysts (Th 1180°C) have the same Pb, Zn and Cu contents. T of melt in extrusive dome was 970°C, Pb, Zn and Cu content increased by 30%. Interstitial melts-brines (S inclusions in quartz of intrusive granodiorites, Th 565°C) contain 2-3 times more Pb, Zn and Cu than clark value, ratio total metals to Na is 1:2. (From the authors' abst., by A.K.)

OVCHINNIKOV, L. N. and MASALOVITCH, A. M., 1977, Experimental study of characteristics of hydrothermal ore-forming 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. 3, p. 76-77 (in Russian; abstract courtesy Dr. A. P. Berzina).

In MeS-HCl-H_2O system at 112-485°C and at initial concentrations of HCl 0.01-0.34M, pyrite dissolves with $FeCl_2$ prevailing and $FeCl^+$ present in small amounts in the solution. When galena or sphalerite dissolves, $PbCl_2$ and H_2S or $ZnCl_2$ and H_2S are formed respectively. Earlier sphalerite precipitation with respect to galena is possible in case of Fe excess. A later sphalerite precipitation than galena is observed in case of lack of Fe. With introducing 2M NaCl in the system sulphide solubility sharply increases.

In 2M NaCl aqueous solution at 242-470°C and at initial pH 7.8 galena and sphalerite solubilities are similar. In the temperature range from 360 to 470°C it is practically constant (3.4-3.6^{-3}mol/kg). Pyrite and antimonite solubility increases continuously with temperature rise. When dissolving antimonite, three types of complexes are formed: hydroxy, chloride, and hydrosulphide.

Prolonged metastability of solutions, containing poly-components of pyrite, sphalerite and calcite, is observed. Mineral solubility in mixed electrolytes exceeds the sum of the solubilities determined in each separately.

At about 0.1mol/kg sulfide, precipitation from solutions results in increase of acidity, that may promote formation of a metasomatic column. When a solid phase is present, pyrite precipitation proceeds discretely It is accompanied by discrete changes of solution acidity. (sic.)

OXTOBY, S. and HAMILTON, D. L., 1978, The discrete association of water with Na_2O and SiO_2 in NaAl silicate melts: Min. and Pet. Mul., v. 66, p. 185-188.

OZEROVA, N.A., BALITSKIY, V.S., KOMOVA, V.V., LAPUTINA, I.P., DOBROVOL'SKAYA, M.G., VOROB'YEV, Yu.K., PASHKOV, Yu.N., VYAL'SOV, L.N., SIDEL'NIKOVA, V.D., FINKEL'SHTEYN, Yu.V. and BASOVA, G.V., 1974, Selenium-bearing mercury sulfides (experimental data and natural observations): in Problems of endogene ore formation, N.V. Pavlov, Moscow, ed: "Nauka" Publishing House (in Russian). Authors at Inst. Geol. of Ore Deposits, Petrogr., Mineral. and Geochem. of Acad. Sci. of the USSR, Moscow.

Mercury sulfides were grown in HCl solution at 150 and 200°C, P 60 atm, run time 12 days. Irregular fluid inclusions in these sulfides (cinnabar) have Th 120-170°C, euhedral inclusions - 175-198°C. The latter inclusions have filling degree 0.88-0.90, i.e. higher than that of autoclave(equal 0.84.) Individual inclusions have Th >200°C, probably due to increasing concentration of solution from cinnabar dissolving. Inclusions are shown in Fig. 16, p. 176. (A.K.)

PAL'MOVA, L.G., 1978, Improvement of prospecting criteria by thermobarogeochemical methods, (Abst): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept 15-18, 1978, v. II, Thermobarogeochemistry and ore genesis: Vladivostok, Acad. Sci. USSR, p. 7-8 (in Russian). Author at the Mineral. Geol.-Prosp. Inst., Moscow.

Zones of pre-ore quartz-sericite metasomatites in the U-Mo deposit (name omitted) bear two types of metasomatite, differing in fluid inclusions in quartz. The first type bears tiny fluid inclusions (up to 6 μm) bearing G 40-70 vol. %, CO_2 content ~3 moles/liter, and low total salt concentration. The second type bears polyphase inclusions up to 50 μm in size (G+L+dms), CO_2 content <0.5 mole/liter, high total salt concentration. Th for the first type 360-240°C, for the second type 370-280°C. The first metasomatites formed prior to the U-Mo ores, the second ones - prior to polymetallic mineralization. (From the author's abst.)

PANINA, L. I., 1977, The crystallization temperatures of certain structural-textural varieties of the Cape Turii alkalic rocks (Kola Peninsula): Akad. Nauk SSSR, Sibirsk. Otdel., Geol. i Geofiz., v. 18, no. 6, p. 45-51 (in Russian; translated in Soviet Geol. & Geophys., v. 18, no. 6, p. 37-43).

See Fluid Inclusion Research--Proc. of COFFI, v. 10, p. 206 (1977)

PANINA, L.I., 1978, Conditions of apatite crystallization in rocks of alkaline-ultrabasic (carbonatite) complexes, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 59-60 (in Russian). Author at Inst. Geol. Geophys. of the Siberian Branch of Acad. Sci. of the USSR, Novosibirsk-90.

Apatite from massifs: Magan, Essey, Yraas and Guli from the Maymecha-Kotuy province (apatite-pyroxene rocks, apatite ijolites, forsterite-magnetite-apatite, and magnetite-apatite rocks) bears silicate melt inclusions with Th 1200-1120°C. Exocontact apatite-aegirine and calcite-phlogopite-pyroxene-apatite rocks bear apatite with salt-melt inclusions of Th 1010-860 and 960-880°C, respectively. A large number of G/L inclusions of several generations were found with Th 600-100°C. (From the author's abst., by A.K.)

PANINA, L.I., 1978, Temperature of crystallization of melilite-monticellite -olivine rocks from the Kovdor massif, (Abst): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 59, (in Russian). Author at Inst. Geol. Geophys. of Siberian Branch of Acad. Sci. of the USSR, Novosibirsk-90.

Silicate melt inclusions were found in forsterite and melilite of the rocks which have been assumed hitherto to be of metasomatic origin. Th inclusions in forsterite was 1340-1250°C and in melitite-1300-1250°C. Position of monticellite is not clear, but experiments with melting suggest the possibility of origin as part of this paragenesis. (From the author's abst., by A.K.)

PANINA, L.I., 1978c, Crystallization temperatures for pyroxene and leucite in alkaline rock of the Synnyr pluton: Akad. Nauk SSSR, Sibirsk. Otdel., Geologiya i Geofiz., v. 19, no. 6, p. 54-60 (in Russian; translated in Soviet Geol. and Geophys., v. 19, p. 42-47).

Using the method of homogenizing inclusions it has been established that in all varieties of alkaline rock of the Synnyr pluton pyroxene crystallized from comparatively dry silicate magmatic melts at high temperatures: 1190-1280°C in alkaline syenite, 1150-1250°C in nepheline rock. Based on crystallization temperatures of pyroxene microlites which contour the growth zones of leucitic (now pseudoleucitic) impregnations, for the first time crystallization temperatures of pre-existing leucite have been established for intrusive rock: for the central areas of phenocrysts they correspond to or are somewhat lower than 1250°C, for peripheral areas they are known to be less than 1200°C. Thermometric study of pyroxene has revised previous theories about the sequence of mineral crystallization and confirmed that the Synnyr Massif was formed in two phases. (Author's abstract)

PARILOV, Yu.,S., 1978, Temperatures, composition and properties of ore-forming fluids of stratiform lead and zinc deposits in Kazakhstan: Geol. Rudn. Mest., v. 20, no. 5, p. 60-71 (in Russian). Author at Inst. Geol. Sci. of Acad. Sci. of Kazakh SSR, Alma-Ata.

Following deposits were studied: Shalkiya in Karatau, Zhayrem and Maykain in Central Kazakhstan and Tekeli in Dzhungarian Alatau. Hydrothermal-sedimentary ores bear L or L + solid inclusions, Td 40-80°C, fluid composition on seven samples (g per kg): H_2O 658-880, total salts 116-275, G 4-66, H_2S 3.8-12.7, SO_3 0-9.5, CO_2 0.2-27.7, N_2 0.3-20.5, K trace-21.8, Na 21.1-35.4, NH_4 trace-17.9, Ca trace-24.5, Mg trace-18.0, Fe^{2+} 0.6-16.9, Fe^{3+} 0-5.2, HCO_3 trace-21.4, SO_4 15.3-91.0, Cl 17.3-79.9, Br 0.3-35.7, I 0-0.7, F trace-43.8, H_2SiO_3 0-50.5, HBO_2 0-7.6. Six samples of metamorphic (metamorphosed hydrothermal-sedimentary) ores with inclusions with G/L, L+xl, G+L+xl or G+LH_2O+L(?) +xl yielded Td 100-500°C, H_2O 64.6-572, total G 31-200, total salts 263.3-765.2, H_2S 2-322, SO_3 0-17.7, CO_2 7.2-126, CO 0-26.6, NH_3 0-3, H_2 0-0.2, N_2 1.3-18.2, Ar 0-16.1, K 0.8-23.1, Na 1.8-16.9, NH_4 0-3.8, Ca 9-225.6, Mg trace-100.8, Fe^{2+} trace-117.1, Fe^{3+} 0-8.3, HCO_3 5.4-164.8, SO_4 25.2-320.1, Cl 7.9-81.1, Br 0.5-5.7, I 0-1.3, F 0-64.0, H_2SiO_3 0-75.9, HBO_2 0-1.1. Pre-ore metasomatites (Td 300-510°C, six samples analyzed) and massive endogene ore (Td 150-490°C, ten samples analyzed) were characterized by the same way. (Abst. by A.K.)

PARRY, W. T., BALLANTYNE, G. H. and WILSON, J. C., 1978, Chemistry of biotite and apatite from a vesicular quartz latite porphyry plug at Bingham, Utah: Econ. Geol., v. 73, p. 1308-1314.

Biotite and apatite occur with copper and iron sulfides, quartz, and traces of other minerals in a vesicular quartz latite dike which intrudes the quartz monzonite stock in the Bingham mine, Utah. Within each of three distinct phases of the dike, biotite in the rock adjacent to vesicles, and in secondary aggregates, is richer in Mg and F and depleted in Ba, Fe, Ti, and Cl relative to magmatic biotite. Both magmatic biotite and hydrothermal biotite increase in Mg and F content from the border phase of the dike to a central phase to a late aplitic phase. Apatite compositions show closely analogous variations involving F enrichment and Fe and Cl depletion. The trends in biotite composition within this single small intrusion are markedly similar to those documented by more extensive studies of the potassic zones at Bingham and at Santa Rita.

The hydrothermal solutions that formed or exchanged with the secondary biotite were probably not markedly fluorine rich. Log f_{H_2O}/f_{HF} during crystallization of the vesicle filling was about 5. Fluorine distribution between adjacent biotite and apatite grains does not represent high temperature equilibrium partitioning and cannot be used to determine the temperature of vesicle filling.

Biotite compositions within the different phases of the dike and of the Bingham stock appear to indicate separate evolution from magmatic to hydrothermal conditions within the intrusive phases of the dike. However, the observed compositional variation could be due to different degrees of exchange with a common, chemically, evolving hydrothermal fluid. (Authors' abstract).

PAVLISHIN, V.I., MAZYKIN, V.V., MATYASH, I.V., and VOZNYAK, D.K., 1978, Changes of content of structural aluminum in the growth of quartz crystals: Geokhimiya, 1978, no. 2, p. 266-275 (in Russian, Engl. abst.). Authors at Inst. Geochem. and Physics of Minerals of the Acad. Sci. of Ukrainian SSR, Kiev.

Quartz with Th 600-400°C (pneumatolytic) and <400°C (hydrothermal) was investigated to define the structural Al-Si substitution; the resulting scheme is quite complicated. (A.K.)

PAVLYUK, L. A., 1977, Spectrophotometric investigation of ionization constants of some acids at temperatures up to 175°C (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. 3, p. 55-56 (in Russian).

PÊCHER, Arnaud, 1978, Composition and density of the fluid phase through a major crustal shear zone: Data on fluid inclusions of quartz from the Himalayan main central thrust zone, Central Nepal, in Société Francaise de Minéralogie et Cristallographie, Colloque "Mineraux et Minerais", Nancy, 26-29 Sept., 1978--Programme et Résumés des Communications: (Nancy), p. 43.

The Main Central Thrust - between the Higher and Lesser Himalayas - is a thick shear zone (more than 10 km) where deformation is accompanied by the well known Himalayan "reverse" metamorphism.

The composition and density of the fluid phase in this exemplary tectonometamorphic zone has been studied utilizing the fluid inclusions of in-schistosity exsolution quartz; a study of about 40 samples shows that:

- CO_2 (in addition to H_2O and salt) is always present in the M.C.T. zone, and is much more abundant in samples collected nearest the thrust (i.e., where the metamorphic intensity is the strongest).
- Apparent fluid pressure, as deduced from fluid density and temperature data (respectively given by homogenization temperature and mineralogical data) is surprisingly low (2,5 to 4,5 kb) versus the medium to high pressure environment (3 to 8,5 kb). (Author's abstract)

PEDAN, M. V. and GRITSAY, Yu. L., 1978, Peculiarities of metamorphism of ferruginous quartzites in the northern part of the Mariupol deposit, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 131-132 (in Russian). Authors at "Mekhanobrechmet" Institute, Krivoy Rog, USSR.

The studied quartzites were metamorphosed under conditions of granulite facies. Tiny inclusions in vein quartz bear fluid rich in CO_2. Td yielded maxima at 140-220, 330-480 and 540-580°C, maximum Th of P incs was 420°C; similar data are typical of quartzite quartz. Garnets from quartzites bear essentially G inclusions ($L \leq 10$ vol. %), Td 680-700°C; this proves the water-poor conditions of garnet crystallization. (From the authors' abst.)

PERTHUISOT, Vincent, GUILHAUMOU, Nicole, and TOURAY, J.-C., 1978, Hypersaline and gaseous inclusions in quartz and dolomite of Triassic evaporites of northern Tunisia: Soc. géol. France, Bull., v. 20, p. 145-155 (in French). First author at Lab. de géologie E.N.S., 46, rue d'Ulm, 75005 Paris; ERA 604.

Optical and thermo-optical studies are reported on fluid inclusions (about 1,500 determinations) in quartz and dolomite (23 samples). Different fluids, daughter and trapped minerals have been determined: nearly fresh water, liquid hydrocarbons, liquid CO_2-gaseous mixtures; halite, sylvite, hematite, carbonates and undetermined minerals. The barometric interpretation is that late quartz crystallized in veins under hydrostatic conditions in a high geothermal gradient -- early quartz and dolomite grew in a lower geothermal gradient (50°C/km). The distribution of sylvite plus halite bearing inclusions versus halite bearing inclusions gives new information about Triassic paleogeography, indicating that one of the deepest parts of the salt basin was in the Teboursouk district. Oil inclusions and CO_2 - hydrocarbon inclusions are scattered inside an area already known for petroleum surface occurrences. (Authors' abstract)

PESHCHEVITSKY, B.I., BELEVANTSEV, V.I., 1977, Regularities of step-wise formation of complexes in aqueous 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. 3, p. 15 (in Russian).

PETRICHENKO, O.I. and KOVALEVICH, V.M., 1978, Experience in the use of thermobarogeochemical methods for studies of sedimentary formations, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. II, Thermobarogeochemistry and ore genesis: Vladivostok, Acad. Sci. USSR, p. 35-36 (in Russian). Authors at Inst. Geol. Geoch. of Natural Fuels of Acad. Sci. of Ukrainian SSR, L'vov.

Review of general problems of fluid inclusion studies in sedimentary minerals (salts, sulfur, diagenetic minerals); no detailed data. (A.K.)

PHILPOTTS, A.R., 1978, Liquid immiscibility in anorthosite-quartz mangerite series (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 10, no. 7, p. 472.

PHILPOTTS, A. R., 1978, Textural evidence for liquid immiscibility in tholeiites: Min. Mag., v. 42, p. 417-425. Author at Dept. Geol. and Geophy., Univ. Conn., Storrs, CT.

The residual liquids of many tholeiitic basalts and andesites, on cooling, split into iron-rich and silica-rich fractions, which may quench to brown glassy globules and clear glass respectively. More commonly, however, cooling is sufficiently slow for the iron-rich liquid to crystallize to globular single crystals of pyroxene. Depending on the cooling rate, these crystallized globules range in shape from spheres to elongated globules bounded by crystal faces. The fine grain size of the mesostasis of most tholeiites is partly due to these small crystallized globules. The silica-rich fraction, on the other hand, is more commonly quenched to a glass, and when preserved as globules in the crystallized iron-rich fraction, it may be bounded by negative crystal faces of the surrounding pyroxene. Globules of the iron-rich liquid commonly nucleate on the surface of the plagioclase crystals where they can become trapped, later crystallizing to spherical pyroxene grains that mostly contain a minor opaque phase. In contrast, iron-rich globules that form next to pyroxene grains commonly become attached to these crystals, giving them lobate boundaries. The immisicible silica-rich liquid becomes trapped between these lobes and, with sufficiently slow cooling, results in finger-like quartzo-feldspathic inclusions extending in from the margins of the pyroxene grains. These textures can provide evidence of immiscibility in a wide range of volcanic and hypabyssal rocks, even when no glass is present. (Author's abstract)

PICCOLI, G. et al., 1977, The Euganeo-Berico hydrothermal system and the geology of Colli euganei: Mem. Inst. Mineral. Geol. Univ. Padova, v. 30, 264 pp (in Italian with 4-page English summary). First author at Istituto di Geologia, Universita di Padova, Italy.

A very comprehensive review of geology, hydrology, cold and thermal springs geochemistry, and hydrothermal circulation in the Euganea-Berica region, northern Italy. Includes several plates and a large-sized geologic map. (P. Lattanzi)

PITRAGOOL, S. and PANUPAISAL, S., 1978, Tin and tungsten mineralization of the Mae Lama mines and its vicinity, N-W Thailand, Open File Report, Dept. Geol. Sci., Chiang Mai Univ., Thailand, 34 pp.

The cassiterite-wolframite-scheelite deposit of the Mae Lama Mine is in the contact zone and closely associated with the Triassic (?) Mae Lama "Granite" (adamellite in composition). The mineralization occurs mainly in a hydrothermal quartz vein system, in pegmatite and disseminated in the adamellite itself. Temperatures of formation of the mineral assemblages have been studied by the following methods: solid solubility of Mg in calcite, amounts of As in arsenopyrite, and fluid inclusions in quartz, calcite and fluorite. The temperatures found range from 125°C to 460°C. Greisenization of the adamellite stock occurs in the ore bodies exposed in the mines as well as in the altered adamellite of the stock. (From the authors' abstract).

PIZNYUR, A. V., 1978a Thermobarogeochemical criteria of systematics of molybdenum deposits: Mineral. Sborn., v. 32, no. 1, p. 20-29 (in Russian). Author at the L'vov State Univ., USSR.

Pneumatolytic solutions acted in Mo deposits down to 400-380°C; at lower T Mo mineralization formed from aqueous liquid solutions. Temporarily pneumatolic solutions appeared at lower T as result of retrograde boiling due to P decrease. The deposits formed over a wide T range, from 730 to 40°C, P varied from 2600×10^5 to 180×10^5 Pa; commercial assemblages crystallized at 470-320°C. Fluid inclusions often bear halite dm, total salt concentration reaches 25-60 wt. %. CO_2 is a frequent and prevailing component, but also H_2 sometimes occupies 43-36 vol. %; N_2 concentration does not exceed 4.5%. Studied samples came from the deposits: Kounrad, Sorskoe, Kadzharan, Bingham, Zhireken, Shakhtama, Bugdaya, Davenda, Climax, Karaoba, Tyrnyauz, Dzhida and NE Kounrad. (Abst. by A.K.)

PIZNYUR, A.V., 1978b, Thermobarogeochemical criteria for the classification of molybdenum deposits; Mineral, Sbor. L'vov, v. 32, no. 1, p. 20-29 (in Russian).

See previous item. (E.R.)

PIZNYUR, A.V., 1978c Thermobarogeochemical criteria for evaluation of molybdenum deposits, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. II, Thermobarogeochemistry and ore genesis: Vladivostok, Acad. Sci. USSR, p. 15-17 (in Russian). Author at the L'vov State Univ., Ukrainian SSR.

Fluid separated from a magmatic chamber developed in two branches: CO_2-rich (pneumatolytic) and chloride-water solution (hydrothermal); both branches are ore-forming. The second one typically has frequent boiling, accompanied by precipitation of Mo, W, Au and polymetallic ores. Ores formed under isochoric, isobaric and isothermic conditions (sic., A.K.). General graphic schemes of ore mineralization in the Zhireken, Shakhtama, Bugdaya,, Davenda and Climax deposits are presented, made on the basis of the author's previously published data. Importance and financial aspects of thermobarogeochemical prospecting are shown. (From the author's abst.)

PLATONOVA, E. L., KOVALISHIN, Z. I., SASIN, G. G. and BRATUS, M. D., 1978, Conditions for the formation of baritic mineralization in the Trans-Carpathians: Teor. Prakt. Termobarogeokhim., (Dokl. Vses. Soveshch.) 5th 1976, N. P. Ermakov, ed.: Moscow, Izd. Nauka, p. 152-157 (in Russian).

Formation of the barite (Bt) ores in the Beregov deposit was interpreted from studies on fluid inclusions. The Bt assocd. with facies of secondary quartzites and in polymetallic ore-bearing veins formed at 150°, whereas that in fissures cutting the quartzites formed at 225°. The gas in the solns. from which the ores formed was mainly CO_2 ($\leq$67 vol.%); C_2H_6, C_3H_8, and CH_4 were also present. The Bt formed from acidic solns. with a high Cl^- concn.; Na^+ was predominant over K^+. (Chem. Abstracts 91: 60437m, 1979)

PODGORNYKH, N.M., 1978, First results of melt inclusion studies in carbonatite calcite, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in Geology: Vladivostok, Acad. Sci. USSR, p. 63-64 (in Russian). Author at Inst. Geol. Geophys. of Siberian Branch of Acad. Sci. of the USSR, Novosibirsk-90.

Calcite of the Tur'iy Cape forsterite-biotite-calcite carbonatite bears polyphase crystallized inclusions which homogenize of $T > T$ of calcite thermal dissociation 820°C. To avoid that dissociation, preparations were heated under PCO_2 50-60 atm, then T dissoc. > 1110°C. Experiments were carried by quenching method with heating up to 780, 840 and 900°C. Homogenized inclusions were analysed by electron microprobe and this revealed that filling consists of silicate-salt melt-solution. (From the author's abst., by A.K.)

POKHILENKO, N.P. and USOVA, L.V., 1978, Secondary melt inclusions in olivines from kimberlite pipe "Udachnaya" (Yakutia), (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 66-67 (in Russian). Authors at Inst. Geol. Geophys. of Siberian Branch of Acad. Sci. of the USSR, Novosibirsk-90.

Olivine grains from "Vostochnaya-Udachnaya" kimberlite pipe bear S melt inclusions of Th from 760-810°C to over 1000°C - the latter inclusions were not homogenized even at $T > 1000$°C. Late melt, wetting the surfaces, has an ultramafic composition that is poor in SiO_2 and rich in CO_2 and H_2O, with relatively low T (Th?). Chemical composition by electron microprobe SiO_2 34-37%, MgO 31-40%, FeO 6.0-7.8%, Al_2O_3 0.5-1.4%, CaO 9.6-13.6%, Na_2O 0.7%, K_2O 0.4%. One inclusion contained a 6-μm calcite crystal (dm?). (From the author's abst., by A.K.)

POLENKOV, A. I. and DOROGOVIN, B. A., 1978, Temperature conditions of metamorphism of volcanogenic rocks of the Blyava ore field (S. Urals), (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 138-140 (in Russian). First author at the Moscow State Univ., USSR.

Over 500 determinations of Th in calcite, chlorite (sic.), epidote, pumpellyite, prehnite, quartz and albite in greenstone-facies-metamorphosed basalt-liparite rocks yielded the following values: for calcite-albite-chlorite subfacies - albite 300-320°C, chlorite 200-230°C, calcite 195-215°C, for epidote-quartz-albite-chlorite subfacies - albite 340-380°C, chlorite 300-330°C, epidote 300-340°C, quartz 300-320°C. Similar values were obtained for pumpellyite-prehnite association (pumpellyite 300-340°C, prehnite 300-320°C). (From the authors' abst.)

POLONSKIY, V.S., ZUYKOV, A.S., LEONT'YEV, A.I. and STYRIKOVICH, M.A., 1978, Model of the concentration process during boiling in capillary porous structures: Akad. Nauk SSSR Doklady, v. 241, no. 3, pp. 579-582 (in Russian). Authors at Inst. Elev. Temperatures of Acad. Sci. of the USSR, Moscow.

Pertinent to heterogenization process of hydrothermal solution, especially during metasomatic processes, and to formation of coeval inclusions with different degrees of fill. (A.K.)

POLYKOVSKII, V.S.; ELINSON, M.M.; SHUVALOV, V.B., 1978, Consideration of the gaseous composition of mineral-forming solutions for prospecting, in Thermobarogeochemistry of the earth's crust and ore formation, N.P. Ermakov, ed.: Moscow, "Nauka" Press, p. 164-167 (in Russian).

Among the gaseous components of the inclusions in minerals and rocks of pegmatites, quartz-feldspar veins, skarns, greisens, and quartz-fluorite bodies of Tien-Shan N, CO_2, and H are predominant and CH_4, Ar, and He have frequent occurrence. The comparative abundance ratios of N, CO_2 and H in the inclusions of the different rock types are given. Ar, He, and CH_4 were obsd. in the inclusions in minerals of pegmatites, quartz-feldspar veins, and skarns. Increase in the H content of inclusions in the quartz in late-formed rocks indicates formation of the H by interaction of soln. with country rocks. (Chem. Abstracts 89: 166308u)

POLYKOVSKII, V.S., MOSKALYUK, A.A., 1978, Temperatures and composition of hydrothermal solutions during a determination of fluorite quality, in Thermobarogeochemistry of the earth's crust and ore formation, N.P. Ermakov, ed.: Moscow, "Nauka" Press, p. 233-248 (in Russian).

Study of the fluid inclusions in fluorite (Ft) of the Mogov deposit (Gissar Range) showed that the ore bodies formed from hydrothermal solns. under continuous-discontinuous change in temp. at 45-320°. The soln. forming late-generation Ft were the most favorable for growth of optical quality crystals. The last portion of the hydrothermal solns., from which colorless transparent crystals grew, was the HCO_3-SO_4^{2-}-Na^+-K^+ type had the lowest concn. of salts (5.49 mg/100 g sample) and the lowest temp. of the Ft-forming soln. (Chem. Abstracts 89: 166312r)

POPIVNYAK, I.V. and LAZ'KO, Ye.Ye., 1978, Phase state, composition, genetic relations, and homogenization temperatures of magmatogenic inclusions in minerals of kimberlite rocks: Mineral. Sborn., v. 32, no. 2, p. 115-118 (in Russian). Authors at the L'vov Univ., Ukrainian

SSR.

Peridotite xenoliths and phenocrysts in kimberlite from two famous pipes (names or localities not given) were studied. Most inclusions were found in olivine from the second pipe, and a few in orange-red garnet of the titanium-rich association. Peridotite xenoliths bear only single inclusions in olivine and orthopyroxene. Inclusions are glassy, partly or completely crystallized, all of magmatic origin. Glass inclusions $n \cdot 10^{-3}$mm bear tiny G bubbles dispersed throughout inclusion volume. These inclusions occur in healed fractures and next to kelyphitic crowns in garnets. Phase ratios: glass 80-95, G up to 20%, Th 900-1000°C. Partly crystallized ($5 \cdot 10^{-3}$mm) inclusions occur in olivine, garnet and in orthopyroxene; G 0-25 vol.%, glass 5-90%, crystallized dms up to 15%, Th 1220-1270°C, although there were inclusions which did not homogenize up to 1400°C. Crystallized inclusions bear the same dms as partly crystallized ones, Th is also in the same range. Inclusions are P(?), PS and S. Garnets sometimes bear decrepitated melt inclusions. (Abst. by A.K.)

POPIVNYAK, I.V. AND MYAZ', N.I., 1978, Melt inclusions in carbonate from the pipe "Vostochnaya-Udachnaya", (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in Geology: Vladivostok, Acad. Sci. USSR, p. 66 (in Russian). Authors at the L'vov State Univ., L'vov.

Lenticular carbonate aggregates up to 1 cm in length occur in kimberlites of the pipe "Vostochnaya-Udachnaya". Carbonate bears glass + G filled inclusions 0.1-0.005 mm in size, G 10-25 vol. %. Inclusions have rhombohedral habit with rounded corners; they are P azonal. At 640-670°C, before any change of inclusion filling, G from inclusions leaks. Up to 700°C shape of glass in inclusion does not change; homogenization was not reached. (From the authors' abst., by A.K.)

POPOV, V.A., 1978, Study of quartzes with carbon dioxide from one of the gold-ore occurrences of Chukotka (USSR), by a homogenization method, in Carbon and its compounds in endogene processes of mineral formation, G.N. Dolenko, ed.: Kiev, "Naukova Dumka" Pub. House, p. 107-110 (in Russian)

The conditions of formation of the Au ore were interpreted from Th and the compn. of gas-liq. and water-salt inclusions in quartz. The ore formed at 80-400° from high- and low-temp. hydrothermal solns. CO_2-contg. solns. were actively involved in formation of the quartz. The ore bodies originated in 2 stages of the hydrothermal process: (1) early formation of high-temp. Au-quartz-low sulfide ore and (2) late Au-quartz sulfide ore. (Chem. Abstracts 89: 200631f)

POPOV, V.K. and EFIMOV, V.V., 1978, Crystallization temperatures of chemically differing volcanic complexes in the Central Sikhote-Alin, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 103 (in Russian). Authors at Far-East Geol. Inst. of Far-East Sci. Center of Acad. Sci. of the USSR, Vladivostok.

Paleogene basalt-liparite series bear in clinopyroxene and plagioclase glass and partly crystallized inclusions with Th as follows: plagioclase from two-pyroxene basalt 1360-1340°C, plagioclase from two-pyroxene andesite 1150-1170°C, clinopyroxene from biotite-pyroxene andesite 1260-1250°C, plagioclase from the same rock 1160-1150°C, plagioclase from pyroxene-biotite liparite 1140-1130°C. T regularly decreased during evolution of magmatic chamber; acid magmas were superheated. (From the authors' abstract, by A.K.)

POPP, R. K., FRANTZ, J. D., VOGEL, G. L. and HARE, P. E., 1978, Measurement of chloride ion concentrations in microsamples, Carn. Inst. Wash. Yearbook 1977-78, p. 913-917 (pub. 1978).

Two new techniques are described for measurement of Cl^- in microsamples (1-10μl) in the range 0.01-0.0001 m chloride. (ER)

POTTER, R. W., II, 1978, Bibliography of the PVTXE properties of the binary system H_2O-NaCl: U. S. Geol. Survey Open File Report #78-549, 34 p.

POTTER, R. W., II and BROWN, D. L., 1976a, The volumetric properties of vapor-saturated aqueous potassium sulfate solutions from 0° to 200°C based on a regression of the available literature data: U. S. Geol. Survey Open-file Report 76-501, 7 pp.

POTTER, R. W., II and BROWN, D. L., 1976b, The volumetric properties of vapor-saturated aqueous sodium sulfate solutions from 0° to 325°C based on a regression of the available literature data: U. S. Geol. Survey Open-file Report 76-255, 7 pp.

POTTER, R. W., II and BROWN, D. L., 1976c, The volumetric properties of vapor-saturated aqueous potassium chloride solutions from 0° to 400°C based on a regression of the available literature data: U. S. Geol. Survey Open-file Report 76-243, 5 pp.

POTTER, R. W., II and CLYNNE, M. A., 1976, The volumetric properties of vapor-saturated aqueous calcium chloride solutions from 0° to 300°C based on a regression of the available literature data: U.S. Geol. Survey Open-file Report 76-365, 7 pp.

POTTER, R. W., III and CLYNNE, M. A., 1978a, Solubility of highly soluble salts in aqueous media-part 1, NaCl, KCl, $CaCl_2$, Na_2SO_4, and K_2SO_4 solubilities to 100°C: Jour. Research U.S. Geol. Survey, v. 6, p. 701-705.

A modified visual method for determining the solubility of highly soluble salts in aqueous media up to 100°C is presented. The solubilities of NaCl, KCl, $CaCl_2$, Na_2SO_4, and K_2SO_4 were determined up to 100°C. The tabulated experimental data and the fitted equations describing the data indicate that the previous literature data for the solubility of these salts were generally high by 0.05 to 2.0 weight percent salt. (Authors' abstract).

POTTER, R. W., II and CLYNNE, M. A., 1978b, Pressure correction for fluid-inclusion homogenization temperatures (abst.), in International Assoc. Genesis Ore Deposits, 5th Symp., Snowbird, Alta, Utah, 1978, Program and Abstracts: (Alta, Utah), p. 146.

Homogenization temperatures represent the true temperature of entrapment of the fluid inclusion, provided the total pressure did not exceed the equilibrium vapor pressure of the solution at the time of entrapment. If the pressure at the time of entrapment was higher, then an appropriate temperature correction based on the volumetric properties of the fluid in the inclusion is required. There are two immediate difficulties: 1) the composition of the fluid must be defined, and 2) the appropriate volumetric data must be available.

In most fluid-inclusion studies, the composition of the fluid is approximated by the NaCl concentration having the same freezing point as the inclusion. This is fortuitous because experimental studies with brines in the system $Na-K-Ca-Mg-Cl-Br-SO_4-H_2O$, have shown that the pressure-volume-temperature-composition (PVTX) properties of these brines are predicted within ±1.0% by the properties of an NaCl solution having the same freezing point. The PVTX properties of brines need to be corrected slightly if the atomic ratios of Ca/Na, K/Na, and Mg/Na are greater than 0.5, 0.3, and 0.2, respectively. The observed ratios in most inclusions are within these limits.

Because the PVTX properties of an equivalent NaCl solution can be used to describe the properties of the fluid in the inclusion, the volumetric properties of the equivalent NaCl concentration may be used to make pressure corrections. Until recently, the only available volumetric data for pressure corrections were those of Lemmlein and Klevtsov (1961). However, the volumetric properties of the NaCl solutions have been reviewed, and a standardized set of regressed values has been generated (Potter and Brown, 1975). These data were used to generate a set of pressure-correction curves for homogenization temperatures (Potter, 1977, USGS Jour. Research, v. 5, p. 603-607). The newer data set has two advantages: 1) it utilizes a wider data base than did that of Lemmlein and Klevtsov, and 2) the correction diagrams are printed in a larger format (i.e., one diagram is about as large as all six of Lemmlein and Klevtsov's diagrams). To be able to use the diagrams, one needs: 1) an estimate of the total pressure, 2) the homogenization temperatures, and 3) the composition of an NaCl solution having an equivalent freezing-point depression. (Authors' abstract)

POTTER, R. W., II, CLYNNE, M. A. and BROWN, D. L., 1978, Freezing point depression of aqueous sodium chloride solutions: Econ. Geol., v. 73, p. 284-285.

New laboratory data on the depression of the freezing point (i.e., Tm ice) for $NaCl-H_2O$ fluids, when regressed along with the best previously published data, yielded the following equation

$$\theta = 0.00+0.581885\ W_s + 3.48896 \times 10^{-3}\ W_s^2 + 4.34 \times 10^{-4}\ W_s^3 \pm 0.03$$

Where W_s = weight percent NaCl in solution and θ is the depression of the freezing point in °C. Equations are also given for θ in terms of molality of NaCl, and for the molality or weight percent in terms of θ. (ER)

Editor's note: for the reader's convenience, I list a tabular series of values of θ and W_s, calculated from the above equation, with thanks to P. Toulmin, III.

θ (°C)	W_s (Wt.%)	θ (°C)	W_s (Wt.%)	θ (°C)	W_s (Wt.%)
0.000	0.000	7.000	10.508	14.000	17.893
1.000	1.698	8.000	11.728	15.000	18.767
2.000	3.343	9.000	12.886	16.000	19.606
3.000	4.922	10.000	13.985	17.000	20.412
4.000	6.430	11.000	15.032	18.000	21.189
5.000	7.862	12.000	16.029	19.000	21.939
6.000	9.221	13.000	16.982	20.000	22.663
				20.500	23.016

POTTER, R.W., CLYNNE, M.A., et al., 1978, [Salt and anhydrite as potential repositories for nuclear waste] (abst.): Geological Research 1978, U.S. Geol. Survey Prof. Paper 1100, p. 276.

The densities, vapor pressures and enthalpies of portions of the systems $NaCl-CaSO_4-H_2O$ and $NaCl-CaSO_4-KCl-MgCl_2-H_2O$ are being explored. The latter system includes components of many of the brine inclusions in domed and bedded salt. These inclusions have been found to be highly concentrated bitterns, not simple NaCl solutions. In the experiments, soluble starting materials are allowed to equilibrate under pressure at a series of controlled temperatures; temperature-pressure relations and the solubilities of the salt in the concentrated brines are then determined.

Addition of components to the simple $NaCl-H_2O$ system restricts the two-phase field in which gas (steam) and solid are in equilibrium. Depending on the extent of this effect, brine not gas, will be the fluid in equilibrium with salt at repository conditions. The proportion of brine to solid greatly affects the strength of rock salt. The greater the number of components, the greater the proportion of brine to solid at any given temperature and pressure.

The solubility relationships of anhydrite were determined in brines saturated with both NaCl and $CaSO_4$ to temperatures of 435°C and pressures of 220 bars. The solubility relationships of $CaSO_4$ in NaCl-saturated brines are complex, being retrograde (less $CaSO_4$ can be dissolved as the temperature is increased) up to approximately 230°C and prograde at higher temperatures. Despite the increased solubility in most brines, $CaSO_4$ remains relatively insoluble even up to the highest temperatures studied.

The retrograde solubility of $CaSO_4$ means that brine inclusions will not migrate to a heat source (<230°C) within anhydrite. This property, the low solubility in brine, and the fact that freshwater infiltrating anhydrite can be fixed by the formation of hydrated minerals, suggest that anhydrite, where present in sufficient thickness, may be a suitable waste containment medium.

Results for the more complex system containing $MgCl_2$ being studied show that ion-pairing processes are significant at 200°C, causing MgCl-rich solutions to become acid (to pH 2). The temperature dependence of the formation of HCl in the gas phase is being accurately determined as preliminary results suggest limiting values may be attained. It is probable that the increased acidity caused by ion-pairing phenomena would increase the corrosion of metal cannisters. (From the authors' abstract)

POZDEEV, K.M., 1978, Physico-chemical conditions of formation and prognosis for polymetallic ores in some deposits of the Sadon group (N. Caucasus), (Abst): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. II, Thermobarogeochemistry and ore genesis: Vladivostok, Acad. Sci. USSR, p. 5-6 (in Russian). Author at the L'vov State Univ., USSR.

Inclusions in minerals of quartz-sulfide veins from the polymetallic deposits: Arkhon and Kholstin yielded Th: 380-240°C (quartz-pyrite stage) 340-160°C (quartz-galena-sphalerite stage), 140-$<$100°C (quartz - carbonate stage). Each stage begins with an abrupt T increase or decrease over an interval of 60-100°C. By water leaches, hydrothermal solutions changed from the early stage ($Cl-HSiO_3-HCO_3-Ca-Na$ type) to the late stage ($HCO_3-HSiO_3-Na-Ca$ type). Heterogenization of the H_2O-CO_2 solutions was observed during ore precipitation; P varied from 2300 to 450 atm, d_{CO_2} - from 0.900 to 0.598 g/cm^3. The pH of water leachates changes together with T decrease from 8.0 to 6.3. Speculations on base metal transport are presented. (Abst. by A.K.)

PRASOLOV, E. M., MALYGIN, N. A. and SUBBOTIN, Ye. S., 1978, Use of small-scale mass-spectrometers for chemical analysis of gases from microinclusions, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1 Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 161 (in Russian). First author at All-Union Sci. Research Geol.-Prosp. Inst., Leningrad, USSR.

Mass-spectrometer 1PDO-2A was used, with special additional instruments; H_2, He, CH_4, N_2, Ar, CO_2 and other gases were determined from samples of 10^{-3} cubic nanocentimeters (sic.; probably refers to (10^{-9} cm^3)) with relative deviation 10% with pumping out and from samples of 10^{-5} - 10^{-6} "ncm^3" without pumping out. (From the authors' abst.)

PRASOLOV, E.M. and TOLSTIKHIN, I.N., 1978, Isotopes of light inert gases (He, Ne, Ar) in microinclusions in minerals - a review, (Abst): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 35 (in Russian). Authors at IGGD of Acad. Sci. of the USSR, Leningrad.

A review of published data by these authors. (A.K.)

PRASOLOV, E. M., TOLSTIKHIN, I. N. and MALYGIN, N. A., 1978, Studies of isotope and chemical composition of gases in young igneous rocks, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 164 (in Russian). Authors at Inst. of Geol. and Geochronol. of Precambrian of Acad. Sci. of the USSR, Leningrad.

High isotope ratio $^3He/^4He \approx 10^{-5}$ proves the influx of mantle helium; low values (10^{-8}) are typical of radiogenic He in the Earth's crust. Young mantle origin igneous rocks were studied. (From the authors' abst.)

PRICE, W.F., and BAILEY, D.K., 1978, The extraction and analysis of gases from volcanic rocks: Natural Envir. Research Council, Pub. Ser. D, No. 11, Progress in Experimental Petrology, p. 237-240.

1-2g fragments in Pt boat are heated by external resistance furnace to 1100°C; evolved gases are condensed in cold trap and then analyzed by mass spectrometer. Numerous problems were encountered. (E.R.)

PTITSYN, A. B., KOLONIN, G. R. and STEPANTCHIKOVA, S. A., 1977, Spectrophotometric study of dissolution processes of metallic copper, bismuth, silver, their sulfides and AgCl in hydrothermal chloride 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. 3, p. 57 (in Russian).

PUCHKOV, L. V. and ZAREMBO, V. I., 1978, Standard values of thermodynamic functions of electrolytes in water solutions at elevated temperatures and pressures: Geokhimiya, 1978, no. 11, p. 1671-1676 (in Russian, English abst.) Authors at Leningrad Inst. of Technology, USSR.

The proposed method of calculation of absolute enthropy, partial molar volume of dissolved electrolyte, enthalpy and Gibbs free energy of electrolyte formation was checked for NaCl solutions at $T \leq 600$ K and $P \leq 100$ MPa. (A. K.)

PUGIN, V.A. and KHITAROV, N.I., 1978, Experimental petrology of deep magmatism: Moscow, Nauka Publishing House, 175 pp. (in Russian).

Extensive petrologic studies include experiments with basaltic magmas, tholeiites, quartz tholeiites, olivine nephelinites, and granite, as well as consideration of the scheme of evolution of magmatic melts. Liquation (i.e., silicate melt immiscibility) in olivine tholeiite described on pp. 105-112 is pertinent to melt inclusion studies. (A.K.)

PULOU, Raymond, BAUDRACCO-GRITTI, Celestine, 1978, A decrepitometric recorder with electronic filter: Bull. Mineral., v. 101, p. 402-405 (in French). Authors at Lab. Mineral. et Crist., Univ. Paul-Sabatier, Toulouse.

A sample of powdered mineral is heated in an electric furnace with a constant rate of increase in temperature. By means of a sensitive microphone the frequency of the decrepitation against temperature is recorded. The interpretation of the obtained curve serves to indicate approximate temperature of deposition for the tested mineral. An original filtering system is utilized to reduce or to eliminate noise interference in microphonic signals and to facilitate the interpretation. (Authors' abstract).

PUTCHKOV, L.V., FEDOROV, M.K., ZAREMBO, V.I., 1977, Influence of contributions of far and near hydration on values of thermodynamic functions of 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. 3, p. 16 (in Russian).

PUZANOV, L. S., 1977, Origin of fluorite mineralization in carbonatite of the Bol'shaya Tagna pluton, Eastern Sayan[1]: Akad. Nauk SSSR Doklady, v. 233, p. 463-466 (in Russian; translated in Doklady Acad. Sci. USSR, v. 233, p. 134-136).

See Fluid Inclusion Research--Proc. of COFFI, v. 10, p. 221-223 (1977).

PUZANOV, L. S., 1978, Conditions for the formation of fluorite in different types of ore formations: Teor. Prakt. Termobarogeokhim., (Dokl. Vses. Soveshch.) 5th 1976, N. P. Ermakov, ed.: Moscow, Izd. Nauka, p. 128-135 (in Russian).

The pressure-temp. conditions of fluorite (Ft) and Ft-contg. ore deposits are outlined, based largely on detns. of Th of fluid inclusions in Ft reported in the literature. Five genetic processes of Ft deposit formation are distinguished: magmatic, pneumatolytic-hydrothermal, hydrothermal, sedimentary and supergene. The types of fluid inclusions in Ft and the CO_2 concn. and pressure of the solns. in the inclusions are considered for various types of deposits. (Chem. Abstracts 91: 77041a, 1979)

PUZANOV, L.S., KANDINOV, M.N., KHITAROV, D.N., KHARLAMOV, E.S., 1978, Significance of carbon dioxide in formation of carbonatite fluorite-barite-iron ore mineralization in East Siberia, in Carbon and its compounds in endogene processes of mineral formation, G.N. Dolenko, ed.: Kiev, "Naukova Dumka" Pub. House, p. 57-62 (in Russian).

This is full paper corresponding to abstract given in COFFI v. 8, p. 148, 1975 (ER)

PUZANOV, L.S. and PARTSEVSKIY, A.I., 1978, Genetic type of the Seligdar apatite deposit (Central Aldan): Akad. Nauk SSSR Doklady, v. 243, no. 1, p. 179-182 (in Russian). Authors at the All-Union Sci.-Research Inst. of Mineral Raw Materials, Moscow.

Apatite mineralization occurs in the Archean Mg-marbles, at the crossing of regional faults. Ore body is an elliptical pipe, 2.4 x 1.0 km. The earliest melt inclusions were found in phlogopite and apatite with signs of liquation of primitive melt to apatite ± isotropic phases and hematite; their formation temperature was evaluated on the basis of T of hematite melting (1350-1360°C) reduced by 15-20% by fluorine influence, i.e. 1080-1150°C. Minerals bear also inclusions of salt crystal, salt crystal + gas and polyphase G 5-10 + solids (apatite, carbonate, hematite, ?carbonates of sodium and potassium) 60-85, solution 10-35 (vol %) with Th 900-980°C. These inclusions are related to melts diluted with gas and solutions. Also inclusions occur with strongly varying phase ratios (Th 740-850°C), that prove explosive processes. Numerous lower-T inclusions were found as well. Carbonates bear similar polyphase inclusions with Th 850-920°C and also lower-T ones; like anhydrite, with Th 795-830°C. Hence, the studied deposit has a magmatic origin. (Abst. by A.K.)

PUZANOV, L.S., PARTSEVSKIY, A.I. and KASHINTSEVA, Ye.N., 1978, On two varieties of high-temperature anhydrite at the Seligdar apatite deposit: Akad. Nauk SSSR Doklady, v. 242, no. 5, p. 1170-1172 (in Russian). Authors at the All-Union Sci.-Research Inst. of Mineral Raw Materials, Moscow.

Magmatic (I) and pneumatolytic-hydrothermal anhydrite (II) were found at the Seligdar deposit, Central Aldan. Anhydrite I bears numerous P inclusions of droplets of crystallized carbonate ± G bubble, Th 795-830°C (liquation phenomena also were observed), and S inclusions consisting of (vol. %) G 3-7, dms 65-85, L 10-30 or G 20-40, dms 25-40, L 40-50, Th 455-650°C; late G/L S inclusions have Th 380-450°C (G > L) and 100-220°C (L > G). Anhydrite II bears inclusions with Th 435-590°C, 370-435°C, 325-365°C and 120-200°C for individual mineralization stages. (Abst by A.K.)

RAFAL'SKY, R.P., 1977, The role of experimental investigation and of thermodynamic analysis of equilibria in the problem of hydrothermal 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. 3, p. 100-101 (in Russian).

RAJAMANI, V. and NALDRETT, A. J., 1978, Partitioning of Fe, Co, Ni, and Cu between sulfide liquid and basaltic melts and the composition of Ni-Cu sulfide deposits: Econ. Geol., v. 73, p. 82-93.

It is concluded that the composition of silicate magma determines not only the initial concentration of ore metals but also their partitioning behavior between immiscible sulfide liquid and silicate magma-the two important factors determining the composition of massive, magmatic Ni-Cu sulfide deposits. (From the authors' abstract).

RAKHIMOV, Sh.Kh., 1978, Geological-structural conditions of localization of the skarn-polymetallic deposits of Karamazar: Tashkent, "Fan" Pub. House of the Uzbek SSR, Tashkent, 143 pp. (in Russian).

Collomorph, disseminated and brecciated ores in granitoids from ore bodies: No. 5, No. 6, No. 7 and "Slepoe" ("Blind") of the deposits Central Kansay and Southern Kansay (Karamazar area in Uzbekistan) yielded Td as follows: galena 210-220°C, sphalerite 210-250°C, pyrite 250-275°C, chalcopyrite 240-250°C, quartz 250°C, calcite 180°C. (Abst. by A.K.)

RAKHMANOV, A. M., 1978, Role of carbonaceous components during post-magmatic stage in evolution of high-temperature ore associations in Southern Gissar (based on studies of fluid inclusions): Vyssh. Ucheb. Zaved. Izv., Geologiya; Razvedka, 1978, no. 2, p. 94-101 (in Russian; translated in Intern. Geol. Rev., 1978, v. 20, no. 11, p. 1287-1292). Author at Tadzhik Univ.

A summary of fluid inclusion data from a series of skarn ore deposits, with mostly descriptive material or generalized ranges of data. Numerous pressure determinations by the "Nakken (Nacken) - Kalyuzhnyi" method (based on syngenetic inclusions of CO_2 and of H_2O, in temperature range 210-270°C; sic.) (ER)

RAKHMANOV, A. M., 1978, Stages in formation of the Takfon skarn-rare metal deposit: Teor. Prakt. Termobarogeokhim., (Dokl. Vses. Soveshch.) 5th 1976, N. P. Ermakov, ed.: Moscow, Izd. Nauka, p. 123-127 (in Russian).

The title ore deposit, in Tadzhikistan, formed in skarn and pneumatolytic-hydrothermal successive stages. The fluid inclusions in minerals from the different stages and substages were studied by aq. extn. and homogenization procedures. The inclusions in pyroxenes, garnets, and actinolite of the skarn stage had Th 400-620°. The inclusions in minerals of the pneumatolytic-hydrothermal substages had Th quartz (Q)-rare metal 250-550, Q-sulfide 290-470, and Q-carbonate 290-360°. The aq. exts. of the inclusions contain mainly HCO_3^-, Cl^-, SO_4^{2-}, Ca^{2+}, K^+, Na^+, and Mg^{2+}. (Chem. Abstracts 91: 77040z, 1979)

RANKIN, A.H., 1978, Course notes for user school on fluid inclusion equipment and methods, Imperial College, London, March-April, 1978, 20 p. plus 22 illustrations, an exercise, and 3 tables (privately printed). Author at Dept. Geology, Imperial College, London SW7 2AZ, England.

Includes a brief review of the composition of inclusions, density and degree of filling, changes since trapping, representativeness, salinity and its measurement, measurement of Th, sample preparation, and pressure correction. (ER)

RANKIN, A. H. and GREENAWAY, Frank, 1978, Macroscopic inclusions of fluid in British fluorites from the mineral collection of the British Museum (Natural History): Bull. Br. Mus. Nat. Hist. (Geol.), v. 30, p. 295-325. First author at Dept. Geol., Div. of Mining Geol., Royal School of Mines, Imperial College, London SW7 2BP.

Exceptionally large (macroscopic) fluid inclusions are present in 21 fluorite specimens from the mineral collection of the B.M.(N.H.). The maximum size of the inclusions, in three dimensions at right angles to one another, range from 1 x 1 x 2 to 24 x 17 x 4 mm. It is estimated that the largest cavity contains between 1 and 1.5 cm^3 of fluid. They are primary in origin, show no visible signs of leakage and, as such, are suitable for further work on the chemical composition of their contained fluids. Macroscopic inclusions (those whose maximum dimensions at right angles to one another exceed 1 mm) are restricted to fluorite from the Weardale area of the North Pennine orefield; they are absent in fluorite from other British localities. (Authors' abstract)

RAUP, O.B. and HITE, R.J., 1978, Bromine distribution in marine halite rocks: Section 6 in: Marine Evaporites, SEPM Short Course No. 4, Oklahoma City, 1978, p. 105-123.

Pertinent to any analysis of the Br content of inclusion fluids from evaporites. (ER)

REYF, F.G., 1978, Liquid phase in crystallized inclusions of the water-poor granite melts, (Abst): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 73-75 (in Russian). Author at GIN BF of Siberian Branch of Acad. Sci. of the USSR, Ulan-Ude.

Magmatic complex of the Dzhida ore field consists of: I - felsite, felsite-porphyry, II - granite, granite-porphyry of the Pervomaiskiy massif, III - dikes of aplite granite, IV - dikes of aplite porphyry, V - dikes of quartz syenite porphyry. Melt inclusions were studied in quartz of granites of all the intrusive phases except felsite of the first phase. L in incs. is not visible at room T, since it forms films and fills interstices between dms. T frz ≳-10°C (sic); L CO_2 was not found. L H_2O was observed in all studied intrusion phases. Quartz of matrix of the second and third phase granites bear inclusions in which melting begins at 720-740, rarely 760°C, next the G bubble disappears, and at 20-40°C higher last dms melt and inclusions become homogeneous. Inclusion filling in phenocrysts begin to melt at 810-830°C. Thermometric data are summarized in the table: (From the author's abst., by A.K.)

Phases	Matrix			Phenocrysts		
	T L+G→L,°C	T beginning of melting,°C	Th,°C	T L+G→L,°C	T beginning of melting, °C	Th, °C
II	315-230	760-720	900-800	-	820-810	1100-960
III	334	760-740	900	-	-	-
IV	285-265	792	1000	270-250	830	1180-1100
V	-	-	-	250-225	830-810	1220

REYF, F.G. and BAZHEEV, Ye.D., 1978, Pecularities of the surface distribution of minerals of tungsten ore fields of Transbaikalia, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, V. II, Thermobarogeochemistry and ore genesis: Vladivostok, Acad. Sci. USSR, p. 27-29 (in Russian). Authors at the Geol. Inst. of Buryatian Division of Siberian Branch of Acad. Sci. USSR, Ulan-Ude.

Inclusions in rock-forming quartz in Dzhida, Kukul'bey and other tungsten deposits of Transbaikalia were studied and types of inclusions were mapped. Secondary inclusions in quartz are specific for individual types of deposits, e.g. those with LCO_2 etc. (From the Authors' abst.)

RICE, J.M., 1978, Stability of clintonite in CO_2-H_2O fluids: observations from the Boulder aureole, Montana (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 10, no. 7, p. 478.

RIKHVANOV, L.P., CHEREPNIN, V.K. and DOMARENKO, V.A., 1978, Physicochemical conditions of hydrothermal mineral-formation in process of origin of volcanogenic-intrusive complex of the post-orogenic stage of development of northern part of Kuznetskiy Alatau, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v.1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 111-113 (in Russian). Authors at Tomsk Polytechnical Inst., Tomsk, USSR.

Studies were made by means of decrepitation and double water leachates. Formation of the studied complex lasted from Middle Paleozoic to Upper

Paleozoic/Mesozoic threshold. Early volcanic deposits with comagmatic gabbro-syenite intrusions, intrusion of alkaline granites, and basaltoid dikes are the main stages, accompanied by hydrothermal activity. That activity yielded propylites (Td 350-400°C) quartz-feldspar-hydromica metasomatites (Td 350-400°C), skarns (Td 500-650°C), albitites (apogranites) (Td 350-570°C) and quartz-feldspar-rare metal veins; basaltoid dikes are altered (Td 350-400, 150-250 and 100-150°C) to quartz-sericite-pyrite and quartz-albite-hematite metasomatites with sulfide-fluorite-barite-carbonate mineralization. Total salts vary from 26.1 to 454.4mg/l. High K, Na and Cl are typical of propylites and albitites; K/Na ratio is usually <1 (0.1-0.7), except quartz-feldspar-hydromica metasomatites and quartz-feldspar-rare metal veins (1.25-2.6). Mg/Na ratio increases from early to late metasomatites. (From the authors' abst., by A.K.)

RIPP, G.S., ARKHIPCHUK, R.Z. and KAVILADZE, M. Sh., 1978, Isotope composition of sulfur in mineral-forming hydrotherms of fluorite deposits in Transbaikalia: Akad. Nauk SSSR Doklady, v. 239, no. 1, p. 207-210 (in Russian). First author at Geol. Inst. of Buryatian Division of the Siberian Branch of the Acad. Sci. of the USSR, Ulan-Ude.

Very steep veins (surface length 300-1300 m, thickness 0.5-26 m, known depth 150-500 m) consist of fluorite (3-97%), quartz, calcite, plus subordinate barite, adularia, stilbite, pyrite, marcasite, galena, kaolinite. Ore bodies are surrounded with zones of silicification and argillitization. By fluid inclusion studies, veins were formed by ascending dilute solutions characterized by Th 260-75°C; barite crystallized at 190-80°C (tabular crystals at 165-115°C, prismatic ones - at 110°C.) Values of $\delta^{34}S$ for sulfur-bearing minerals are listed: sulfides of 6 deposits average -3.1‰, barite of 8 deposits average + 11.7‰. (Abst. by A.K.)

RITTER, C.J., 1971, Trace elements of gold-bearing quartz veins of the Lamaque mine, Bourlamaque, P. Q., Canada: Ph.D. dissertation, Univ. of Michigan, 214 pp.

Three sheet-like, lensoid gold-bearing-quartz veins in the Lamaque Mine, Bourlamaque, Quebec, Canada, were microscopically and chemically studied. The average amounts of Na (115 ppm), Ca (123 ppm), Al (63 ppm), Mg (3.0 ppm), Fe (2.8 ppm), Mn (14 ppm), Cu (3.5 ppm), and Ti (7.0 ppm) were measured. Trend surface analysis shows that the concentrations of gold in the quartz plus adjoining wall rock and some of the trace elements in the quartz vary systematically over a vein. The trend surfaces, scatter diagrams, and simple correlation coefficients indicate that there are significant inverse correlations between vein width and some of the elements, particularly Na, direct correlations between vein width and gold, and inverse correlations between gold and various elements, particularly Na.

Carbonate, tourmaline, chlorite, quartz, other silicates, and pyrite formed early, followed by most of the quartz, late carbonate, albite, paragonite and gold.

Aligned, secondary fluid inclusions make up approximately 0.2-0.5 percent of the total volume of the quartz. It is proposed that they were formed by the redistribution of trapped primary (vein-forming) fluids during cataclasis and that the fluids are located close to their original positions.

It is concluded that open filling was the major vein-forming process, and replacement was of minor importance.

If the correlations which occur in the Lamaque Mine exist in other gold-bearing quartz veins, then the measurement of trace element concentrations and vein width can be used to detect the presence of and, to a certain extent, to predict the amount of gold present. This would be of great assistance in directing ore exploration and evaluation. (From the author's abstract)

ROBINSON, B. W., 1978, Isotopic evidence on the origin of sulphur in Mississippi Valley-type deposits, particularly in the British Isles (abst.), in International Assoc. Genesis Ore Deposits, 5th Symp., Snowbird, Alta, Utah, 1978, Program and Abstracts: (Alta, Utah), p. 154.

ROBINSON, B. W., 1978, Isotopic equilibria between sulphur solute species at high temperatures, p. 203-206 in Stable Isotopes in the Earth Sciences, Robinson, B. W., ed., Wellington, New Zealand, DSIR.

ROBINSON, B. W., and CHRISTIE, A. B., 1978, Epithermal Au-Ag mineralisation, Maratoto Mine, New Zealand: stable isotopes and fluid inclusions (abst.), in International Assoc. Genesis Ore Deposits, 5th Symp., Snowbird, Alta, Utah, 1978, Program and Abstracts: (Alta, Utah), p. 155.

In the Coromandel Peninsula (Hauraki gold field) Au-Ag and base metal-quartz veins occur in hydrothermally altered Coromandel Group andesites (Miocene age) and underlying Jurassic greywackes. This mineralisation, together with granodiorite and other porphyry intrusives, occur in a mobile belt of calcalkaline magmatism, i.e., an island arc setting. Samples from the Camoola and Silver Queen reefs (Maratoto Mine) within the andesites exhibit the general paragenetic sequence of Stages: (1) Blocky calcite with pyrite; (2) sulphide and silver minerals, carbonates and quartz; (3) minor carbonate, quartz and pyrite. Stage 1 and 2 sulphides (pyrite, chalcopyrite, sphalerite and aguilarite) have $\delta^{34}S$ CDT values of +2+2‰ and sulphur isotope temperatures of 280± 80°C. Primary fluid inclusions in quartz and calcite (two phase liquid-vapour) give filling temperatures of 260± 70°C with negligible pressure corrections.

Stage 1 and 2 calcites have $\delta^{18}O_{SMOW}$ and $\delta^{13}C_{PDB}$ values of +3±3 and -8±1‰ respectively. Higher isotopic ratios for Stage 3 calcite suggest lower temperatures of deposition (down to 50°C with $\delta^{18}O$+ 18‰ and $\delta^{13}C$-1‰). The calcites show a positive linear relationship on a plot of $\delta^{18}O$ versus $\delta^{13}C$ and lie about a theoretical curve for calcite precipitating in equilibrium with a large excess of H_2CO_3 in solution and $\delta^{13}C$ about -7‰. The inferred large quantity of carbon in solution and its isotopic composition suggest the source to be magmatic CO_2. Reduced sulphur in the ore fluid would have an isotopic composition of about +4‰ (similar to geothermal H_2S), but Stage 3 pyrite has a $\delta^{34}S$ value of around +16‰. The latter may reflect the isotopic composition of the ΣS in the fluid which originated as sulphate from the greywackes and underwent reduction.

Water from primary plus secondary fluid inclusions in Stage 1 calcite and primary plus pseudo-secondary inclusions in Stage 2 quartz yielded δD_{SMOW} ratios of -36 ± 4 and -45± 4‰, respectively. These values together with calculated oxygen isotopic ratios for the ore fluid (-6‰ early, -4‰ main stage) suggest it to be deeply circulating meteoric water similar to present day geothermal waters. The salinity of the fluids is low (up to three equivalent wt % NaCl) and leachates show the following elements to be present in order of abundance: Cl, Na, K, Ca, Li, Mg, Cs, and Rb.(Authors' abstract)

ROEDDER, Edwin, 1978a, Origin and significance of magmatic inclusions, in Société Francaise de Minéralogie et Cristallographie, Colloque "Mineraux et Minerais", Nancy, 26-29 Sept., 1978--Programme et Résumés des Communications: (Nancy), p. 40. Author at 959 National Center, U.S. Geol. Survey, Reston, Va., 22092.

This is a review of past work from the world literature, and of present work in several United States laboratories, on melt inclusions in terrestrial and extraterrestrial samples.

Normal silicate melt inclusions are trapped from a homogeneous melt due to some irregularity of growth of the host crystal. Heterogeneity in the host melt, due to a wide variety of types of fluid phase immiscibility (in the broad sense) results in the trapping of immiscible-fluid inclusions that are sometimes confusing, and almost always nonrepresentative of the bulk of the magma, but that are extremely important in delineating the sequence of magmatic events. In both cases, the inclusions present us with samples of the magma, with the original complement of dissolved volatile constituents at the time of trapping still intact, enclosed in single crystal bottles.

The changes that may occur within the inclusion after trapping include: 1) crystallization of one or more phases; 2) separation into two or more immiscible fluid phases; 3) further precipitation of the host mineral on the walls and/or reaction with the walls; and 4) leakage of some original constituents outward (e.g., H_2), or of others inward (e.g., H_2O on alteration). Inclusions are small systems, and the included melts may have high viscosities, so equilibrium may be difficult to achieve and metastable phenomena are common. Although these features cause experimental problems, they also provide some useful constraints on the cooling rates in nature.

Perhaps the most valuable information to be derived from melt inclusions concerns the composition of the included material and what it tells us of magmatic differentiation and the liquid line of descent. Compositions may be estimated semiquantitatively by petrographic techniques, or quantitatively by electron microprobe, scanning electron microscope, ion microprobe, gas chromatograph, mass spectrometer, or other methods. None of these methods provides an analytical panacea, however, as numerous problems affect both the precision and the accuracy of most of the results.

The other major type of data to be derived from a study of melt inclusions concerns the temperatures of various events. The most important of these is the temperature of trapping (i.e., sealing) of the inclusion by host crystal growth. This is usually assumed to be given by the temperature of homogenization of the inclusion contents in the laboratory. Under some circumstances, the temperatures at which the melt becomes saturated with new phases (other than the host crystal) on cooling can also be determined. These types of data are indeed valuable, but are subject to possibly serious errors in both accuracy and interpretation.

The various types of data will be illustrated with lunar and terrestrial examples. Although the inclusion data sets are generally concordant with and explicable in terms of reasonable hypotheses, several types of inclusions in the lunar samples remain enigmatic. In spite of these enigmas, magmatic inclusions have yielded much valuable information already, some otherwise unobtainable, on a wide variety of petrologic problems, and shows much promise for the future. (Author's abstract)

ROEDDER, E., 1978b, A new ultramicrochemical analytical technique for fluid inclusions (abst.): U.S. Geol. Survey Prof. Paper 1100, Geologic Survey Research 1978, p. 177.

A new analytical procedure for the chemical analysis of individual minute fluid inclusions, making use of the tremendous sensitivity of the electron microprobe, has been developed. There have been several studies published recently by others that used the electron microscope to analyze qualitatively individual solid phases in fluid inclusions. Special methods of sample preparation were also used that were not applicable to analyzing the liquid phase. The new method involves taking a very tiny mineral fragment containing an inclusion of interest, cracking it open under clean conditions, adding (under the microscope) a micro drop ($\sim 10^{-7}$g) of pure water to the crushed debris, transferring this liquid by micropipette to a hydrophobic-coated planchet of beryllium or copper, adding an appropriate amount of a water-soluble organic glassformer, evaporating to form a tiny disk of organic glass containing the $\sim 10^{-8}$g of water-soluble ions from the inclusion fluid, uniformly distributed, and then probing the whole disk with the electron beam for Na, K, Ca, Mg, S, and Cl. Since the most effective glass-former found to date is corn syrup (a mixture of sugars that effectively interfere with each other's crystallization, forming an organic glass), the resulting tiny sample disk is essentially a sugar glass. As such, it is, in effect, a miniature lollipop, hence the procedure has been dubbed the "minimillimicrolollipop method." A number of other organic glass formers are still to be tried, but the requirements of the method are surprisingly restrictive in this selection. The most important function of the glass former is to prevent the crystallization of the inclusion salts on drying thus yielding a sample with a maximum concentration of salts homogeneously distributed throughout a minimum volume of uniform glass. The volume minimum is set by the depth of penetration of the electron beam into the glass. Preliminary studies indicate that valid ratios of Na:K:Ca:Mg:S:Cl can be obtained with the method, but considerably more developmental and calibration work will be required. (Author's abstract)

ROEDDER, E. and BELKIN, H.E., 1978a, Fluids present during the diagenetic history of the Salado formation, Delaware basin, southeastern New Mexico, as recorded by fluid inclusions (abst.): Amer. Geophy. Union, Trans; v. 59, no. 4, p. 226.

Inclusions were examined in cores from the site of a proposed underground nuclear waste repository in the Permian Salado salt beds. Petrography & freezing, heating & crushing stages were used. The aim was to help understand the origin and geological history of the basin and the diagenetic mineral assemblages, and to anticipate what problems the inclusions might cause during long-term waste storage. The available data indicate the following diagenetic stages:

The original fine-grained, dark-gray salt contains vast numbers of $\sim$1-2μm, mostly one-phase primary liquid inclusions ($\leq 10^{10}$cm^{-3}) in arrays outlining cubic hopper growth. Low first-melting temperatures show the trapped fluid to be a strong bittern, not simply saturated NaCl. Subsequent recrystallization and grain growth caused inclusion coalescence, yielding a few larger inclusions in coarse clear salt. Only $\sim$1% of the salt remained unrecrystallized. The new inclusions also contain strong bitterns, variable in composition, possibly derived in part from those in the original hopper crystals. Some contain unidentified birefringent daughter crystals. Large inclusions ($\sim$1mm) have small shrinkage (vapor) bubbles, containing no detectable noncondesable gas ($<10^{-14}$g; crushing stage data), homogenizing at 20°-46°C. Later, fracturing in the presence of a pore fluid containing bubbles of gas (methane?) under pressure (crushing stage data) caused trapping of this mixture in some opened inclusions, yielding variable G/L ratios.

These inclusions make up <1 vol.%; an additional possibly even greater volume % fluid is present in situ, filling intergranular pores. The evidence for extensive recrystallization is important, but available data do not permit more than qualitative evaluations of the deleterious effects of such fluids on atomic waste storage. (Authors' abst.)

ROEDDER, E., and BELKIN, H.E., 1978b, [Fluid inclusions in salt] (abst.): Geological Research 1978, U.S. Geol. Survey Prof. Paper 1100, p. 278.
See previous item. (E.R.)

ROEDDER, Edwin, and WEIBLEN, P.W., 1978a, Late-stage differentiates in mare lavas (abst.): Geological Research 1978, U.S. Geol. Survey Prof. Paper 1100, p. 299-300.

On the basis of about 1,000 analyses, there are three compositional types of late-stage melts in the mare lavas: immiscible "high-iron" and "high-potassium" melts, and a possibly contemporaneous but enigmatic "low-potassium" melt. The explanation of these three melts is clouded by the fragmental nature of the record and by crystallization of the trapped melt. The compositional data differ from sample to sample, thus permitting a grouping and recognition of some rock types; they verify but do not explain the previously reported strongly bimodal distribution of K_2O values for inclusions in ilmenite; and they delineate some differentiation trends such as increasing SiO_2, K_2O, and FeO/FeO+MgO, but some unanswered questions remain. Thus, silicate liquid immiscibility seems to occur at about 2 percent K_2O, but the stage cannot be specified exactly. The origin of the low-potassium, high-silicon melt inclusions in ilmenite reported earlier remains obscure. (Authors' abstract)

ROEDDER, Edwin and WEIBLEN, P. W., 1978b, Melt inclusions in Luna 24 soil fragments: Merrill, R. B. and Papike, J. J., editors. Mare Crisium: The View from Luna 24, Pergamon Press, New York, p. 495-522. First author at 959 National Center, U.S. Geol. Survey, Reston, Virginia 22092.

Optical examination of 28 slides (polished grain mounts) of Luna 24 soil fragments (0.09-0.50 mm size range) revealed melt inclusions in grains of olivine, plagioclase, pyroxene, spinel, and ilmenite, as well as interstitial inclusions. Electron microprobe analyses (63) are given of the inclusions and their daughter, host, and associated minerals. In contrast with the Apollo samples, the Luna 24 samples contain sulfide melt inclusions indicating that saturation with respect to an iron sulfide melt took place throughout much of the crystallization history, even while olivine was crystallizing. The Luna 24 silicate-melt inclusions have recorded a more extensive differentiation toward higher iron magmas than have the Apollo inclusions, but they have recorded some inexplicably low aluminum values; silicate immiscibility eventually took place and formed "high-Fe," and "high-silica," high-K_2O granitic melts, all generally higher in Fe than their Apollo counterparts. Two uniquely high-SiO_2 melt inclusions in olivine (87.2 and 93.8% SiO_2) were found; they may have formed by metastable subliquidus immiscibility in these unusually Fe-rich melts. Swarms of microinclusions in plagioclase appear to be of olivine composition and may represent exsolution products. (Authors' abstract)

ROEDDER, E. and WEIBLEN, P.W., 1978, High-silica glass inclusions in olivine of Luna 24 samples (abst.): Amer. Geophy. Union, Trans; v. 59, no. 4, p. 225.

Optical examination of nine polished grain mounts of Luna 24 drill core material (0.09-0.50 mm) revealed several inclusions in olivine crystals that consist of clean glass with exceptionally high silica, yet they contain no visible silicate daughter minerals and no reaction effects from the olivine walls. One has glass with the composition SiO_2 87.2, Al_2O_3 6.84, FeO 1.27, MgO 0.95, CaO 1.76, Na_2O 0.9, K_2O 0.02, TiO_2 0.36, MnO 0.15, Cr_2O_3 0.01, total 99.46, and shows no other phase except a shrinkage bubble; the other has glass with the composition SiO_2 93.8, $Al_2O_3$1.51, FeO 2.32, MgO 1.61, CaO 0.06, Na_2O <0.05, K_2O 0.11, total 99.41, and contains a shrinkage bubble and a globule of immiscible sulfide melt. Both compositions are unique and quite unlike the high-silica, high-potassia melt of granitic composition that is found as inclusions in late-stage minerals in these (and the Apollo) samples -- the result of silicate liquid immiscibility. Although most Luna 24 olivine (and pyroxene) is iron rich, the host olivine for the first of the two inclusions is among the most magnesian olivines found (Fo_{73}). The origin of these inclusions and the lack of reaction effects are perplexing unresolved problems. (Authors' abstract)

ROEDDER, Edwin and WEIBLEN, P. W., 1978, Significance of melt inclusions in olivine of Luna-24 samples (abst.): Lunar Science IX, Houston, TX, Lunar Sci. Inst., p. 970-972.

See preceding two abstracts. (E.R.)

ROGERS, P. J., 1978, Fluid inclusion studies on fluorite from the Askrigg Block: Trans. Inst. Min. and Met., Sect. B, v. 87, p. 125-131. Author at Inst. of Geol. Sci., London.

Primary fluid inclusions have been studied in fluorite samples from the lead-zinc-fluorite-barite deposits of the Askrigg Block. These inclusions represent actual samples, usually the only available ones, of the ore-forming fluid.

Homogenization studies indicate depositional temperatures in the range 92-159°C on the Askrigg Block and 120-179°C in the Craven Basin. Freezing studies demonstrate the presence of highly saline fluids of between 15 and 25% (equivalent by weight) of sodium chloride with potassium-sodium weight ratios from 0.018 to 0.19.

The ore-forming fluid was probably a concentrated sodium-calcium-potassium chloride brine similar to modern oil field waters found at depths in sedimentary basins. The brine was probably heated by circulation to depths in excess of 6 km and expelled from flanking sedimentary basins in response to compaction pressure and tectonic activity. Deposition of the ore and gangue minerals in structural traps is thought to have resulted from mixing of the heated brine and a sulphide-rich pore fluid. (Author's abstract)

ROGOVA, V. P., 1978, Formation conditions of charoite rock--a new stone for jewellery and carving (abst.): XI General Meeting of International Mineralogical Association, Novosibirsk, Abstracts, v. 2, p. 108 (in English).

A deposit of charoite rock is localized in the potassium alkaline syenites of the Murun massif (Aldan) of Mezosoic age. The temperature of mineral formation of tinaxite, associated with charoites, about 400°C, was determined from gas-liquid inclusions.

ROIZENMAN, F. M., FORTUNATOV, S. P., DOROGOVIN, B. A., EZHOV, S. V., KARSKII, B. E. and PETROVA, M. G., 1978, Two main stages of postmagmatic ore formation, in Thermobarogeochemistry of the earth's crust and ore formation, N. P. Ermakov, ed.: Moscow, "Nauka" Press, p. 55-61 (in Russian).

Formation of com. accumulations of postmagmatic ore deposits in 2 main stages was established for various deposits of different genetic types. In the 1st stage of formation disseminated, low-grade ore forms at 320-420° from a soln, which is essentially aq. in compn. In the 2nd stage richer, more concn. ore forms at 200-320° from a soln, in which substantial CO_2 is constantly present. The existence of the 2 stages is evident from Td of fluid inclusions in minerals of Au. polymetallic, W, Hg, quartz-crystal and other deposits. The 2 stages of mineralization are explained by the presence of a thermodn. barrier (Trufanov, V. N., 1973) which is related to the soly. of various minerals, e.g. SiO_2 which is extd. from country rocks at >374° but is pptd. below this temp. (Chem. Abstracts 89: 166305r, 1978)

ROMBERGER, S.B., 1978, Hydrothermal transport and deposition of uranium, and the origin of vein uranium deposits (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 10, no. 7, p. 480.

RONA, P. A., 1978, Criteria for recognition of hydrothermal mineral deposits in oceanic crust: Econ. Geol., v. 73, p. 135-160.

ROSE, D., 1978, Geochemical and petrographical investigations on the emplacement of the zoned pegmatite Brabant (Southwest Africa, Namibia). Diss. Tech. Univ., Berlin, 200 pp., 126 figs., 23 tables (in German).

Includes fluid inclusion Th measurements, on apatite only, on p. 126-127 (E. Horn).

ROSE, W. I., JR., ANDERSON, A. T., JR., WOODRUFF, L. G. and BONIS, S. B., 1978, The October 1974 basaltic tephra from Fuego volcano: Jour. Volc. and Geother. Res., v. 4, p. 3-53. First author at Mich. Tech. Univ., Houghton, Mich. 49931 (U.S.A.)

The largest of a series of 20 vulcanian eruptions of Fuego volcano between 1944 and 1976 occurred in October 1974 in four distinct 4-17-hour pulses over a 10-day period. The eruption produced more than 0.2 km^3 of pyroclastic high-Al_2O_3 basalt (equivalent to >0.1 km^3 of void-free magma), quenched at a temperature of about 1050°C. Early erupted magma was rich in plagioclase and poor in mafic phenocrysts, magmas erupted next in sequence were poor in all phenocryst phases, while the final magmas were rich in all phenocryst phases. These changes, and variations in 8 major and 21 minor elements can be explained by crystal/liquid fractionation of high-Al_2O_3 basalt. Crystals in Fuego's magma contain inclusions of glass with an average H_2O content of about 3%, an amount that suggests that crystallization began at a depth of $\geqslant$5 km. Petrographic data, observed extrusion rates, glass inclusion analyses, regional geological features, and various geophysical considerations collectively suggest that crystallization and differentiation occurred within a vertical, dike-like conduit during a period of a few days to several months. The Fuego parental basalt contained 5% MgO, 10% FeO* and about 0.8% K_2O, it began crystallization at 1030 ± 50°C with plagioclase (An_{95-89}), olivine (Fo_{76-66}) and magnetite (4.3-15% TiO_2) the principal phases. Plagioclase was apparently rafted upward by bubbles within the magma body. Tidal triggering of crystal growth, magma ascent and eruption are suggested. (Authors' abstract)

ROST, R., DOLGOV, Yu.A. and VISHNEVSKIY, S.A., 1978, Gases in inclusions in the impact glass of the Ries crater (FRG) and finding of high-pressure polymorphs of carbon: Akad. Nauk SSSR Doklady, v. 241, no. 3, pp. 695-698 (in Russian). First author at the Charles Univ., Praha, ČSSR.

Studied specimens were collected at Otting, Hainsfahrt, Oberringen Fünfstellen, Bollstadt and Heerdorf, and they are typical suevites. Individual G inclusions were studied (P and G composition, see Table). Both G composition and P in various inclusions of the same glass piece vary significantly (P from 1 to 0.03 atm, but often bubble dia. decreased after inclusion opening below the magnifying power of microscope, and P should be in individual cases < 0.001, $< 0.00014 < 0.00001$ atm.). The above differences may be explained by variable viscosity and quenching regime of cooling of the drops of former impact melt; seemingly both inclusions in equilibrium with outer medium and not equilibrated, were sealed. Impact glass formed from graphite-bearing gneiss contains 0.1-0.3mm crystals of diamonds crystallized from graphite due to impact metamorphism. By X-ray powder pattern the above grains are intergrowths of diamond with lonsdaleite, probably formed at P > 700kb.

From table 1; composition of G in inclusions are as follows (in vol%): 1) CO_2 + acid gases 97, hydrocarbons 2, H_2 1, N_2, O_2 and CO-nil, P at 20°C 0.06 atm; 2) acid G nil, CO_2 11, hydrocarbons 8, H_2 11, N_2 70, others-nil; 3) CO_2 7, N_2 93, others-nil; 4) acid G + CO_2 31, H_2 13, N_2 56, others-nil, P at 20°C 0.11 atm; 5) H_2 35, N_2 65, others-nil, P at 20°C 1.0 atm; 6) hydrocarbons 33, N_2 67, others-nil, P at 20°C 0.17 atm; 7) acid G 25, CO_2 75, P at 20°C 0.06 atm; 8) acid G 36, CO_2 19 H_2 18, N_2 27, others-nil, P at 20°C 0.74 atm; 9) acid G 95,

CO_2 5, P at 20°C 0.03 atm; 10) acid G + CO_2 100, P at 20°C 0.51 atm; 11) acid G + CO_2 100 (acid G = total of H_2S, SO_2, NH_3, HCl, HF, SO_3). (Abst by A.K.)

ROWE, E. C. and SCHILLING, J.-G., 1978, Fluorine in Reykjanes Ridge basalts (abst): Eos, Trans. Amer. Geophy. Union, v. 59, p. 409-410.

ROWLEY, P. D. and BARKER, D. S., 1978, Geology of the Iron Springs mining district, Utah: Guidebook to Min. Deps. of S.W. Utah, Utah Geol. Assoc., Pub. 7, p. 48-56.

Fluid inclusion evidence (p. 56) indicates the ore was transported by a fluid with a high CO_2/H_2O ratio, plus appreciable F and Cl. (ER)

ROYZENMAN, F.M., FORTUNATOV, S.P. and MOZOLEVA, T.S., 1978, Possibilities of prospecting and evaluation of the phlogopite deposits in the Aldan Mts. by use of the "impregnation haloes", (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. II, Thermobarogeochemistry and ore genesis: Vladivostok, Acad. Sci. USSR, p. 10-11 (in Russian). Authors at the Mineral. Geol. Prosp. Inst., Moscow.

In the area with phlogopite mineralization, four generations of diopside rocks were distinguished by Td studies:

a) metamorphic diopside schists, Td 660-820, maximum at 760°C;

b) diopside skarns (+pargasite, spinel, and phlogopite) of the migmatization stage, Td 480-660, maximum at 520 (and 560)°C;

c) post-magmatic skarns (+pargasite, phlogopite, scapolite, spinel), Td 300-480, maximum at 400°C;

d) post-magmatic phlogopite-bearing metasomatites, Td < 300°C.

Analysis of a large number of decrepigraphs permitted the authors to propose the decrepitation index $D = \frac{\Sigma 300}{\leq 800} 100\%$, where $\Sigma 300$ is the total impulses over Td interval ≤ 300, and $\Sigma 800$ is the total over Td interval ≤ 800°C. High values of D outline the commercial phlogopite ore bodies. (From the authors' abst.)

RUCKLIDGE, J. C., 1978, The enigmatic role of Cl in the alteration of ultramafic rocks (abst.): XI General Meeting of International Mineralogical Association, Novosibirsk, Abstracts, v. 1, p. 44 (in English).

RUSINOV, V. L. and RUSINOVA, O. V., 1977, Variations in vertical zonation during peri-ore argillization, their causes and petrogenetic significance: Akad. Nauk SSSR, Izvestiya, Ser. Geol., 1977, no. 10, p. 147-158 (in Russian; translation in Intern. Geol. Rev., 1978, v. 20, no. 12, p. 1363-1372).

Includes a discussion of H/D and 180/160 data for several ore deposits (from literature?; source of data not given). (ER)

RUSSELL, M. J., 1978, Downward-excavating hydrothermal cells and Irish-type ore deposits: importance of an underlying thick Caledonian prism: Inst. Min. Metal., Trans., Sect. B, v. 87, p. B 168-171.

RYE, D.M., and WILLIAMS, N.P., 1978, Stable isotope geochemistry of the McArthur River ore deposits; an epigenetic sedimentary-type Pb-Zn deposit? (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 10, no. 7, p. 483-484

RYERSON, F. J. and HESS, P. C., 1978, Implications of liquid-liquid distribution coefficients to mineral-liquid partitioning: Geochem. Cosmo. Acta, v. 42, p. 921-932.

SAKAI, H. and DICKSON, F. W., 1978, Experimental determination of the rate and equilibrium fractionation factors of sulfur isotope exchange between sulfate and sulfide in slightly acid solutions at 300°C and 1000 bars: Earth Plan. Sci., Let., v. 39, p. 151-161. First author at Inst. for Thermal Spring Research, Okayama Univ., Misasa, Tottori-Ken, 682-02 Japan.

A sulfur isotope fractionation of 20.0 ± 0.2‰ was measured between aqueous sulfide and sulfate at 300°C and 1000 bars using gold-cell hydrothermal solution equipment. The value is 2‰ smaller than previously published values. Rates of exchange were determined as a function of pH and total sulfur content. Initial mean ^{34}S concentration was changed to approach equilibrium from two directions. Half-times ranged from 3.4 to 8.2 days, with shorter times obtained for more acid and more concentrated solutions.

The sulfate-sulfide isotope temperature scale based on theory should be revised according to this new fractionation factor. The rate data permit assessment of the extent to which equilibrium may be attained in some natural systems. For example, the lack of agreement between temperatures based on sulfide mineral pairs and sulfide-sulfate mineral pairs from Kuroko ore deposits of Japan might imply that the residence time of sulfate and sulfide in Kuroko solutions was not longer than 1000 years, if the present kinetic data are correct. Geothermal systems such as the Wairakei system of New Zealand may reach sulfur isotope equilibrium between sulfate and sulfide in 300 years at 300°C, but would be increasingly removed from equilibrium at lower temperatures if residence times were 300 years or less. (Authors' abstract).

SAKAI, Hitoshi and TSUTSUMI, Makoto, 1978, D/H fractionation factors between serpentine and water at 100° to 500°C and 2000 bar water pressure, and the D/H ratios of natural serpentines: Earth Plan. Sci. Let., v. 40, p. 231-242. Authors at Inst. for Thermal Spring Research, Okayama Univ., Misasa, Tottori-ken 682-02 Japan.

According to the present fractionation factors, almost none of the continental lizardite-chrysotile serpentines could have formed at a temperature below 500°C under equilibrium with fluids of δD values similar to the present-day local meteoric waters. The fluid responsible for oceanic serpentinization could be either a mixture of oceanic and magmatic water or oceanic water alone. However, full interpretation of the δD values of natural serpentines should wait until kinetic behaviors of hydrogen isotopes in serpentinization are better understood. (From the authors' abstract).

SAKHAROVA, M. S., BATRAKOVA, Yu. A. and RYAKHOVSKAYA, S. K., 1977, The study of kinetics of gold-silver co-precipitation process by electrochemical methods (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. 3, p. 78-79 (in Russian; abstract courtesy Dr. A. P. Berzina).

The experiments permit consideration of an electro-chemical mechanism as one of the possible methods of Au and Ag co-crystallization in natural processes. The influence of precipitator mineral on ore grade of sediments is established.

SAKHNO, V.G., EFIMOV, V.V., MALAKHOV, V.V. and ROMANENKO, I.M., 1978, Temperatures and fluid regime of melt inclusions in ignimbrites of volcanic zones of Far East, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 104-105 (in Russian). Authors at Far East Geol. Inst. of Far East Sci.Center of Acad. Sci. of the USSR, Vladivostok.

Part of inclusions in plagioclase and quartz from ignimbrites was decrepitated, but some, especially in quartz, did not leak. CO_2 (by gas chromatography) prevails in high T inclusions, and next its content decreases with H_2O content increase; S inclusions (Th 500-550°C) have the highest H_2O/CO_2 ratio. Main elements (by electron microprobe analysis of glass inclusions) are distributed extremely unevenly, probably due to liquation after partial crystallization in magmatic chamber. Composition of gases suggests that crystallization of quartz and plagioclase was under "dry" conditions in area above liquidus. Liquation may be caused by H_2, F_2, H_2O and other gases. Data are given in the table: (From the authors' abst., by A.K.)

Location, Sample	Th of P inclusions, °C	Gases, vol. %					
		H_2	N_2	CO	CH_4	CO_2	CO_2/H_2O
Sikhote-Alin',							
quartz	1100-1150	32.6	4.9	23.2	2.3	37.0	0.22
plagioclase	1030-1050	-	0.4	trace	-	99.6	0.005
Bogopol'skiy							
quartz	1040-1120						
quartz	1220-1250						
plagioclase	1150-1180	-	2.4	5.7	1.6	90.3	0.15
Badzhal'skaya							
liparite	950-980	65.2	0.3	8.7	2.9	22.9	0.15

SAMARTSEV, I.T., OVSYANNIKOV, I.I. and INSHINA, V.M., 1978, Gypsum-anhydrite mineralization in the deep levels of some gold-ore deposits of the Middle Urals: Akad. Nauk SSSR Doklady, v. 239, no. 5, p. 1215-1217 (in Russian). Authors at the Division of Exper. Studies of the Central Sci.-Research Geol.-Prosp. Inst. Tula, USSR.

Gold ores of three deposits in Caucasus (names of the deposits not given) bear up to 50% of sulfates: Gypsum, anhydrite and transitional compound between monosulfate $CaSO_4$ and trisulfate CaS_3O_{10}. Highest concentration of sulfates was found at the depth 300-400 m. Th of inclusions in anhydrite 230-280, 180-230 and 250-280°C in the individual deposits. (A.K.)

SAMORUKOVA, L.M., 1978, Studies of melt inclusions in granitiods of the Sangilen massif in Tuva, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 77-78 (in Russian). Author at IGED of Acad. Sci. of the USSR, Leningrad.

Polymetamorphic Precambrian rocks of the Sangilen massif bear various granitoid complexes. Most of the ultrametamorphic granitoids formed due to anatexis under granulite facies conditions. Quartz of those granitoids bears melt inclusions with Th 820-950°C (beginning of melting 550-750°C), G occupies 10-15 vol% and it dissolves at T somewhat lower than Th (820-900°C). Quartz from granitoids contemporaneous with early folding stage bear rare melt inclusions with Th 800-850°C and beginning of melting 620°C. G$\leqslant$5 vol.% and it dissolves at 650°C. Granitoids at end of tectonic-magmatic cycle have Th 900-1200°C, and beginning of melting 790-800°C, G dissolving 900-1015°C, but those finishing the last, fourth cycle have Th 830-920°C, T of beginning of melting 650-750°C; single glass incs. have Th 770-790°C, and G dissolving after dms melting. Crystallization T of granitoids were close to crystallization of "dry" granite eutecties, or somewhat higher. (From the author's abst., by A.K.)

SAMOYLOVICH, M. I., KOMOV, I. L. and SHAPOSHNIKOV, A. A., 1978, Application of electron paramagnetic resonance, IR spectroscopy and thermobarometry for studies of conditions of formation of topaz, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 169 (in Russian). Authors at All-Union Sci. Research Inst. of Synthesis of Artificial Mineral Raw Materials, Alexandrov, USSR.

Th of P incs were 450-550°C (pegmatite topaz), 400-450°C (greisen topaz) and 260-350°C (topaz from hydrothermal veins). (From the authors' abst.)

SANS, J. R., 1978, Volcanic temperatures inferred from glass inclusions in phenocrysts (abst.): Eos, Trans. Amer. Geophy. Union, v. 59, p. 225.

The ratio (D) of MgO in included glass to MgO in host olivine or pyroxene is a sensitive indicator of temperature. We have empirically calibrated the system by heating natural phenocrysts at 1277, 1225, 1183, 1120, 1057 and 1050°C in evacuated silica-glass capsules. Heating times ranged from 70 to 360 hours to ensure equilibrium. The quenched phenocrysts and their enclosed glasses were analyzed on the electron microprobe. D was found to depend on the temperature of heating and the bulk chemistry of the glass. Olivine phenocrysts typically contain basaltic glasses. For such glasses the best composition parameter was found to be P. L. Roeder's activity coefficient γFeO. (γFeO=(0.048) (wt% Al_2O_3) +(0.084) (wt% Na_2O)+(0.12) (wt% K_2O)+0.29). On a plot of logD versus γFeO, all of the glass-phenocryst pairs fall on a straight line for a given temperature of heating. Pyroxene phenocrysts generally contain andesitic or dacitic glasses. For these more siliceous glasses the best composition parameter was found to be simply wt% SiO_2. On a plot of logD versus wt% SiO_2 the glass-pyroxene pairs again fall on a straight line for a given temperature. When both an olivine and a pyroxene temperature can be determined, they are consistent. Our temperatures agree with other temperature estimates such as iron-titanium oxides or optical pyrometer.

Volcano	Eruption	Tpyx	Tol	Tother
Kilauea	1955	1100	1140	1160-80
Pavlof	Cone G	1050	1010	-
Shasta	S 17	1140	1020	-

(Author's abstract)

SAWKINS, F. J., 1978, Single stage versus two stage ore deposition in subduction - related volcanoplutonic arcs (abst.), in International Assoc. Genesis Ore Deposits, 5th Symp., Snowbird, Alta, Utah, 1978, Program and Abstracts: (Alta,Utah), p. 163.

Fluid inclusion and stable isotope studies of metal deposits in volcanoplutonic arcs are now sufficiently numerous to demonstrate that most porphyry copper deposits are directly related to magmatic fluids (single stage), although they are subject to modification by inward-collapsing meteroric water geothermal systems. At the other extreme, systems that generate precious metal vein or massive sulfide deposits appear to be dominated by meteoric and seawater respectively (two stage), although participation of small, but possibly significant, amounts of magmatic fluids cannot be ruled out. Silver-bearing base-metal vein and replacement deposits can exhibit either magmatic (single stage), meteoric (two stage) or mixed genetic affiliation. (From the author's abstract)

SAXBY, J. D., 1976, The significance of organic matter in ore genesis, chapt. 5 in Handbook of Strata-Bound and Stratiform Ore Deposits, v. 2, Principles and General Studies, K. H. Wolf, ed.: Amsterdam, Elsevier Publ. Co., p. 111-133.

An extensive review (~120 references). (ER)

SAZONOV, V. N., 1978, PT-conditions of the berezitization and listvenitization process, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 146-147 (in Russian). Author at Inst. Geol. Geoph. of Ural Sci. Center of Acad. Sci. of the USSR, Sverdlovsk, USSR.

Maximum Th (corrected for P) for berezitization and listvenitization is 390°C, P 1.2-1.5 kbar to 0.6 kbar, Th in quartz veins 380-210°C (corrected), P comparable with the above values. The Th data were compared with T obtained by various mineral geothermometers. (A.K.)

SCHILLING, J.-G., 1978, F, Cl, Br in mar glasses and Azores basalts (abst): Eos, Trans. Amer. Geophy. Union, v. 59, p. 409.

SCHNEIDER, G. M., 1978, High-pressure phase diagrams and critical properties of fluid mixtures, chapt. 4 in Chemical Thermodynamics (London), v. 2, p. 105-146.

A very extensive review (151 references), with many examples of the numerous configurations taken from experimental studies on inorganic and particularly organic systems. (ER)

SEDOVA, I. S., 1978, Quartz-plagioclase metasomatites - a low-temperature rock analogous to ultrametamorphic granitoids, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 144-145 (in Russian). Author at IGGD ANSSSR, Leningrad, USSR.

In the Muzkol'skiy complex together with usual ultrametamorphic process resulting in alkaline-earth granitoids, metasomatites with low biotite and gedrite contents (plagiogranite-gneiss) also formed with normative albite 55%, quartz 30%, orthoclase 8%, anorthite 7%. These metasomatites bear fluid inclusions filled by H_2O, H_2O+CO_2, H_2O+dm NaCl, the highest Th 600-650°C, lower Th range 150-300°C for water incs, 250-320°C for H_2O-CO_2 incs. Alkalic intrusions bear inclusions of melt-solutions (Th 640-750°C), salt inclusions (Th 420-460°C), melt (silicate?) inclusions (Th 750-840°C). P of some S inclusions was 2-4.5 kbar. (From the author's abst.)

SEDOVA, I. S., 1978, Thermodynamic conditions for the formation of ultrametamorphic granitic rocks of zones of metamorphism at moderately high pressures: Teor. Prakt. Termobarogeokhim., (Dokl. Vses. Soveshch.) 5th 1976, N. P. Ermakov, ed.: Moscow, Izd. Nauka, p. 66-74 (in Russian).

Authochthonous and allochthonous metasomatic and anatectic types of ultrametamorphic granitic rocks (GR) are distinguished. Secondary inclusions are predominant in the allochthonous GR. Melt inclusions are absent from the metasomatic GR. The early salt inclusions in the GR of amphibolite facies have max. Th 650-700°. The anatectic granites occurring as veins and void-fillings in migmatites have, in addn. to salt and fluid inclusions, melt inclusions with Th 780-830°. (Chem. Abstracts 91: 60604p, 1979)

SENDEROV, E.E., 1977, The role of silicate equilibria in the composition of 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. 3, p. 102 (in Russian).

SERGEEVA, N. Ye., 1978, Metamorphic mineralization at the Shemonaikhin deposit: Akad. Nauk SSSR Doklady, v. 239, no. 5, p. 1190-1192 (in Russian). Author at the Moscow State Univ., Moscow.

The Shemonaikhin pyrite-polymetallic deposit in the SW part of the Aley anticlinorium occurs in lavas, lava-breccias and tufts of liparites and basalt porphyrites, with extensive development of skarn-type metamorphic rocks consisting of epidote, garnet, actinolite and calcite. Ore body has a lenticular shape with thickness up to 40 m. Garnets bear inclusions with Th 320-350°C. (Abst. by A.K.)

SHAIDETSKAYA, V. S., 1977, Characteristics of the chemical compositions of solutions in inclusions in halite from rock salt of the Holmes structure in the Dnieper-Donets depression: Geol. Geokhim. Solenosnykh Form.

Ukr., V. I. Kityk, ed.: Kiev, USSR, "Naukova Dumka", p. 100-104 (in Russian).

The solns. in the fluid inclusions in halite samples from different depths contained K^+ 3.5-34.5, Ca^{2+} 35.5-127.0, and Mg^{2+} 14.0-48.0 g/L. Fe^{2+}, Fe^{3+}, and NH_4^+ were qual. detected. The K^+ concn. of the solns. increases from the lower to upper part of the stratigraphic section in which the halite occurs, indicating K accumulation in soln. as the halite crystd. The behavior of Ca^{2+} was opposite that of the Na^+; Ca^{2+} was gradually lost from the solns., through formation of authigenic carbonate and sulfate. The compn. of the solns. were inherited from primary sedimentary halite, which probably formed in an evaporite basin. (Chem. Abstracts 89: 92452n)

SHAIDETSKAYA, V.S., 1978, Inclusions of liquid carbon dioxide in halite from Devonian rock salt in the Dnieper-Donets Basin, in Carbon and its compounds in endogene processes of mineral formation, G.N. Dolenko, ed.: Kiev, "Naukova Dumka" Pub. House, p. 154-158 (in Russian).

This is full paper corresponding to abstract given in COFFI v. 8, p. 163, 1975 (ER)

SHAPENKO, V.V., 1975, Thermobarogeochemical reconstruction of mineral formation conditions at the Kholtoson tungsten deposit (Western Transbaikal region): Deposited Doc. 1975, VINITI 642-76, 169-171 (in Russian) Avail. VINITI.

Apparently same material as in Shapenko, 1976 (Fluid Inclusion Research -- Proc. of COFFI, v. 9, p. 123, 1976). (E.R.)

SHAPENKO, V.V. and SHCHEPETKIN, Yu. V., 1978, Paleotemperatures of the oil- and gas-bearing beds in the SE part of the West-Siberian plate: Akad. Nauk SSSR Doklady, v. 242, no. 2, p. 402-404 (in Russian). First author at Inst. Geoch. Anal. Chem. of Acad. Sci. USSR, Moscow.

Fluid inclusions in carbonates from the oil- and gas-bearing beds are S (one-phase or with Th 40-90°C) and P (with Th 150-250°C); Th of P incs. exceeds 2-3 times the recent T in the beds. Freezing studies gave results as follows: no changes on cooling down to -196°C; next, on slow heating to -68°C, all inclusions frozen, ice has dark-brown tint; eutectic melting occurs at -52 to -42°C, when one brownish crystal and one bluish were in inclusion. Next cooling caused growth of brown crystal hydrate to 95% of vacuole; repeated heating gave beginning of melting at -52°C (eutectic $CaCl_2$-$MgCl_2$-H_2O); last crystal of brownish crystal hydrate disappeared at -34°C; heating to -30°C and cooling down to -45°C caused crystallization of colorless ice coexisting with above bluish ice. Melting of colorless ice was at -34°C, its complete disappearance at -26°C (eutectic $MgCl_2$-H_2O). Bluish phases begin to melt at -42°C and disappeared at T between -20 and -10°C; this phase may be $MgCl_2 \cdot 12H_2O$. Salt concentration is up to 40 wt.%. (Abst. by A.K.)

SHAPOSHNIKOV, A. A., and ERMAKOV, N. P., 1978, Fluid inclusions in synthetic quartz crystals, (abst.), in International Assoc. Genesis Ore Deposits, 5th Symp., Snowbird, Alta, Utah, 1978, Program and Abstracts:

(Alta, Utah), p. 167.

Data on natural mineral-forming conditions are being sought in inclusions as a reliable guide for the autoclave synthesis of rare materials. On the other hand, the synthetic crystals obtained under known physical and chemical conditions display inclusions that help us to ascertain some natural mineral-forming parameters, based on extrapolations of T,P and X.

We have had many years of practice in growing quartz and other minerals in aqueous solutions of various concentrations at 320-370° C and under pressures of 250 to 1700 kg/cm^2. The homogenization temperatures for the fluid inclusions obtained under pressures below 400 kg/cm^2 are up to 20° C lower than the true temperatures. These corrections are less significant at pressures < 300kg/cm^2, so it is possible to take the homogenization temperatures (T_h) as the true temperatures of formation of the minerals. The decrepitation temperature (T_d) differs from T_h inversely with inclusion dimensions and fluid density.

The use of highly concentrated aqueous salt systems of NaCl (10-40 %) and KCl (20-50 %) in quartz growth permits us to reproduce some polyphase inclusions of mother solution with daughter minerals (halite, sylvite, etc.). We have found that inclusions containing small NaCl and KCl crystals form when the salt concentration is 40 ‰ and more.

It has been found also that the thermodynamic conditions of crystal growth - concentrations and pressures - produce compensating effects on the homogenization temperature. The more concentrated the solutions, the higher the homogenization point, and there are always conditions at which this point and the true temperature of crystal growth coincide.

Volatile substances - CO_2, HF etc. - dissolved in the starting solutions are always present in the crystal inclusions, and in the same concentrations. This is direct evidence for the possibility of studying the natural mineralforming media by fluid inclusion analyses.

A high degree of saturation of the solutions by volatile components raises T_h. This point shows only the temperature of gas dissolution in the liquid hydrothermal systems.

The pH values of the autoclave solutions are strongly affected by the degree of gas saturation and the crystallization temperatures. It is therefore difficult to determine them for room temperature analysis - a part of the components evaporate instantly from an opened inclusion.

Some other methods of approach to the study of natural fluid inclusions are also found to be very helpful in developing the theory of laboratory mineral synthesis. (Authors' abstract)

SHARAS'KIN, A. YA.; KARPUKHIN, V.E.; ROMANCHEV, B.P., 1978, Inclusions in minerals of Middle Atlantic Ridge basalts, <u>in</u> Thermobarogeochemistry of the earth's crust and ore formation, N.P. Ermakov, ed.: Moscow, "Nauka" Press, p. 65-68, (in Russian).

Inclusions in plagioclase phenocrysts from the 3 different types of porphyritic tholeiites of the Mid-Atlantic Ridge have the same morphol. form, are finely cryst. and primary, and during heating homogenize to silicate melts without marked increase in vacuoles. Th of the inclusions are similar (in the 1200-80° range) for the plagioclase, olivine-plagioclase, and olivine types of tholeiites. The Th are approx. the same in spite of substantial differences in normative mineral compn. Equality in the crystn. temps. of olivine and plagioclase indicated formation of the 2 types of tholeiites under similar conditions; this is also shown by the closeness of the tholeiite compns. to the eutectic of the basalt system. The plagioclase and olivine tholeiites probably formed at different H_2O pressures in the upper mantle. (Chem. Abstracts 89: 166397x)

SHARP, J. M., JR., 1978, Energy and momentum transport model of the Ouachita basin and its possible impact on formation of economic mineral deposits: Econ. Geol., v. 73, p. 1057-1068.

The lead-zinc mineralization in the northern Arkansas-southeastern Missouri area may have been formed by discrete pulses of hot pore fluid from the Ouachitas which probably originated after faulting of geopressured sections in the late Paleozoic. (From the author's abstract).

SHATAGIN, N.N. AND DOROGOVIN, B.A., 1978, Reconstruction of the paleoerosion level of a weathering granite massif by fluid inclusion studies in quartz from granite fragments from conglomerates, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. II, Thermobarogeochemistry and ore genesis: Vladivostok, Acad. Sci. USSR, p. 34-35 (in Russian). First author at Moscow State Univ., Moscow, USSR.

In quartz from granite massifs the following inclusion types occur: 1 - G inclusions in endocontact quenching zone, 2 - immediate contact zone, inclusions with variable G/L ratios plus polyphase inclusions, 3 - granite from central parts, inclusions $L \gg G$. Also solidified melt inclusions consequently change their phase composition, from quenched two-phase melt inclusions in outer part of massif to completely crystallized inclusions in central parts of massif. Analysis of inclusions in granite fragments in conglomerate permitted detection of the course of erosion of granite massifs in Rudnyi Altai, Krasnomaralikhinskiy massif. (From the authors' abst.)

SHATAGIN, N.N., DOROGOVIN, B.A. and KHETCHIKOV, L.N., 1978, Regression analysis and the dependence of the temperature of decrepitation of gas-liquid inclusions on their size, distance from the edge of the grain, and the pressure of mineral formation: Geologiya Rudnykh Mestorozh, v. 20, no. 1, p. 73-83 (in Russian, see translations). First author at Moscow State Univ.

SHAW, D. M., 1978, Trace element behaviour during anatexis in the presence of a fluid phase: Geochim. Cosmo. Acta, v. 42, p. 933-943. Author at Dept. Geol., McMaster Univ., Hamilton, Ontario, Canada.

If anatexis takes place in the presence of an immiscible volatile-rich fluid phase, the behaviour of a trace element depends not only on partition coefficients $D^{i\ell}$ between mineral i and silicate liquid, but also on coefficients D^{if} between mineral i and fluid. The limited experimental data available, as well as theoretical arguments, suggest that for common minerals these coefficients differ, in some cases (REE) notably.

Theory has been developed to permit calculation of concentration variations with the fraction F of rock melted, if D-values are known.

In its present state this theory neglects the influence of T, P and composition variations in liquid and fluid on the D-values: if such variations can be expressed as functions of F, appropriate modifications can be made. The theory also neglects the effects of T and P on the solubility of fluid in liquid and the resulting modifications to phase petrology, by assuming simply that a given mass of rock melts in the presence of a mass proportion v of fluid. By choosing different values of v, from 0 (dry melting) to 100 (large fluid excess), the response of the trace element concentrations can be followed, beginning with concentration c_o in the unmelted rock. Such treatment is highly idealised, but serves to indicate some limits on what can occur. (Author's abstract)

SHCHEKA, S.A., 1978, Liquation phenomena in basalt melts: Acad. Sci. USSR Doklady, v. 238, no. 3, p. 691-694 (in Russian). Author at the Far-East Geol. Inst. of the Far-East Sci. Center of the Acad. Sci. USSR, Vladivostok.

Neck of the Neogene-Quaternary alkaline-basalt volcano Podgelbanochnyi in Primorie (USSR Far East) is filled with glass-rich rock (40% of brown glass cementing microliths of Ti-augite, ilmenite and K-Na spar.) Phenocrysts (10%) are olivine (Fa18), Ti-augite and Na-sanidine, plus about 5% of xenocrysts of olivine (Fa8-10), chrome diopside, enstatite and spinel, being fragments of hyperbasic xenoliths. Brown glass bears spherical or drop-shaped glassy inclusions (3-5 mm to 2-3 cm dia.) of low refractive index, and more rarely, in microdolerites, tiny "flows" of the same glass, that was still liquid after crystallization of basalt melt. Some inclusions have two-phase constitution: inner core consists of brown glass with lower n̲ than that of light glass of the outer core. Both n̲ values are different than n̲ of the essential glass matrix. Inner core is surrounded by a very thin layer of ore mineral, inside glass stars of Ti-augite were found. Inner core glass is very variable in its optical properties and composition (by electron microprobe), probably due to microliquation. Crystallized glass inclusions, converted into aggregates of sanidine, Ti-augite and ilmenite, were commonly described as pseudoleucite. Total composition of basalt refers to alkaline basalt (first value in wt.%), but inner core glass - to phonolite (second value): SiO_2 46.69-53.69, TiO_2 1.70-1.54, Al_2O_3 14.90-20.62, Fe_2O_3 3.25-4.20, FeO 8.52-1.50, MnO 0.25-0.13, MgO 6.95-1.53, CaO 5.58-3.16, Na_2O 3.92-8.72, K_2O 3.20-3.82, H_2O^+ 2.13, 0.67, H_2O^- 0.27-trace, F 0.14-0.19, total 100.20-99.77 (wet method). The data prove the immiscibility of alkaline basalt and phonolite melts. (Abst. by A.K.)

SHCHEKA, S.A., KURENTSOVA, N.A., ROMANENKO, I.M. and CHUBAROV, V.M., 1978, Inclusions of melt in nodules in basalts, related to problem of primary basalt magma, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 89-91 (in Russian). Authors at Far-East Geol. Inst. of Far-East Sci. Center of Acad. Sci. of the USSR, Vladivostok.

Glass inclusions in nodules from tholeiitic basalts of the rift zones of Indian and Atlantic oceans were studied. Inner core of nodules has composition of Alpine-type hyperbasites and troctolites, outer core in equilibrium with tholeiite basalt melt is richer in Fe and in alkalies.

Glass inclusions in inner cores of olivine and pyroxene grains has lower Mg and Fe contents, and higher Al and Si, but plagioclases have reverse contents (compared with tholeiite basalt melt). Glass inclusions in outer cores of grains have no differences with tholeiite basalt melt. Zoning in inclusions as well as microliquation phenomena were found; zoning may be caused by crystallization differentiation. (Authors' abst., translated by A.K.)

Table. Composition of glass inclusions in nodules in basalts

Oxides	Glass inclusions, analyzed by IXA-5a electron microprobe							Bulk of sample
	Inner core of grain					Outer core of grain		
	Olivine	Pyroxene	Plagioclase			Pyroxene	Plagioclase	
SiO_2	49.17	53.86	50.92	48.74	48.48	50.46	52.20	48.96
TiO_2	1.04	1.34	0.75	0.84	0.97	0.89	0.80	0.75
Al_2O_3	17.42	19.98	10.33	12.61	12.31	14.40	14.20	16.21
FeO	6.59	10.32	9.70	8.44	8.44	7.97	7.72	9.36
MnO	0.15	0.14	0.10	0.13	0.13	0.20	0.14	0.20
MgO	4.60	1.20	12.86	11.81	11.87	8.88	8.02	8.47
CaO	12.86	7.48	11.85	11.29	11.27	12.71	13.00	12.76
Na_2O	2.55	1.76	2.10	2.03	2.04	1.02	1.70	1.89
K_2O	0.13	0.09	0.06	0.22	0.25	0.03	0.07	0.18
Cr_2O_3		0.00	0.26	0.16	0.16	0.15		
Total	94.51	96.17	98.93	96.27	95.92	96.38	97.71	99.52

SHCHERBAKOVA, M. Ya., SOTIVIKOV, V. I., PROSKURYAKOV, A. A., MASHKOVTSEV, R. I. and SOLNTSEV, V. P., 1976, Use of the ESR spectra of quartz to assess ore content (as in gold-ore and copper-molybdenum mineralization): Geolog. Rudnykh Mestor., 1976, no. 5, p. 63-69 (in Russian; translated in Intern. Geol. Review, 1978, v. 20, no. 7, p. 839-843).

Inclusions in Au-quartz ores (very fine grained quartz) have Th mainly below 300°C, with evidence of boiling. (ER)

SHILO, N.A., SIDOROV, A.A., and GONCHAROV, V.I., 1978, Conditions of formation of ore deposits in volcanic belts: Geol. Rudn. Mest., v. 20, no. 6, p. 3-12 (in Russian). Authors at the North-East Complex Sci.-Research Inst. of Far-East Sci. Center, Magadan, USSR.

In volcanic belts two formations of deposits occur: 1) volcanogenic, 2) volcanogenic-plutonogenic. Typical features of those deposits are mixing of ore-forming fluids with vadose waters, boiling, active role of SiO_2 gels, high T>T critical, variable P and T conditions. Gold- and silver-argentite deposit types have Th 390-250°C, P 250-50 atm; T, total salt content, K content and acid gases, i.e., H_2S, HF and HCl, increase from early to late formation stages (acid gases up to 45 vol.% of total G). The copper porphyry (Cu-Mo) deposits bear polyphase inclusions with Th 750-650°C, G inclusions with Th 600-500°C, L incs. with Th 440-210°C, P variable, up to 1000 atm. Vein polymetal Sb-Hg and Sb deposits formed at Th <300°C, whereas Sb-Hg ones formed at 255-180°C, P varied strongly, T gradient large (20-30°C/100m), ore-forming solutions were of HCO_3-Ca-Na type, rich in SO_4, Mg and K. Shallow metacolloid veins and surrounding metasomatites yield Th 150-200°C, solutions were of H_2SiO_3-HCO_3-Cl type. Paper also bears literature data on the Kuroko-type deposits. (Abst. by A.K.)

SHIRONOSOVA, G.P., KOLONIN, G.R., BITEYKINA, R.P., 1977, Conditions of pyrite, pyrrhotite and magnetite equilibria in sulfide solutions at 300 and 400°C (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. 3, p. 90-91 (in Russian; abstract courtesy Dr. A.P. Berzina).

At 300°C a hexagonal pyrrhotite containing 47.38 atom% Fe is in equilibrium with pyrite as well as with pyrite and magnetite. The pyrrhotite of this composition is characterized by $lgf_{S_2} = -11.183$ and $lga_{FeS} = -0.25$. In a solution that is in equilibrium with Fe_3O_4 + $Fe_{1-x}S$ + FeS_2 at 300°C, calculated values are $lgf_{O_2} = -33.43$ and $lga_{H_2S} = -2.48$ ($a_{H_2S} = 0.0033$). With temperature increase sulphide sulphur becomes more active.

SHISHAKOVA, L.N., ANDRUSENKO, N.I. and EPSHTEYN, Yu.A., 1978, Temperature zoning in a gold-silver deposit in the North-East [territory], (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. II, Thermobarogeochemistry and ore genesis: Vladivostok, Acad. Sci. USSR, p. 30-32 (in Russian). Authors at the Central Sci.-Res. Geol.-Prosp. Inst., Moscow.

The deposit (name not given) occurs in the NW margin of a caldera 4 km dia. formed in andesites with dacite lenses and effusive intercalations. Ores consist of eight associations (from early to late): 1-quartz-pyrite, 2-essentially quartz, 3-quartz-arsenopyrite,, 4-quartz-gold-polymetal, 5-quartz-carbonate-gold-polybasite, 6-quartz-amethyst-sulfide, 7-carbonate-pyrite-marcasite, 8-carbonate-polymetal. Ores formed at Th 460-180°C. Those at Th 400°C are typical of associations 1, 2 and 3. Commercial gold ores formed at Th 400-200°C. Horizontal Th zoning was revealed in sections perpendicular to caldera rim, with the highest Th in the rim. (From the authors' abst.)

SHMONOV, V.M., SHMULOVITCH, K.I., 1977, P-V-T measurements in hydrothermal systems at high temperatures and pressures (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. 3, p. 17-18 (in Russian).

SHVADUS, M. I., 1978, Composition of recrystallized inclusions in quartz of ore-bearing granitoids of western Transbaikal and P-T-conditions for crystallization: Akad. Nauk SSSR, Sibirsk. Otdel., Geologiya i Geofizika, v. 19, no. 5, p. 31-36, (in Russian; translated in Soviet Geol. & Geophys., v. 19, no. 5, p. 24-28).

Identified for the first time and studied in quartz of ore-bearing granitoids of western Transbaikal are four types of crystallized melt inclusions: quartz-muscovite (granite porphyry phenocrysts), quartz-feldspar (matrix of granite porphyry), quartz-feldspar-muscovite (granite, granosyenite, quartz syenite of transitional zone from endocontact to center), and quartz-feldspar-fluorite (granite of central area of massif). (Author's abstract).

SHVADUS, M.I., 1978, Fluids of rare-metal granitoids from Transbaikalia., (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 81-83 (in Russian). Author at GIN BF of Siberian Branch of Acad. Sci. of the USSR, Ulan-Ude.

Wall granitoids of the F-rare metal deposits were studied. Massifs consist of medium-grained granites (central parts), porphyric granites and granosyenites (intermediate zone) and granite- or syenite-porphyries (periphery). Volatiles concentrated in upper parts of massifs. Results of inclusion studies are listed in the table: (From the author's abst. by A.K.)

Rock	Mineral	Inclusions		
		Type	Composition	Th, °C
Granite-poryphyry	quartz-phenocrysts	melt	G+L+quartz+muscovite	≤ 930
	quartz-matrix		G+quartz+feldspar	890
Skarns	fluorite garnet vesuvianite	fluid		660 800-820
Prophyric granite	quartz	melt	G+quartz+feldspar+ +muscovite	865
Medium-grained granite	quartz	melt	G+quartz+feldspar+ +?fluorite;	820
			G+L+silicates+salts	780
	interstitial fluorite and xenotime	fluid		≲720
Granosyenite dike	quartz	melt	G+quartz+feldspar;	920
			G+L+silicates+ +salts	780
Albitite with rare earth minerals	quartz fluorite xenotime	fluid		≤ 600 690
Microcline metasomatite	quartz and fluorite	solution		490-620

SIDORENKO, A.V., TYENYAKOV, V.A. and SIDORENKO, Sv.A., 1978, Sedimentary-metamorphic processes and "gaseous breathing" of the Earth's crust: Acad. Sci. USSR Doklady, v. 238, no. 3, p. 705-708 (in Russian).

Discussion of gas balance, partly pertinent to fluid inclusion studies. (A.K.)

SIDOROV, A.A. and GONCHAROV, V.I., 1978, Zones of ore precipitation in deposits of the Okhotsk-Chukotka volcanogenic belt: Akad.

Nauk SSSR Doklady, v. 239, no. 6, p. 1415-1418 (in Russian). Authors at the North-East Complex Sci.-Research Inst. of the Far-East Sci. Center of Acad. Sci. USSR, Magadan.

Deposits of the Cu-Mo, polymetallic, Au-Ag and Sb-Hg formations in Ikhotsk-Chukotha area are connected with zones of hydrothermal-explosive brecciation. Argillites above the veins formed at T (Th) 50-250°C, P 1-20 atm, solutions $HCO_3 > SO_4 > Cl/Ca > K > Na$; metacolloidal veins: 80-320°C, 5-85 atm, $HCO_3 > Cl/Ca > Na > K$, gases $CO_2 > N_2 >$ (HCl, HF) $> CO > O_2$; hydrothermal-explosive brecciation, upper part: 220-410°C, 110-280 atm, $Cl > F > HCO_3/Ca > K > Na$, $CO_2 > N_2 >$ (HCl, HF); same, lower part: 200-410°C, no P determinations, $SO_4 > Cl > F > HCO_3/K > Ca > Mg$, $N_2 > CO_2 > O_2 >$ (HCl, HF); same, "porphyry-like:" 210-700°C, up to 1000 atm, no other data; laminated veins: 50-365°C, 200-250 atm, $HCO_3 > Cl > SO_4/Ca > Na > K$, $CO_2 > N_2 > O_2$ (HCl, HF), geothermal gradient 10-30°C/100 m. (A.K.)

SINYAKOV, V.I., 1978, Temperature regime of the magnetite ore mineralization in skarn deposits: Akad. Nauk SSSR Doklady v. 241 no. 6, pp. 1413-1416 (in Russian). Author at the Inst. Geol. and Geophysics of Siberian Branch of Acad. Sci. of the USSR, Novosibirsk.

Studies were carried out on magnetite specimens from the skarn deposits of the Kuznetsk-Sayan province. Decrepitation determinations yielded T of origin 580-420°C. Recrystallization of magnetite occurred at 520-400°C. Comparison of Td of magnetite with Th in paragenetic minerals proved that Td of magnetite needs a correction of -80°C. (Abst. by A.K.)

SIROTIN, S.K. and SIROTIN, K.M., 1978, Application of decrepitophonic analysis during prospecting for hidden ore bodies under conditions of scarce outcrops in the E. slope of the S. Urals, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. II, Thermobarogeochemistry and ore genesis: Vladivostok, Acad. Sci. USSR, p. 9-10 (in Russian). Authors at the Sci.-Research Inst. of Geology SGU, Saratov, USSR.

Decrepitation characteristics of 4500 samples taken from the weathering zone (network 25x50m, sampling depth 0.7-0.8m) and 9800 samples from drilling cores revealed a number of hydrothermally altered zones. (A.K.)

SIVORONOV, A.A. and BOBROV, A.B., 1978, Fluid regime of migmatite formation, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 120-121 (in Russian). Authors at the L'vov State Univ., L'vov, USSR.

Quartz and diopside from migmatites of the Kuandin and Udokan complexes bear following inclusions:

1. P L CO_2 + L H_2O + salt inclusions, with volumes (in %) L CO_2 + G CO_2 10-45, crystals 15-22, L H_2O 33-75; NaCl dissolved at 215-470°C, Th 475-575°C, calculated P of fluid 1500 atm.

2. PS inclusions of two varieties: A. water-salt inclusions, halite dissolves at 120-310°C, Th in L at 210-360°C, NaCl concentration 39-40%, P 1000-800 atm; B. G/L inclusions, G 35-40%, Th 320-430°C, Th + P corrections 400-500°C.

3. S inclusions: A. CO_2-bearing inclusions, three groups: a. L CO_2

(45-70%) + G CO_2 (25-45%) + L H_2O (5-10%), G CO_2→L CO_2 at 29.5-30.2°C, Th in L at 210-260°C, P 430 atm. б. L CO_2 (40-50%) + G CO_2 (15-20%) + L H_2O (25-30%), G CO_2→L CO_2 at 25.6-26.0°C, Th 170°C, P 340 atm. c. L CO_2 (73-83%) + G CO_2 (7-17%) + L H_2O (10-15%), G CO_2→L CO_2 at 23.8-24.0°C, Th 115-125°C, P 130 atm.

B. Essentially L, G>L, L>G and essentially G inclusions with irregular vacuole shape, Th 85-200°C.

P inclusions characterize conditions of amphibolite facies, PS and S- conditions of retrograde metamorphism. Migmatites formed with complete absence of traces of magmatic melt. (From the authors' abst., by A.K.)

SIVORONOV, A.A., and ZHIKHAROV, A.P., 1978, Inclusions of mineral-forming fluid in hypersthene granulite facies, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok Acad. Sci. USSR, p. 121-122 (in Russian).

Metamorphosed oligomictic sandstones of the Lower Precambrian in the central Ukrainian shield, Ingul river region, are now biotite gneisses with boudins of diopside-plagioclase-quartz schists (granulite and amphibolite facies). Ultrametamorphism yielded migmatites, biotite-garnet granitoids and pegmatites. P G/L inclusions in quartz homogenized at ≤ 580°C, PS inclusions at 450-350°C, S ones at 227-217°C; all in L, except a few which homogenized in G. Probably all inclusions are connected with retrograde metamorphism of the ultrametamorphic assemblages. (From the authors' abstract).

SKARZHINSKAYA, T.A. and SKARZHINSKIY, A.V., 1978, Thermobarometric studies of crystalline schists: Vladivostok abst., v. I p. 126-127 (in Russian). Authors at the Inst. Geochem. and Physics of Minerals of Acad. Sci. of the Ukrainian SSR, Kiev.

Crystalline schists of New-Krivoy-Rog suite, formed mostly by metasomatic alteration of amphibolites, were studied by fluid inclusion homogenization method. Th in quartz from altered amphibolite, presently quartz-biotite schist, equals 380°C. Quartz from quartz veins in altered amphibolites has similar Th (310-350°C), but carbonate is much lower (Th 100-170°C). (From the Authors' abst.)

SKIBA, B. I. and ARUTYUNYAN, L. A., 1977, Methods of study of element migration in solid bodies under hydrothermal conditions (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. 3, p. 80-81 (in Russian).

SKOPIN, Yu. A., KORMUSHIN, V. A. and LIPOVA, Z. M., 1978, Application of ion-selective electrodes for analysis of water leachates from minerals, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 156-157 (in Russian). Authors at the Kazakh Inst. of Mineral Raw Materials, Alma-Ata.

Leachates were made from quartz of the Boguty deposit (Central Kazakhstan). Ion-selective electrodes ESL 51-07, ESL 91-07, and

ESrL-01 were used for Na, K and Cl determinations, respectively. Fluoride ion was determined by electrode with membrane of LaF_3 with europium admixture. Reference was the standard chlorine-silver electrode, the pH-meter used was the "pH-121" apparatus. The control determinations were made by usual methods. The selectivity of the applied electrodes was sufficient. (From the authors' abst.)

SKRYABIN, V.Yu., 1978a, Composition of crystallized inclusions of granite melt: Akad. Nauk. SSSR Doklady, v. 242, no. 2, p. 416-418 (in Russian). Author at the Voronezh State Univ., Voronezh, USSR.

Studies of the composition of phases and products of homogenization of the crystallized "muscovite" inclusions in quartz of granite in the Liskinskiy massif near Voronezh. Apical part of the massif consists of fine-grained and granophyric granites, and the central part, of medium-grained biotite granite. Inclusions were studied in the latter variety, but also fine-grained and granophyric granites bear similar inclusions. The studied inclusions are primary and have constant phase ratios. Quartz from the melt filling vacuoles crystallized on the vacuole walls, thus true inclusion size may only be evaluated after homogenization. About 60 vol.% is occupied by subhexagonal muscovite, G phase forms one or few bubbles; also a Na and Ca-bearing isotropic phase was found in inclusions. Th of inclusions varies from 840 to 920°C; on cooling (either slow or rapid) homogenized inclusions quenched without heterogenization. Chemical composition of quenched inclusion after homogenization, and mica, is as follows, respectively: SiO_2 76.67, 50.00; Al_2O_3 10.75, 31.22; total Fe as Fe_2O_3 0.43, 2.22; MgO trace, 0.12; CaO 0.31, not found; Na_2O 1.31, 0.14; K_2O 7.92, 12.81; total 97.43, 96.51; in weight %, by electron microprobe analysis. Composition of homogenized inclusion differs a little from mean composition of granites. Muscovite inclusions are trapped portions of magmatic melt enriched in K seemingly due to earlier crystallization of plagioclase. (Abst. by A.K.)

SKRYABIN, V. Yu.,b 1978, Some peculiarities of conditions and mechanism of formation of hypabyssal granite intrusives, (Abst): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 71-73 (in Russian). Author at the Voronezh State Univ., Voronezh.

Liskinskiy hypabyssal granite massif occurs in SE part of the Voronezh crystalline plateau in the Lower Proterozoic tectonic-magmatic zone, of Archean rocks. Central part of the massif consists of medium-grained biotite granite, and apical part of micrographic granite with zones of fine-grained granite. Quartz of medium-grained granite bears crystallized melt inclusions filled with muscovite-like mica and G bubble. At 750-780°C a rim of melt appears at the mica/G and mica/quartz contacts. At 780-820°C G dissolves in melt. Complete homogenization with a 50-80 % increase in inclusion volume is at 840-925°C; the sequence is $dm+G \rightarrow dm+G+melt \rightarrow dm+melt \rightarrow melt$. Calculated inclusion filling: mica 53-63 vol. %, quartz 32-43 vol. %, and G 4-5 vol. %; hence calculated water content in melt 2.8-3.4 wt.%, if H_2O content in mica accepted ca. 5%, and PH_2O on trapping ca. 0.5 kb. T and PH_2O permit an estimate of melt viscosity $2 \times 10^6 - 1 \times 10^7$ poise. Presence of coeval inclusions of K-Na spar, biotite, and magnetite in quartz suggests granite melt crystallization under equilibrium conditions sanidine + biotite + magnetite, thus from Th and biotite composition, P_{O_2} may be evaluated as 10^{-15} - 10^{-13} atm.

Quartz of apical fine-grained granite often bears crystallized melt inclusions filled with mica-type aggregates (47 vol. %), L (11-12 vol. %), G (0.5-1 vol. %) and quartz (41 vol. %); inclusion volume increases 89-90 % on homogenization. On heating at 380°C inclusions become darker, presumably due to transition of L phase in supercritical state (sic). T of this phenomenon proves the essentially aqueous composition of L, At higher T inclusions became lighter and melt rim forms, plus several large G bubbles. Preliminary results of Th measurements are 1050-1120°C, inclusion behavior on heating: dms+L+G → dms+G → dms+G+melt → melt+G → melt. Moreover, in the same granite, quartz grains have inner cores dotted with G and G/L inclusions, and outer growth zones bearing inclusions of K-Na-spar. Hence G/L inclusions are P, proving crystallization of apical granite from "boiling" melt saturated with H_2O, $P_{total} = PH_2O$. Calculated H_2O content in melt $5 \times 10^3 - 1 \times 10^4$ poise). Presence of coeval hematite inclusions proves high P_{O_2}. (Author's abst., translated by A.K.)

SMALL, A. T., 1978, Zonation of Pb-Zn-Cu-F-Ba mineralization in part of the North Yorkshire Pennines: Inst. Min. Met., Trans., v. 87, Sect. B, p. B10-B13.

Zonation of mineral occurrence with four principal zones is described. It is paralleled by changes in the concentration of yttrium in fluorite and of silver and antimony in galena, and in Na: K ratios of mineral leachates. Overall control of zoning is ascribed to the flow path of solution; the suggested mechanism is progressive interaction with an effectively uniform environment, perhaps combined with mixing of a second solution. A connate origin of the solutions is postulated. (Author's abstract)

SMIRNOVA, S.V., POLYKOVSKIY, V.S., YASKOLKO, T.I., GUGUTSI, M.T. and IVANOVA, N.A., 1978, Applying decrepitation of quartz to distinguish commercial mineral association in gold ore deposits, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. II, Thermobarogeochemistry and ore genesis: Vladivostok, Acad. Sci. USSR, p. 21-22 (in Russian). Authors at the Geol. Ministry of the Uzbek SSR, Tashkent.

The studied mineralization occurs in the Chadak ore field in hydrothermal veins consisting of quartz, carbonate, adularia, wollastonite plus chlorite, hematite and gold (electrum). Veins cut Carboniferous trachyandesite formation. Quartz from those veins has very characteristic decrepitation patterns (not described, A.K.). (From the authors' abst.)

SMITH, F. W. , 1978, Fluid inclusion measurement of cooling gradients in vein mineralization (abst.), in International Assoc. Genesis Ore Deposits, 5th Symp., Snowbird, Alta, Utah, 1978, Program and Abstracts: (Alta, Utah), p. 177.

Although it is commonly believed that cooling was the major cause of mineral deposition in many veins, surprisingly little is known about the actual temperature gradients that existed in hydrothermal systems. Fluid inclusion geothermometry can be used to reconstruct isotherms for individual phases of mineralization in veins - provided that there is reliable evidence for the contemporaneity of the specimens used. It is then possible to measure flow-line cooling gradients (which are usually vertical rather than horizontal). An important coincidental use for the isotherm sections is found in mine exploration and development (e.g., Greenwood and Smith, Trans. Instn. Min. Metall,. Sect. B, 1977, vol 86).

More than 60 flow-path cooling gradients and simple vertical temperature gradients have been abstracted from the literature concerning more than 20 regions or orefields. They range from 1 °C per 1.4m to 1°C per 25m; clustering mainly between 1°C per 3m and 1°C per 14m. There is no outstanding distinction according to type of deposit. Differences between deposits of the same type may be greater than those between totally contrasting orefields.

Cooling gradients from the Weardale fluorspar veins, Northern England, lie mainly in the range 1° C per 5.6 to 1° C per 8.9m. Minimum temperatures of mineralization, measured at more than 40 horizons in a vertical range of 880m, indicate the contemporaneous background temperatures - or rock geothermal gradient (1° C per 13M). Any solutions migrating laterally, i.e., away from the main body of flow, eventually cooled to the surrounding rock temperature and ceased depositing minerals - and observable relationship in some orebodies.(Author's abstract)

SOBOLEVA, G. I. and DERNOV-PEGAREV, V. F., 1977, Experimental methods of study of mineral solubility under high temperature conditions (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. 3, p. 58 (in Russian).

SOKOLOV, S.V., 1978, Attempted study of inclusions of mineral-forming media in pyrochlore from carbonatites, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in Geology: Vladivostok, Acad. Sci. USSR, p. 62-63 (in Russian). Author at the All-Union Inst. of Mineral Raw Materials, Moscow.

Accesory pyrochlore from forsterite-calcite carbonatites of E. Siberia bears P and S inclusions mostly of octahedral habit. Their filling consists of 1-3 anisotropic dms, L and dark bitumen-like phase. G bubble appeared on heating (sic) at 170°C, complete homogenization was reached only in several early-secondary inclusions (in L or melt at 670-720°C). At 760-800°C pyrochlore rapidly becomes opaque, and before this T dms in P inclusions dissolved only in part; thus Th should be >720°C and pyrochlore might crystallize from concentrated melt-solutions. (From the author's abst., by A.K.)

SOKOLOV, S.V., 1978, Temperature sequence of formation of minerals of carbonatite massifs, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in Geology: Vladivostok, Acad. Sci. USSR, p. 60-62 (in Russian). Author at the All-Union Inst. of Mineral Raw Materials, Moscow.

Th of inclusions in carbonatite minerals from massifs of the provinces: Aldan, Sayan, Maymecha-Kotuy,& Karelia-Kola are listed in the table:

Rock	Mineral	Th, °C
Meymechite	Olivine	1480-1420
Olivinite	do.	1310-1220
Peridotite	do.	1330-1260
	Pyroxene	1255-1165
Pyroxenite	do.	1260-1110
Olivine-melilite	Melilite	1130-1080
Turjaite	do.	1080-970
	Pyroxene	1060-960
	Nepheline	1020-950
Ijolite	Pyroxene	1060-980
	Nepheline	1020-965
	Apatite	1010-840
Calcite carbonatites	Pyroxene	1000-880
	Nepheline	920-850
	Olivine	820-640
	Apatite	760-675
		575-250
Apatite-forsterite-magnetite and apatite-magnetite	Olivine	890-690
	Apatite	480-300

Some minerals formed over a range of T in various rocks in sequence:

Olivine: meymechite (1480-1420°C) → olivinite, peridotite (1330-1220°C) → apatite-forsterite magnetite ores and forsterite-calcite carbonatites (890-640°C);

Pyroxene: peridotite, pyroxenite (1260-1110°C) → alkaline rocks (1060-960°C) → pyroxene-calcite carbonatites (1000-880°C);

Melilite: olivine-melilite rock (1130-1080°C) → turjaite (1080-970°C);

Nepheline: alkaline rocks (1020-950°C) → nepheline-calcite carbonatites (920-850°C);

Apatite: ijolite (1010-840°C) → calcite carbonatites and apatite-magnetite ores (890-675, 575-250°C). (From the author's abst.)

SOKOLOV, S. V. and ROMANCHEV, B. P., 1978, Thermometric study of the minerals of ultrabasic-basic and carbonatite complexes (using the Kovdor Massif as an example): Teor. Prakt. Termobarogeokhim., (Dokl. Vses. Soveshch.) 5th 1976, N. P. Ermakov, ed.: Moscow, Izd. Nauka, p. 87-95 (in Russian).

The phase compn. and Th are given of solid- and fluid-phase contg. inclusions in principal minerals of the Kovdor ultrabasic-alk. rocks of the Kola Peninsula. Th of the inclusions decreases consistently in accordance with the order of formation of the rocks: olivinites 1220-1300, pyroxenites 1110-1210, turjaites and ijolites 950-1080, and carbonatites 520-820°. The compn. of the inclusions evolves, in parallel, from crystd. oxides and silicates in the minerals of the ultrabasic rocks to salt, fluid-enriched phases and fluids in the minerals of the carbonatites. The inclusions in the minerals from melilitic rocks show liquation phenomena, which suggests that liquation was involved in segregation of carbonate liqs. during differentiation of the alk.-ultrabasic magma. (Chem. Abstracts 91: 77079u, 1979)

SOMMER, M.A., II, 1978, Volatiles in silicate melt inclusions from the air-fall and ash-flow tuffs of the Bandelier Tuff, Jemez Mountains, New Mexico (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 10, no. 7, p. 495.

Silicate melt inclusions in quartz phenocrysts from the air-fall pumices of both the lower and upper members of the rhyolitic Pleistocene Bandelier Tuff, Jemez Mountains, New Mexico have volatile totals averaging about 6 wt% water. Assuming saturation this concentration is equal to about 1500 bars or 5 km to the depth of the magma chamber. (Determinations based on mass spectrometric and electron microprobe techniques. CO_2, CO, and other gases were present but in small concentrations). The volatiles in the inclusions in these phenocrysts are assumed to have a representative assemblage of the volatiles in the chamber prior to eruption. The phenocrysts and inclusions collected in the ash-flows overlying the air-falls have textural indications of formation during post-eruption decompression and magma boiling. The ash-flow inclusions have water contents of between 1 and 3 wt%, a dramatic decline from the 6 wt% concentration in the air-falls. These data suggest that volatiles (primarily water) were incorporated into the magma chamber until the overburden pressure was exceeded and explosive eruption occurred. Rapid decompression caused vapor saturation, magma boiling and volatile loss. Collapse of the cauldron blocks eventually ceased eruption. Pressure once again built in the chamber with the incorporation of volatiles until the process was repeated. (Authors' abstract)

SØRENSEN, H., 1977, Features of the distribution of uranium in igneous rocks - uranium deposits associated with igneous rocks: p. 47-52 in Recognition and evaluation of uraniferous areas: Vienna, Int. Atomic Energy Agency. Author at Univ. of Copenhagen, Copenhagen, Denmark.

The generally accepted main features of the distribution of uranium and thorium in igneous rocks are briefly reviewed. It is pointed out that uranium in most cases examined is strongly partitioned into the melt during consolidation of magmas and that uranium is concentrated in the most volatile-rich parts of magmas. The mode of emplacement and the consolidation of magmas control the retention or the expulsion of the volatile phase from consolidating magmas and also the distribution of uranium between magmas and the volatile phase. After a brief review of the types of uranium deposits associated with igneous rocks it is concluded that it is difficult to establish universally valid exploration criteria to be used in the search of these types of deposit. It is emphasized, however, that detailed petrological and geochemical studies may be useful in outlining exploration targets. (Author's abstract)

SØRENSEN, Henning and LARSEN, L. M., 1978, Aspects of the crystallization of volatile-rich peralkaline undersaturated magams--exemplified by the Ilímaussaq intrusion, South Greenland: Jornal de Mineralogia, Volume Djalma Guimaraes, Recife. v. 7, p. 135-142.

Volatile-rich peralkaline magmas possess a number of distinct physical and chemical properties which are reviewed and discussed. For the Ilímaussaq intrusion, South Greenland, the process of volatile transfer has previously been advocated to account for large concentrations of alkalis, volatiles and some residual elements in the roof rocks. However, the magma was at this stage undersaturated with water, and a separate hydrous phase did probably not exist. The behavior of Mg, Zr and U during crystallization of both the roof and bottom rocks of the intrusion is discussed. Fractional crystallization can account for some of the observed trends in the distribution of Mg and Zr, but to explain the U-trend we must assume that this process has been assisted by preferential retention of complex ions in the melt. At the roof uranium diffused downwards from the crystallization front into the underlying magma, and the roof rocks show no U-enrichment with progressive crystallization. The youngest members of the intrusion are accompanied by uranium mineralizations. (Authors' abstract).

SOROKIN, V. I., OSADTCHY, E. G. and NEKRASOV, I. Ya., 1977, Thermodynamics of sphalerite and stannite solid solutions. Stannite-sphalerite geothermometer (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. 3, p. 88 (in Russian; abstract courtesy Dr. A. P. Berzina).

Fe and Zn distribution between stannite and sphalerite at 1-1500 bar does not actually depend on pressure and can be presented as ion-exchange reaction

$$Cu_2FeSnS_4 + ZnS = Cu_2ZnSnS_4 + FeS$$

Distribution constant $K_D = (Fe/Zn)_{sph} / (Fe/Zn)_{st}$ at 200-600°C varies with temperature change in conformity with equation $\lg K_D = -1274/T + 1.174$ and can be used as a geological thermometer. The temperatures of formation of sphalerite-stannite pairs at a number of the USSR deposits are in the range 580° to 250°C.

SOTNIKOV, V. I. and BERZINA, A. P., 1978, Geochemical features of ore-forming process at copper-molybdenum deposits associated with subvolcanic processes, in International Assoc. Genesis Ore Deposits, 5th Symp., Snowbird, Alta, Utah, 1978, Program and Abstracts: (Alta, Utah), p. 179.

The paper presents the results of studying a number of copper-molybdenum deposits in the USSR and Mongolia. The considered mineralization occurs in a close spatial and temporal association with stock and dike-like bodies of polyphase complexes of subvolcanic granitoids. The development of the endogenetic process is multiphase with repeated appearance of subvolcanic rocks, explosive breccias and ore-metasomatic formations.

The crystallization of ore-bearing granite and granodiorite porphyries is likely to have taken place in the temperature range from 900° to 1200° C. The early igneous emanations accompanying the formations of subvolcanic intrusions are characterized by high CO_2 and low halogen contents.

The formation of intrusive bodies was accompanied by explosive brecciation. The temperature range of brecciation varies between 700° and 600° C (when breccias are developed at the early endogene stages) up to 300-250° C at their final stage. The fixed pressure of brecciation was about 3000-2000 atm. The fluids of this process are mainly haloid with predominant role of chlorine. At later brecciation the most important role belongs to CO_2.

The formation of ore-metasomatic rocks took place in the wide temperature range: between 800° and 600° C at their early period (K-feldspathization, albitization, early silicification) to 450-200° C (major ore-formation stage as well as sericitization, silicification, argillization) and lower in their closing period. The pressures changed from 2000 to 100-80 atm. The solutions are generally of alkaline-chloride type. The initial high-temperature fluids are characterized by the high HCl contents. The later metasomatic processes and ore formation proceeded from the essentially carbon-dioxide solutions. At this period the separation of the two-phase from saline fluids proceeded as follows: one-rich H_2O and CO_2 and other-rich H_2O and NaCl. The boiling of the ore-forming solution proceeded at 400-500°C and resulted from the sudden change of pressure at relatively small depth and well penetrable structures. Repeated boiling resulted in somewhat higher content of salts in the liquid phase. Fair spatial correlation was found between the zone of high-saline solutions and the ore-deposition. The ore-forming process at the copper-molybdenum deposits under consideration is characterized by the important role of chlorine. An increase of fluorine content in hydrothermal solutions affected both the nature of metasomatic alterations (in particular the development of albitization) and mineral-geochemical peculiarities in the deposits, such as enrichment in molybdenum, increased triclinicity of K-feldspar, etc. (Authors' abstract.)

SOTNIKOV, V. I., BERZINA, A. P., NIKITINA, E. I. and KOROLYUK, V. N., 1978, Chlorine and fluorine contents and their distribution in some minerals from copper-molybdenum deposits with reference to the peculiarities in the mineral-forming process (abst.): XI General Meeting of International Mineralogical Association, Novosibirsk, Abstracts, v. 1, p. 168 (in English).

Chlorine and fluorine are the important volatile elements of the mineral-forming solutions in copper-molybdenum deposits. They significantly influence the general development of endogene process, and the formation of some rock types and mineral associations. Biotite and apatite from a number of copper-molybdenum deposits in the USSR and Mongolia have been analyzed for chlorine and fluorine by electron microprobe. These minerals are practically the only concentrators of volatile elements. Chlorine and fluorine contents in gas-liquid inclusions have been also determined.

Apatites from all the examined rocks (granitoids of the ore-forming magmatic complexes, explosive breccias, and metasomatic rocks) are fluorine rich. Chlorine concentrations range from 0.1 to 1.3 wt.%. Maximum concentration of this element is fixed for apatite formed at an early high-temperature stage from gaseous fluid produced by volatilization of magmatic melt. Apatite with much lower Cl/F ratio is formed from later liquid solution though there is present significant amounts of chlorine ion. Apatite is not usually homogenous with respect to chlorine. Its amount decreases at the periphery of grains (according to decrease of mineral formation temperature).

The contents of chlorine and especially fluorine in biotite are lower compared with the coexisting apatite. The Cl/F ratio in biotite from potassic alteration decreases with regard to biotite from granitoids and explosive breccia. Halogen value decreases sharply in chloritic biotites.

Apatite and biotite from the formations temporally related to ore deposition are characterized by minimum Cl/F ratio. Higher Cl/F ratios in biotite and apatite are one of the peculiarities of the copper-molybdenum-bearing granitoids. (Authors' abstract)

SPOONER, E.T.C., 1978, Ophiolitic (Cyprus-type) massive sulphide deposits:

mode of occurrence, economic significance and origin (abst.), in International Assoc. Genesis Ore Deposits, 5th Symp., Snowbird, Alta, Utah, 1978, Program and Abstracts: (Alta, Utah), p. 181.

Recent geochemical information derived principally from fluid inclusion and isotopic studies on Cyprus material suggests that the deposits formed by discharge of a convecting hydrothermal fluid of sea water origin. 205 determinations (accuracy=±0.2°C) of the freezing points of fluid inclusions in quartz intimately intergrown with sulphides from three deposits in Cyprus give a unimodal and symmetrical distribution about a mean value of -1.9°C with a standard deviation of ±0.4°C (Spooner and Bray, 1977). Fluid inclusion homogenisation temperatures indicated stockwork mineralisation temperatures of 300°C - 350°C. Significant ^{87}Sr contamination of ore and hydrothermally metamorphosed surrounding material has been observed (Spooner, Chapman and Smewing, 1977; Chapman and Spooner, 1977). The isotopic composition of sulphide sulphur suggests that a significant, but as yet unknown, proportion is of reduced sea water sulphate origin (Spooner, 1977). (From the author's abstract)

SREBRODOL'SKIY, B. I., 1978, Nature of organic matter in native sulfur: Akad. Nauk SSSR Doklady, v. 240, no. 4, p. 957-958 (in Russian). Author at the Inst. Geol. Geochem. Fuel Raw Materials of Acad. Sci. of Ukraine, L'vov.

Bituminous inclusions in native sulfur from the Rozdol deposit were characterized by chemical analysis and IR absorption spectra; they consist of oils, resins, asphaltens, and bitumens. (A.K.)

SRETENSKAYA, N.G., 1977, Electroconductivity of aqueous solutions of hydrogen sulfide and carbonic acids at elevated temperatures and pressures (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. 3, p. 33-34 (in Russian).

STEMPROK, Miroslav, 1978, Differentiation of some elements by ore-bearing granites: Metallization Associated with Acid Magmatism, vol. 3, p. 393-403.

Recent experimental work suggests that Sn, W, Mo, etc. can be separated from granitic melts as either a fluoride-rich, water solution, or as an immiscible fluoride, tungstate, or molybdate melt. (ER)

STEMPROK, M., BURNOL, L. and TISCHENDORF, G., eds., 1978, Metallization associated with acid magmatism, v. 3: Stuttgart, E. Schweizerbart'sche Verleg. 446 pp.

STEPISIEWICZ, Marek, 1978, Hydrothermal laumontite from the Strzelin granitoids: Acta Geologica Polonica, v. 28, p. 223-233 (in English with Polish abstract).

Laumontite occurs in post-magmatic veins in the Strzelin granitoids, Lower Silesia (southern Poland). Studies of fluid inclusions in associated quartz show that it originated jointly with associated minerals in the range 340-175°C of ≤ 730 ± 70 bars, from dilute CO_2-bearing hydrothermal solutions. (From the author's abstract).

STERN, C. R. and WYLLIE, P. J., 1978, Phase compositions through crystallization intervals in basalt-andesite-H_2O at 30 kbar with implications for subduction zone magmas: Amer. Min., v. 63, p. 641-663.

STEWART, D. B., 1978, Petrogenesis of lithium-rich pegmatites: Amer. Min., v. 63, p. 970-980. Author at U. S. Geol. Survey, Reston, VA 22092.

The experimentally determined liquidus of the system $NaAlSi_3O_8$ (Ab)-SiO_2(Qz)-$LiAlSiO_4$(Eu)-H_2O at 2 kbar P_{H_2O} has a eutectic near Ab34Qz50Eu16 weight percent at 640° ± 10°C. The field boundary of albite and quartz is depressed nearly 100°C from the Ab-Qz-H_2O sideline by saturation in Eu component; the field boundary between albite and lithium minerals varies little in Li_2O content (19 ± 3 percent Eu) between the eutectic and the Ab-Eu-H_2O sideline. Liquidus temperatures rise very steeply as Qz increases in the quartz field. The field boundaries indicate that pegmatite magma will crystallize feldspar and quartz and concentrate lithium in the reamaining magma. Similar relations have been observed for the Or-Qz-Eu-H_2O system by Munoz (1971). Petalite will form if the field boundary is reached at high temperatures and low pressures; spodumene forms at lower temperatures and higher pressures.

The bulk compositions of natural homogeneous Li-rich pegmatites plot on a diagram for the system (Or,Ab)-Qz-Eu-H_2O in the thermal minimum or slightly toward (Or,Ab) from it. The geologic abundance and similarities of these bulk compositions together with the experimental data support a magmatic origin of homogeneous Li-rich pegmatites. Li-rich magma probably forms by partial melting of Li-bearing metasediments at temperatures 75°C or more below the minimum melting temperature at the same P_{H_2O} of the simplified "granite" system $KAlSi_3O_8$-$NaAlSi_3O_8$-SiO_2-H_2O. An origin by anatexis is most consistent with the irregular distribution of Li-rich pegmatites close to the sillimanite isograd but farthest of all pegmatite varieties from granites related to the same thermal event. The sparsity of Li-rich pegmatite bodies within related granites is also in accord with an anatectic origin: further heating in the source area would yield larger amounts of granitic rock and dilute the Li content to the normal <100 ppm.

Magmatic differentiation adequately explains the sequence of zones in zoned pegmatites, including the abrupt appearance of lithium minerals in quantity and the observed limit on the abundance of lithium minerals in common natural bulk compositions. The occurrence of petalite or spodumene cannot be related to bulk composition, as all Li-pegmatite falls compositionally into the alkali feldspar-quartz-petalite volume. The high temperature-low pressure assemblage isochemically equivalent to zone 5 of Cameron et al. (1949) is perthite-plagioclase-petalite-quartz, and to zone 6 is plagioclase-petalite-quartz. These zones seem to be the last that can reasonably be interpreted to have originated from molten silicate magma.

Gases more siliceous than coexisting lithium aluminum silicate minerals were experimentally studied at 575°C and 2 kbar P_{H_2O}. Precipitation of the solids from such gases would yield compositions like those of silica-rich pegmatite zones. Compositions that could have formed from gas have quartz > feldspar. Eucryptite probably forms solely in the presence of such gases. (Author's abstract).

SUSHCHEVSKAYA, T. M., 1976, Interpretation of chemical analyses of the liquid phase of inclusions in minerals: Geokhimiya, 1976, p. 115-119 (in Russian; translated in Geochem. International, v. 13, p. 78-81 (1976). Author at V. I. Vernadskiy Inst. Geochem. Acad. Sci., USSR, Moscow.

A careful evaluation of the many pitfalls in the interpretation of the chemical data obtained by various methods of extraction and analysis of fluid inclusions. Extrapolation from composition at room temperature to the amounts and nature of the complexes present at elevated temperature is hazardous. (ER)

SUSHCHEVSKAYA, T.M., 1978, Estimation of redox potential in tin-bearing hydrothermal solutions from gas-liquid inclusion data (abst.), in International Assoc. Genesis Ore Deposits, 5th Symp., Snowbird, Alta, Utah, 1978, Program and Abstracts: (Alta, Utah), p. 186.

The main productive mineral association of cassiterite-silicate-sulfide type crystallized at 450-280° C, from moderately mineralized neutral or slightly alkaline aqueous solutions.

The content of dissolved gaseous components in the inclusion solutions was established by gas chromatographic analysis of the gases from thermally decrepitated inclusions in quartz.

Carbon dioxide was shown to predominate, with CH_4, CO, and N_2 much lower. The equilibrium composition of homogeneous hydrothermal solutions, containing known quantities of various elements and saturated with respect to quartz has been computed for 300° C. Analytically determined concentrations of dissolved gases are close to equilibrium values at the temperatures of the process for CO_2, CH_4, N_2, but CO is several orders of magnitude greater. Temperature does not influence CO_2 and CH_4 equilibrium concentrations, for all practical purposes.

Data on CO_2-CH_4 equilibrium and on solution compositions permit an estimate on the redox values (Eh) of solutions in the inclusions. Calculated Eh^{300} values are within -(0.6 to 0.9) v, that is, tin ores crystallized in a reduced environment. In the range of pH and Eh values found, carbon and sulfur exist predominantly in the form of undissociated molecules - CO_2 and H_2S. (Author's abstract)

SUSHCHEVSKAYA, T. M., RYZHENKO, B. N., KNYAZEVA, S. N., MALAKHOV, V. V. and BARSUKOV, V. L, 1978, Redox potential of tin-bearing hydrothermal solutions: Geokhimiya, 1978, no. 8, p. 1129-1138 (in Russian). First author at V. I. Vernadsky Inst. Geochem. USSR Acad. of Sci., Moscow.

Based on the data of gas-chromatographic analysis of composition of gas-liquid inclusions in quartz belonging to productive stage of cassiterite-sulfide-silicate deposits the composition and concentration of dissolved gaseous components of tin-bearing hydrothermal solutions were determined. Using computer calculation it was shown that the concentrations revealed in analysis and the concentrations being in equilibrium under the temperatures of the inclusions opening are nearly the same for CO_2, CH_4, and H_2. CO_2/CH_4 ratio does not vary depending on temperature. The values Eh^{300}, lying within the interval of (0,6-0,9)B, were calculated from the CO_2/CH_4 equilibrium using the data on salt compositions and pH of the liquid phase. Under the conditions determined by the revealed values of pH and Eh the predominant forms of occurrence for carbon and sulfur are represented by undissociated CO_2 and H_2S. (Authors' abstract)

SUTTON, R. L., 1978, Bubble crystals: Explorers Journal, v. 56, no. 1, p. 7-11.
Adapted from Lapidary Journal, v. 18, p. 924-934, 1964 (E.R)

SVADUS, M., 1978, Composition of crystalline inclusions and the conditions for granite formation: Teor. Prakt. Termobarogeokhim., (Dokl. Vses. Soveshch.) 5th 1976, N. P. Ermakov, ed.: Moscow, Izd. Nauka, p. 96-100 (in Russian).

During study of the ore-bearing (F-rare metal) granitic rocks in western Transbaikalia, 3 types of vacuoles were obsd. in quartz (Q) crystals: Q-feldspars, Q-feldspars-micas, and Q-muscovite. The Q-muscovite inclusions in the intratelluric phenocrysts of granite porphyries had Th $\sim 910^\circ$ and contained ~ 3 wt.% H_2O (at $P_{H_2O} < P_{total} < 3.2$ kbars). Enplacement of the granitic massif occurred under hypabyssal conditions, with lowering of P_{total}, partial loss of volatiles, and rapid crystn. of part of the magma. (Chem. Abstracts 91: 77080n, 1979)

SVERJENSKY, D. A. and WASSERMAN, M. D., 1978, Hydrothermal alteration around a Mississippi Valley-type deposit in the Virburnum Trend, southeast Missouri (abst.): Econ. Geol., v. 73, p. 1398.

Alteration of the oxygen and carbon isotopic composition of carbonate host rock has been found for as much as a mile around Mississippi Valley-type deposits and is a guide to the pathways of the hydrothermal solutions that formed the deposits. (E.R.)

SYCHEV, V.V. and SPIRIDONOV, G.A., 1978, Determination of thermodynamic functions of gases and liquids from the experimental P-V-T data by means of electronic computer mathematical modelling: Akad. Nauk SSSR Doklady, v. 241 no. 4, pp. 808-811 (in Russian). Authors at the Moscow Energetic Inst.

TAKAHASHI, Eiichi, 1978, Partitioning of Ni^{2+}, Co^{2+}, Fe^{2+}, Mn^{2+} and Mg^{2+} between olivine and silicate melts: compositional dependence of partition coefficient: Geoch. Cosmo. Acta, v. 42, p. 1829-1844.

TAKENOUCHI, S., 1978, Fluid inclusion study of siliceous network orebodies beneath bedded Kuroko deposits, Akita, Japan (abst.), in International Assoc. Genesis Ore Deposits, 5th Symp., Snowbird, Alta, Utah, 1978, Program and Abstracts: (Alta, Utah), p. 189.

Recent intensive exploration of the Kuroko deposits in the Hokuroku area, Akita Prefecture, Japan, revealed many pipe-shaped siliceous network orebodies in hydrothermally altered rhyolite domes beneath the bedded Kuroko depostis. From the geological settings, it is considered that these stockwork orebodies would have been channels of the ore-forming fluids which formed the above-situated bedded orebodies. In the Uchinotai orebodies of the Kosaka mine, the above-situated bedded Black Ore (Kuroko) orebodies are larger in scale compared to the pipe-shaped network orebodies which are composed of siliceous pyrite-chalcopyrite ore (Siliceous Yellow Ore). On the other hand, in the Uwamuki orebodies the bedded Black Ore orebodies are smaller compared to the network orebodies which consist of siliceous pyrite-chalcopyrite ore and siliceous sphalerite-rich ore. In the Matsumine mine, the bedded orebodies are composed of three layers. The upper and middle layer consists of Black Ore and of Black and Yellow Ores, respectively. The lower one consists of Yellow-Pyrite ores. Beneath these bedded orebodies, siliceous pyrite-chalcopyrite network orebodies are found in autobrecciated rhyolite domes.

Quartz samples were collected from the levels which cut the network orebodies at a few tens of meters below the supposed bottom of the bedded orebodies. Fluid inclusions found in quartz samples are exclusively two-phase liquid inclusions and no gaseous or highly saline inclusions are recognized. The salinities of primary and secondary inclusions measured by the freezing-stage method gather in a range between 2 to 4 weight percent NaCl equivalent concentration, showing that the salinities of ore-forming fluids were similar to those of sea waters. Recognizable change of salinity was not observed within the orebodies. Primary inclusions in quartz from the stockworks of the Matsumine orebody generally contain small aggregates of flaky minerals (probably sericite). The range of filling temperatures of fluid inclusions was 290 -330 C for primary inclusions and 250 -310 C for secondary inclusions. In the Uwamuki No. 4 orebody, the filling temperatures of primary inclusions in the stockwork orebodies are apparently higher than those in the above-situated bedded orebodies, and fluid inclusions in sphalerite generally show slightly lower filling temperatures than those in quartz associated with the sphalerite.

Assuming the temperature as 300 C and the salinity as 3 wt. percent, the pressure of fluids at the formation of the stockwork orebodies is estimated to be greater than 85 bars, because the occurrence of fluid inclusions shows no evidence of the boiling of fluids. (Author's abstract)

TAKENOUCHI, S., 1978, High salinity fluid inclusions in breccias of intrusive breccia dikes in the Hokuroku Kuroko area, Japan (abst.), in International Assoc. Genesis Ore Deposits, 5th Symp., Snowbird, Alta, Utah, 1978, Program and Abstracts: (Alta, Utah),p. 188.

Intrusive breccia dikes are occasionally found in the vicinity of Kuroko deposits of the Hokuroko area, Akita, Japan, suggesting an intimate relation to the Kuroko mineralization and related acidic magmatic activities. It is considered that these breccia dikes would have been formed by a rapid generation of vapor from crystallizing magmas. Fluid inclusions in such breccia dikes were studied at the Uwamuki No. 4 Orebody of the Kosaka mine, and Tsunokakezawa Orebody of the Fukasawa mine. As these breccia dikes intersect the orebodies, the intrusion is apparently postore. The dikes consist mainly of subangular fragments of rhyolite, dacite, quartz diorite, and basement rocks of pre-Tertiary age, and argillized tuff-like matrices. In some cases, they contain fragments of siliceous ore. The breccia dikes of Uwamuki No. 4 Orebody carry fragments of quartz diorite which is not observed in the area even in drilling cores, and those of the Tsunokakezawa Orebody accompany fragments of quartz porphyry as well as of quartz diorite. From the textures and constituent minerals, the fragments of quartz diorite would be one of the Tertiary granitic rocks brought up from deeper places.

In quartz grains of these fragments, many polyphase inclusions are observed with liquid and gaseous inclusions. In the case of the Kosaka mine, polyphase inclusions carry a cubic halite crystal and rarely a sylvite crystal. The salinity of inclusion was estimated as 33-60 wt.% from the temperature data. Gaseous inclusions occur in some parts but they are not necessarily associated with polyphase inclusions. Liquid inclusions having irregular shapes are the most abundant among these inclusions. In quartz fragments of the matrices, the similar occurrence of inclusions is observed. These quartz fragments would have been separated from quartz diorite by demolition during their ascent. In the case of the Fukasawa mine, polyphase inclusions are observed both in quartz diorite and quartz porphyry. Those in quartz diorite commonly accompany sylvite besides halite, while those in quartz porphyry rarely contain sylvite. The estimated concentration of chlorides from the temperature data is 18-28%KCl and 29-42%NaCl for quartz diorite, and about 16%KCl and 30-41%NaCl for quartz porphyry. Gaseous inclusions are common and associated with polyphase inclusions suggesting "boiling".

These occurrences of high salinity fluid inclusions in breccias of quartz diorite and quartz porphyry in breccia dikes suggest striking activities of saline hydrothermal fluids in deeper places of the area and a possibility of approaching to the origin of the ore-forming fluids which formed the Kuroko deposits. (Author's abstract)

TALANTSEV, A.S., 1978, Equation of isochores of solutions from gas-liquid inclusions, homogenizing in liquid phase: Akad. Nauk SSSR Doklady, v. 240, no. 1, p. 185-188 (in Russian). Author at Inst. Geol. and Geochemistry of the Ural Sci. Center of the Acad. Sci. USSR, Sverdlovsk. (See translations).

TALANTSEV, A.S., SAZONOV, V.N., and ILYASOVA, L.K., 1978, Evolution of PT conditions of formation of the wall-rock metasomatites in ore deposits of the berezite-listvenite formation: Geol. Rudn. Mest., v. 20, no. 1, p. 64-72 (in Russian). Authors at the Inst. Geol. Geochem. of the Urals Sci. Center of Acad. Sci. USSR, Sverdlovsk.

The paper bears PT data obtained by dolomite-calcite geothermometer and some fluid inclusion reference data. (A.K.)

TAUSON, L.S., and KUZ'MINA, T.M., 1977, Characteristics of the composition of aqueous extracts from quartz of pegmatite veins with a different mineralization: Geokhim. Metody Poiskov, Metody Anal, L.V. Tausin, ed: Irkutsk, USSR, Akad. Nauk SSSR, Sib. Otd., Inst. Geokhim. im. A.P. Vinogradova, p. 67-71 (in Russian)

The compn. of mineral-forming solns. during pegmatite formation in East Siberia is assessed from the geothermometry and geochem. of fluid inclusions, as well as from the compn. of the solns. extd. from quartz. Muscovite pegmatites formed from solns. having K^+ and HCO_3^- as the main cation and anion, resp. Rare-metal pegmatites originated from solns. in which Na^+ was the prevalent cation and HCO_3^- or Cl^- the dominant anion. (Chem. Abstracts 90: 41484n)

TAUSON, V.L., TCHERNYSHEV, L.V., 1977, Phase relations in the ZnS-MnS-CdS 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, Siberian Branch, v. 3, p. 89 (in Russian; abstract courtesy Dr. A.P. Berzina).

Wurtzite can be formed in nature as a stable phase in the ZnS-MnS-CdS system, but in this case the total content of MnS and CdS should be more than 20 mol%.

The admixture of Cd and/or Mn in crystalline ZnS is not the cause of polytype formation which are different from 3C and 2H (sic.) and the polytypes do not possess their own stability fields in the range of sphalerite-wurtzite transformation. The polytypes can be connected with metastable growth at relatively low temperatures and their formation is likely to be random character.

TAYLOR, B. E. and LIOU, J. G., 1978, The low-temperature stability of andradite in C-O-H fluids: Amer. Min., v. 63, p. 378-393.

The low-temperature stability of andradite was experimentally investigated as a function of temperature, X_{CO2} and f_{O2}, at constant P_{fluid} of 2000 bars. Relative to the stability field of grossular in C-O-H fluids, andradite is stable with fluids richer in CO_2 at a given temperature and pressure for all values of f_{O2}, although the temperatures of reactions which delineate the stability field of andradite are sensitive to slight changes in either X_{CO2}, f_{O2}, or both. Like grossular, andradite is stable to lower temperatures with H_2O-rich fluids. Addition of Fe^{3+} to grossular extends the thermal stability limits of grandite plus quartz to both higher and lower temperatures. In natural systems, simple retrograde carbonation of grandite may not occur if the fluid is sufficiently H_2O-rich to stabilize epidote. (From the authors' abstract).

TAYLOR, H.P., and FORESTER, R.W., 1978, Oxygen and hydrogen isotope evidence for the origin, development, and circulation pattern of the meteoric-hydrothermal convective system associated with the 50-M.Y. old Skaergaard basaltic magma chamger, east Greenland (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 10, no. 7, p. 503.

TCHERNYSHEV, L.V., 1977, On investigation of equilibria of minerals of variable composition with aqueous salt 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. 3, p. 92 (in Russian).

THEODORE, T.G., BATCHELDER, J.N., BLAKE, D.W., and KRETSCHMER, E.L., 1978, Molybdenum mineralization in the Battle Mountain mining district of Lander County, Nevada (abst.): Geological Research 1978, U.S. Geol. Survey Prof. Paper 1100, p. 8.

Numerous base and precious metal deposits in the Battle Mountain mining district are related to Upper Cretaceous and middle Tertiary granodiorites to quartz monzonites emplaced into thick sequences of Paleozoic sedimentary rocks. Molybdenum mineralization occurs sporadically throughout the district, but is especially concentrated in an elongate stockwork system near Copper Basin. Many of the molybdenite-stockwork veins and their selvages reflect locally intense potassic alteration, and the veins typically contain potassium feldspar-biotite-calcite-molybdenite, and quartz-molybdenite-calcite±potassium feldspar±white mica assemblages. The molybdenite-bearing veins contain abundant liquid plus vapor fluid inclusions. Preliminary fluid-inclusion studies of these veins suggest the bulk of the molybdenite mineralization occurred during circulation of nonboiling to slightly boiling, moderately saline fluids that range mostly between 8 and 12 weight percent NaCl equivalent. Temperatures were approximately 300° to 400°C. The values of $\delta^{18}O$ of the water calculated to be in equilibrium with hydrothermal quartz from molybdenite-bearing veins are +5.7 to +6.2, an unusually restricted range suggesting significant isotopic exchange with the wallrocks. Last, the molybdenite-stockwork system has been intruded extensively by a series of late north-south-striking, westward-dipping quartz latite porphyry dikes associated with minor lead and zinc mineralization. (From the authors' abstract)

THEODORE, T.G. and BLAKE, D.W., 1978, Geology and geochemistry of the West ore body and associated skarns in the Copper Canyon porphyry copper deposits, Lander County, Nevada, U.S. Geol. Sur. Prof. Paper 798c, 85 pp.

The Copper Canyon porphyry copper deposits in north-central Nevada include a small, 4-million-ton, copper-gold-silver skarn ore body, herein called the west ore body, that developed in favorable beds of calcareous argillite.

Fluid-inclusion studies suggest that early crystallization of andradite occurred at temperatures of about 500° ± 50°C from highly saline fluids. Temperatures were probably about 320° ± 40°C during crystallization of most of the pyrrhotite-chalcopyrite ores in the skarn, and the fluids by then were much more saline, possibly about 35-45 weight percent NaCl equivalent. Most important, fluid-inclusion relations suggest that the andradite-bearing assemblages of the skarn crystallized under lithostatic conditions (possibly about 380 bars), whereas most other assemblages may have formed under hydrostatic conditions (150 bars) with the fluid boiling. Indeed, there is some evidence in the granodiorite for a very late, low-density, high-temperature fluid that may reflect some additional opening of channels to the surface after they were sealed by silica. Sometime during the final hypogene stages of the skarn, less saline fluids at 160°-220°C circulated through the ore body concomitant with emplacement of minor chlorite-iron oxide-carbonate veinlets. (From the authors' abstract)

THEODORE, T. G. and DE WIT, M. P., 1978, Porphyry-type metallization and alteration at La Florida de Nacozari, Sonora, Mexico: Jour. Research U.S. Geol. Survey, v. 6, p. 59-72.

Pervasive secondary biotite-rich mineral assemblages, characteristic of potassic alteration found in the cores of most commercial porphyry copper systems, are associated spatially with a conspicuous color and a geochemical anomaly at La Florida de Nacozari, Sonora. These composite biotite-magnetite assemblages, with or without actinolite, quartz, rutile, sphene, chalcopyrite, and pyrite assemblages, are primarily the result of early dispersed biotitic (EDB) alteration of andesite. The bulk of the near-surface copper in the area, however, was introduced later by veins that cut the EDB-altered andesite. These later veins are distinguished by a quartz-calcite-chlorite±laumontite±chalcopyrite assemblage, and the chalcopyrite in these veins may reflect upward remobilization of deep EDB copper by fluids associated with the emplacement of nearby coarse-grained granite. Fluid-inclusion relations in the late veins suggest that their fluids were nonboiling and relatively dilute. (Authors' abstract).

THIEDE, D. S. and CAMERON, E. N., 1978, Concentration of heavy metals in the Elk Point evaporite sequence, Saskatchewan: Econ. Geol., v. 73, p. 405-415.

Core samples of all members of the Elk Point evaporite sequence, Saskatchewan Subbasin, from basal shale to potash-rich and halite-rich members, have been analyzed for copper, lead, and zinc. The highest concentrations of all three metals are in the basal Ashern shale, the overlying Winnipegosis dolomite, and anhydrite layers in the Prairie Evaporite. Copper and lead contents are related to the contents of water-insoluble materials in various members of the sequence, whereas zinc shows no such relation.

Total copper present in the evaporite sequence appears to be much less than would be supplied from sea water entering the basin, if the metal content of Devonian sea water were comparable to that of modern sea water. It is thus possible that copper was concentrated in residual brines. The contents of lead and zinc in the sequence, however, are such that concentration of the two metals in residual brines appears unlikely.

The results indicate that an evaporating basin provides an effective mechanism for concentrating the three metals and that the amounts of metals present in a major evaporite sequence may be very large. Such a sequence could be an important source both of metals and of chloride-rich brines capable of transporting the metals to evaporite-associated deposits such as cupriferous shales and Mississippi Valley-type deposits. Chloride-rich brines could have been generated at three stages in the history of the Saskatchewan Subbasin: during compaction of the sediments; during diagenesis, when large volumes of water would be released by conversion of gypsum to anhydrite; and during postdepositional circulation of ground waters. (Authors' abstract)

TIMOFEEVSKII, D.A., GREBENCHIKOV, A.M., ANDRIANOVA, S.I., 1978, Characteristics of the behavior of carbon dioxide in gold ore deposits of various ore formations, in Carbon and its compounds in endogene processes of mineral formation, G.N. Dolenko, ed.: Kiev, "Naukova Dumka" Pub. House, p. 114-117 (in Russian).

This is full paper corresponding to abstract given in COFFI v. 8, p. 184, 1975 (ER)

TOMILENKO, A.A. and DOLGOV, Yu. A., 1978, Conditions of formation of the "granulated" quartz from the Borus chain (Western Sayan): Akad. Nauk SSSR Doklady, v. 242, no. 5, p. 1173-1176 (in Russian). Authors at the Inst. Geol. Geoph. of Siberian Branch of Acad. Sci. USSR, Novosibirsk. Gas analyses (25) of inclusions in quartz show them to be CH_4-rich. From Th (L + G) (-149 to -87°C), the specific volume of the gas phase is estimated (2.46-4.32 cm^3/g) and hence Tt is estimated to be >400°C and Pt <8kb (ER).

TORSSANDER, P., 1978, Sulfur isotopes in Icelandic geothermal waters: An Interim report: Annual Rept. Ore Research Group, Stockholm Univ., D. T. Rickard, ed.: Stockholm, Geol. Inst., Stockholms Univ., P. 85-95 (in English).

Sulfur in Iceland's geothermal fluids seems to be magmatic with the exception of the Reykjanes peninsula and a few other areas close to the coast, where the sulfur is marine or partly marine magmatic. This is not only reflected in the sulfur isotope composition of the geothermal waters but also in the geothermal gases.

The hydrogen content and $\delta^{34}S$ for H_2S from a fumarole at Krafla in northern Iceland changed in connection with a volcanic eruption there, which is interpreted as (the result of) addition of volcanic gas to the geothermal system. (Author's abstract)

TROLL, G., FARZANCH, A. and CAMMANN, K., 1977, Rapid determination of fluoride in mineral and rock samples using an ion-selective electrode: Chemical Geology, v. 20, p. 295-324.

TUFAR, W., 1978a, Ore mineralisations from the Eastern Alps, Austria, as stratabound-syngenetic formations of Pre-Alpine Age, (abst.), in International Assoc. Genesis Ore Deposits, 5th Symp., Snowbird, Alta, Utah, 1978, Program and Abstracts: (Alta, Utah), p. 192.

Multiphase fluid inclusions show homogenisation temperatures of around 230° C and can be correlated with inclusion data from East Alpine sparmagnesites. (From the author's abstract)

TUFAR, W., 1978b, Fluid inclusions in barites in the Graz Paleozoic (Styria) and in magnesites of Radenthein, Carinthia: Graz, Landesmus. Joanneum, Abt. Mineral., Mitteilungsbl., 1978, 1ss:46, p. 27-37.

See previous item. (E.R.)

TURNER, J. S. and GUSTAFSON, L. B., 1978, The flow of hot saline solutions from vents in the sea floor--Some implications for exhalative massive sulfide and other ore deposits: Econ. Geol., v. 73, p. 1082-1100.

A variety of fluid flow phenomena involving fluids with thermal and compositional variations are reviewed, first as they are observed in simple laboratory experiments and then as they may apply to the formation of sulfide deposits resulting from exhalation of hot saline solutions from vents in the sea floor. Of particular interest is the case where the effluent is both very salty and hot, so that the two properties have opposing effects on the density difference between the exhaled fluid and its surroundings. This can lead to a very nonlinear density behavior during mixing, which makes it possible for initially light fluid to become heavier than sea water and for an oscillating flow to develop. Even more important are the "double-diffusive" effects which can occur because of the different molecular diffusion rates of the two properties. An outflow can separate into two parts, a hot, less concentrated plume which rises and a warm con-concentrated flow which spreads as a bottom current away from the source, maintaining a sharp boundary with the overlying sea water as it does so. If the hot salty fluid is injected into a density gradient, a situation which is typical of the ocean, a stratified lateral transport of the lighter fraction can result. For the heavier fraction, the effect of the combined processes is to maintain a stable boundary between the sea water and an exhaled hydrothermal ore solution, which might thus flow with minimal mixing along the sea floor over large distances to a distant depression before dumping its contained metals. A continuing inflow of dense fluid into such a depression produces a stable stratification, so that in a steady state the outflow spilling over the edge of the depression would be at a lower temperature and salinity and higher or lower f_{O_2}. This condition provides a mechanism for localizing precipitation of sulfides within a small restricted depression from very large volumes of ore solution. Evidence of density stratification in the Bushveld Complex suggests the importance of related phenomena in the formation of layered igneous complexes. Analogous behavior in porous media is also indicated. (Authors' abstract)

UCHAMEYSHVILI, N.Ye. and KHITAROV, N.I., 1978, Composition of fluid inclusions in quartz and sanidine from Eldzhurtin granite, related to its origin, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 87-88 (in Russian). Authors at GEOKHI of Acad. Sci. of the USSR, Moscow.

Eldzhurtin granite bears melt inclusions proving its magmatic origin, and water inclusions, with Th as follows: a) two-phase? gaseous 420-280°C in G, b) brine inclusions 750-330°C in L, c) G/L inclusions 350-130°C in L. By water leachates, inclusions in quartz and sanidine bear Cl, Na, K, plus SiO_2 and Al_2O_3 as brines with total solids up to 80-95%. K/Na ratio is 0.7 for concentrated solutions and it decreases down to 0.2 in G/L inclusions. Salt melt (brine) separated from granite melt at 750-730°C. (Authors' abst., translated by A.K.)

UDODOV, Yu. N., SILKOV, A.A., 1977, A unified apparatus for electrochemical investigations of solution properties at elevated temperatures and pressures (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. 3, p. 37-38 (in Russian).

UDODOV, Yu.N., SILKOV, A.A., OTROSHOK, V.V., 1977, The experimental study of electroconductivity of aqueous sodium perchlorate solutions at temperatures up to 200 C and pressures up to 1000 atm, (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. 3, p. 35-36 (in Russian).

URABE, Tetsuro, 1978, Quartz simultaneously precipitated with Kuroko ores in the Uwamuki No. 4 deposit, Kosaka mine: Mining Geology (Japan), v. 28, p. 337-348 (in English).

Quartz is the only silica mineral in black, yellow and siliceous ores of the Uwamuki No. 4 (Kuroko) deposit, Kosaka mine. Intimate textural relationship between quartz and sulfide minerals in Kuroko ores suggests that these minerals were precipitated simultaneously. Filling temperatures, T, of fluid inclusions in quartz from the siliceous ore (Marutani, 1977) can be fitted by:

$$T(^{\circ}C) = 289.7 + 0.2159y$$

where y is the vertical distance in meters from estimated sea bottom at the time of siliceous ore mineralization. The steep thermal gradient within siliceous orebody may be a consequence of mixing between ascending hydrothermal solution and downward-circulating cool sea water. Net contamination of sea water is computed to be less than 25%.

Contents of quartz and barite in six black ores are measured. The ratios quartz/sulfides and barite/sulfides show excellent parallel relation. Mixing of cool and oxygenated sea water with discharged hydrothermal solution causes both decrease in temperature and introduction of sulfate ion. Consequently, quartz and barite precipitate simultaneously with sulfide minerals in black ore. Common occurrence of bipyramidal quartz in black ore indicates that the quartz grew up in open space. Besides, the grain size of quartz increases towards the margin of the black orebody. It is ascribed to gradational slow cooling of the discharged hydrothermal solution on sea floor. (Author's abstract).

URABE, Tetsuro and SATO, Takeo, 1978, Kuroko deposits of the Kosaka mine, Northeast Honshu, Japan--Products of submarine hot springs on Miocene sea floor: Econ. Geol., v. 73, p. 161-169.

A magmatic origin of the ore-forming fluid is proposed on the basis of fluid inclusion data and geologic evidence. (From the authors' abstract).

URUSOVA, M. A., 1977, P-V-T-X relationship in the NaCl -H_2O system at elevated temperatures and pressures (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. 3, p. 59 (in Russian).

UTADA, Minoru, SHIMODA, Tetsuo and ITOH, Tadashi, 1978, Hydrothermal alterations appearing in the Neogene sediments of Higashi-Aizu mineralization area, northeast Japan: Mining Geology, v. 28, p. 83-97 (in Japanese with English abstract). First author at Geol. Inst., Univ. Tokyo, Hungo, Bunkyo-Ku, Tokyo, Japan.

Though "Kuroko-type" ore deposits in this are area embedded in various stratigraphic horizons ranging from middle to upper Miocene, characteristic authigenic minerals are distributed zonally around them. They are grouped into several zones by a definite assemblage of silicates. A typical arrangement of the zones is as follows: from the nearest to the ore body to the margin: K-feldspar zone→chlorite-sericite zone→mixed layer mineral zone→montmorillonite zone→analcime zone→mordenite zone→clinoptilolite-mordenite zone.

The shapes of alteration zones are usually mushroom shaped, suggesting horizontal extension of hydrothermal solutions to porous sediments. Chemically, potassium and magnesium are concentrated in the K-feldspar zone and the chlorite-sericite zone in the central part, while the zeolite zones at the margin are characterized by concentration of sodium and calcium. Thus, the zoning suggests chemical redistributions by hydrothermal solutions which may have moved within each semi-closed space around the ore deposits. The temperatures of hydrothermal solution at the center of alteration zones are estimated at 200°-250°C from fluid inclusion data of ore minerals, while those at the margin are 40°-80°C from data on diagenetic clinoptilolite and mordenite. The horizontal thermal gradients around two ore deposits are tentatively estimated as 4.0-5.2 and 3.0-5.2°C/100 m. (Modified by E.R. from the authors' abstract).

VACHER, A., 1977, Study of tubular cavities in aquamarine: Rev. de gemmologie, no. 50, p. 4-6 (in French).

A brief review, describing methods of formation of tubular inclusions and illustrates CO_2-H_2O inclusions. (E.R.)

VACHER, A., 1978, La Vie des Inclusions: Le Monde et des Minéraux, no. 21, Jan.-Feb. 1978, p. 624-625 (in French).

A brief review. (ER)

VAKHRUSHEV, V.A., MAKAGON, V.M. and SINITSKAYA, Ye. G., 1978, Conditions of formation of amethyst in the magnetite deposits of the Angara-Katskiy iron-ore region (Siberian Platform): Akad. Nauk SSSR Doklady, v. 239, no. 3, p. 680-683 (in Russian). Authors at the Geochem. Inst. of Siberian Branch of Acad. Sci. USSR, Irkutsk.

In the Fe deposits Katskoe, Kapaerskoe, Chapkinskoe, and Neryundinskoe and others, amethysts occur in quartz-calcite veins. Amethyst crystals reach 30 cm in length. They bear P inclusions of acicular pyrite, solid bitumens of globular or reniform habit and two-phase G/L inclusions with very stable Th for all studied deposits 330-390°C. Inner colorless quartz core of amethyst crystals bears P G/L inclusions with Th 410-420°C. (Abst. by A.K.)

VAKHRUSHEV, V. A., MAKAGON, V. M., SINITSKAYA, E. K. and TATARINOV, A. A., 1977, Amethyst mineralization in iron deposits of the Siberian platform. Geokhom. Endog. Protsessov 1977, 149-152 (in Russian). Edited by L. V. Tauson, Akad. Kauk SSSR, Sib. Otd., Inst. Geokhim. im. A. P. Vinogradova: Irkutsk, USSR.

The amethyst mineralization is in skarn-magnetite deposits on the Siberian platform. Crystals of amethyst contain solid inclusions of syngenetic pyrite and bitumens. Thermometric data show that the amethyst crystals formed from hydrothermal high-temp. (310-400°) solns. (Chem. Abstracts 91: 160449k)

VALARELLI, J.V., COUTINHO, J.M.V., and BELLO, R.M.S., 1978, Metamorphism at Buritirama, Pará: Anais XXX Congresso Brasileiro de Geologia, v. 3, p. 1357-1363 (in Portuguese with English and Portuguese abstracts).

The manganese protore from Serra de Buritirama, Brazil, is a suite of impure Mn-bearing siliceous carbonatic rocks, surrounded by impure siliceous marbles, pelitic schists, and quartzites. Study of quartz from protore and country rock showed fluid inclusions of several generations with different CO_2 content and high salinity. CO_2 critical density of 0.87 g/cm^3 in primary inclusions at an inferred temperature of 550°C indicated a pressure of 3 kb at the peak of metamorphism in the Buritirama area. (Authors' abstract, shortened by K. Fuzikawa)

VALLEY, J.W., and O'NEIL, J.R., 1978, C+O isotopes in Grenville marble, N.Y.: petrologic implications (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 10, no. 7, p. 508.

VALYASHKO, V.M. and KRAVCHUK, K.G., 1978, P-T-X parameters of critical phenomena in solutions of the system SiO_2-Na_2O-H_2O: Akad. Nauk SSSR Doklady v. 242, no. 5, p. 1104-1107 (in Russian) Authors at the Inst. General and Inorganic Chemistry of Acad. Sci. of the USSR, Moscow.

van der RIJST, Henk, SCHUILING, R.D., and JANSEN, J.B.H., 1978, Isograds in siliceous dolomites, Naxos, Greece (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 10, no. 7, p. 508.

Progressive metamorphism around a migmatite dome on Naxos, Greece has resulted in a metamorphic gradient from 350-700°C at a total pressure of 5-7 kb. Earlier isograd mapping rocks of pelitic and bauxitic compositions which alternate with the marbles, makes it possible to interpolate the temperature for each assemblage found in the siliceous dolomites. Isograds used for this interpolation are the + corundum, + biotite, - chloritoid, + sillimanite and + melt. Talc, tremolite and diopside successively appear in the dolomites with increasing grade of metamorphism; forsterite has not been found on Naxos. The mineral assemblages found represent the isobarically univariant reaction curves 4,8,16,17 and 19 (numbers after Skippen, 1974) and invariant points I and II. In most cases the fluid composition has been buffered by the reactions resulting in an increase of Xco_2 with metamorphic grade. The isograds mapped in the siliceous dolomites are the + tremolite and + diopside represented in the T-Xco_2 diagram by invariant points I and II. The approximate temperature of both isograds is respectively 560 and 640°C. It is possible, however, that assemblages characteristic of the isograds form at the CO_2-rich as well as at the H_2O-rich side of the T-Xco_2 diagram. A complementary fluid inclusion study showed that these assemblages were formed at the CO_2-side. The activity of OH-tremolite will be reduced by the presence of fluorine in tremolite. For the Naxos tremolites the molar F/F+OH+Cl ratio is ranging from 0.05 - 0.45, which could result in a maximum shift of 25°C. The + diopside isograd is at a higher position than the + sillimanite isograd, contrary to findings in the Central Alps. The difference may be caused by a lower total pressure for the metamorphism on Naxos. (Authors' abstract)

VARYASH, L. N. and REKHARSKY, V. I., 1977, Experimental study of processes of hydrolysis and complex formation of univalent copper in chloride solutions at elevated temperatures (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. 3, p. 43 (in Russian; abstract courtesy Dr. A. P. Berzina).

The univalent state of copper in hydrothermal solutions and the important role of complex formation during its migration are shown. New data on conditions of formation of univalent copper complexes, depending on pH and at variable Cl^- ion concentrations (1.10^{-4} - 1 mol/kgH_2O) in solutions are presented.

VASILEVSKII, M. M., et al, 1977, Metallogenesis of the upper structural stage of Kamchatka and problems of the ore specialization of the stage of tectonic-magmatic development of folded regions, Chapt. 2, pp. 14-59, in Prognosis of estimation of the ore-bearing capacity of volcanogenic formations, V. V. Makshimova, ed.: Moscow, "Nedra" Press (in Russian).

Melt inclusions in volcanics are discussed extensively, particularly ones with a large vapor phase, in plagioclase (Fig. 10), some with large and varied ions (Fig. 12). Inclusions in biotite are also shown (Fig. 14). (E. R.)

VDOVYKIN, G.P. and ZADOROZHNYI, I.K., 1978, Inert gases in high-carbon meteorites: Akad. Nauk SSSR Doklady, v. 241, no. 2, pp. 467-470 (in Russian). First author at the Sci.-Research. Inst. of Natural Gases, Moscow.

VERES, G.I. and TRANKVILLITSKAYA, I.A., 1978, Some practical possibilities for the chromatographic analysis of the volatile components of gas-liquid ultramicroscopic inclusions in minerals: Teor. Prakt. Termobarogeokhim. (Dokl. Vses, Soveshch.) 5th 1976, N.P. Ermakov, Ed.: Moscow, Izd. Nauka, p. 187-190 (in Russian).

Decrep. anal. of 2 samples of the same vein quartz (Q) indicates that grinding to 100 mesh size causes decrep. activity over a wide temp. range, and the decrep. (ΔP vs. temp.) of the finely ground sample differs in configuration from that for samples with 0.25 mm grain size. This is explained by the bursting of almost all fluid inclusions in the finely ground samples. The thermobarog. effect of finely ground Q samples is detd. by the decrep. of ultramicroscopic inclusions (UI) contg. H_2, CO_2, CO, CH_4, and H_2S. In Q crystals, massive destruction of the UI occurs at $\geqslant$300°. Using a U-shaped glass tube for extn. and concn. of gases from the UI, chromatog. data were obtained from construction of calibration curves for the schist-chalcopyrite system. Phase chromatog. anal. based on the H_2 in UI can be used to characterize the primary haloes of some ore deposits. (Chem. Abstracts 91: 60362h)

VERES, G.I. and TRANKVILLITSKAYA, I.A., 1978, Decrepitation activity of geochemical samples and its importance for determination of infiltration-diffusion haloes, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. II, Thermobarogeochemistry and ore genesis: Vladivostok, Acad. Sci. USSR, p. 22-23 (in Russian). Authors at VZPI, Moscow.

Samples from the polymetallic deposit Arkhon, very finely ground (as for spectrographical analysis) were studied by vacuum decrepitation of "ultramicroinclusions" (sic., A.K.). No differences were found either in the shape of the decrepigraph, water content or K and Na concentration (probably water-leachable) in the studied samples. The authors were not able to determine the G composition in the studied "ultramicroinclusions", except for H_2O reportedly released by "decrepitation" and dehydration of minerals. (Abst. by A.K.)

VERWOERD, W. J., 1978, Liquid immiscibility and the carbonatite-ijolite relationship: Preliminary data on the join $NaFe^{3+}Si_2O_6$-$CaCO_3$ and related compositions: Carn. Inst. of Wash. Yearbook 1977-8 (pub. 1978), p. 767-774.

Immiscibility between carbonate and silicate liquids was obtained above 800°C, and applied to the natrocarbonatite lava of Mt. Oldoinyo Lengai, and mixed carbonate-silicate rocks in alkaline complexes. (ER)

VIL'DENBERG, Ye. V., VYSOTSKIY, I.V., VOYTOV, G.I. and MUROGOVA, R.N., 1978, Gases in salts from Fore-Caspian depression and adjacent regions: Akad. Nauk SSSR Doklady, v. 239, no. 6, p. 1430-1433 (in Russian). Authors at the Moscow State Univ.

Gases were analyzed in 308 specimens of Permian salts, collected in the Buzuluk depression (Markovskaya, Elkhovskaya and Zlobinskaya areas) and in the Fore-Caspian depression (Linenskaya area). Gases were released by salt dissolution. The results are listed in the Table.

Table 1. Chemical composition of gases in salts.

Area	No. of Samples	Depth, m	Total gas content, cm^3/kg	N_2	CO_2	H_2	Hydrocarbons							
							Total	CH_4	C_2H_6	C_3H_8	Iso-C_4H_{10}	n-C_4H_{10}	Iso-C_5H_{12}	n-C_5H_{12}
Zlobinskaya	32	425-620	72.1	$\frac{67.6}{93.8}$	$\frac{4.3}{5.9}$	$\frac{0.17}{0.23}$	$\frac{0.03}{0.04}$	$\frac{0.02}{53.4}$	$\frac{0.004}{10.7}$	$\frac{0.005}{13.3}$	$\frac{0.0019}{5.0}$	$\frac{0.002}{5.3}$	$\frac{0.0005}{1.3}$	$\frac{0.0041}{11.0}$
Elkhovskaya	93	585-740	56.4	$\frac{40.9}{87.0}$	$\frac{7.7}{12.4}$	$\frac{0.3}{0.5}$	$\frac{0.03}{0.1}$	$\frac{0.054}{67.0}$	$\frac{0.009}{11.0}$	$\frac{0.01}{12.0}$	$\frac{0.0022}{2.0}$	$\frac{0.0038}{4.0}$	$\frac{0.0006}{1.0}$	$\frac{0.003}{3.0}$
Markovskaya	164	640-864	41.2	$\frac{39.4}{45.5}$	$\frac{1.6}{3.9}$	$\frac{0.2}{0.5}$	$\frac{0.03}{0.1}$	$\frac{0.02}{59.0}$	$\frac{0.003}{8.0}$	$\frac{0.003}{8.8}$	$\frac{0.0023}{6.7}$	$\frac{0.0017}{5.0}$	$\frac{0.0027}{7.9}$	$\frac{0.0013}{3.8}$
Linevskaya	19	1865-3474	66.3	$\frac{56.0}{84.5}$	$\frac{9.8}{14.0}$	$\frac{0.24}{0.4}$	$\frac{0.21}{0.3}$	$\frac{0.09}{32.2}$	$\frac{0.036}{13.0}$	$\frac{0.03}{11.0}$	$\frac{0.0319}{11.4}$	$\frac{0.0554}{20.0}$	$\frac{0.0139}{5.0}$	$\frac{0.0204}{7.4}$

VILOR, N.V., GANTIMUROVA, T.P., KONOVALOV, I.V., SHKARUPA, T.A., and SHKANDRIY, B.O., 1977, Composition of gas in quartz veins in the northern part of the Baikal-Patom highlands: Akad. Nauk SSSR, Doklady, v. 232, no. 5, p. 1175-1178 (in Russian; translated in Doklady Akad. Nauk SSSR, Earth Sci. Sects., v. 232, p. 210-212, 1978.)

Gases from quartz veins in various metamorphic and igneous terrains were analyzed. Data are presented only as plots of (H_2O,CO_2) vs. (H_2,CH_4) vs. CO, log CO_2 vs. log CO, and log CO_2 vs. log H_2O. (ER) (See also same item in Fluid Inclusion Research -- Proc. COFFI, v. 10, p. 290, 1977). (ER)

VOLKOV, V.M., 1976, Composition of ore-forming solutions and the temperature of ore formation in the Lyabavinsk gold ore deposit, according to data from inclusions in minerals: Izv. Tomsk. Politekh. Inst., v. 289, p. 16-23 (in Russian).

Apparently same material as in Volkov, 1976, Fluid Inclusion Research -- Proc. of COFFI, v. 10, p. 291, 1977. (E.R.)

VOROB'EV, E. L., 1978, Exploration for potassium salts on the Siberian Platform according to the fluid inclusions in hydrothermal minerals: Teor. Prakt. Termobarogeokhim., (Dokl. Vses. Soveshch.) 5th 1976, N. P. Ermakov, ed.: Moscow, Izd. Nauka, p. 206-209 (in Russian).

The inclusions of ore-forming fluids in calcite and apatite of Angara-Ilim type Fe ore deposits of the title region are multiphase (with brine, gas bubbles, and salt crystals) and have solns. with salt concns. >450 g/L. The anomalously high salt mineralization was caused by reaction with underlying Cambrian saline strata. Highly saline fluid inclusions in hydrothermal minerals indicate the presence of underlying salt deposits. (Chem. Abstracts 91: 60440g, 1979)

VORONTSOV, A.Ye., PUKHNAREVICH, M.M., AFONINA, G.G., MAKAGON, V.M., SMIRNOV, V.N. and ZAV'YANOVA, L.L., 1978, Hydrothermal feldspars from the Korshunovskoe iron ore deposit: Akad. Nauk SSSR Doklady, v. 241, no. 5, pp. 1171-1174 (in Russian). Author at Inst. Geochem. of Sib. Branch of Acad. Sci. USSR, Irkutsk.

Orthoclase and anorthite were found in metasomatites and ores in the central part of the deposit,in working pits about 200m below surface; the crystals (2-12cm) fill vugs and fractures together with epidote, calcite and amphibole. Anorthite does not contain orthoclase or albite component, but it is rich in inclusions of Ba silicates; orthoclase also does not contain anorthite component and it is rich in Ba. Anorthite and epidote bear three-phase (G+L+dms) and two-phase (G+L) inclusions. Th of inclusions in anorthite is 460-510°C, in epidote - 360-380°C, in early calcite - 195-200°C (they bear 10-15% of NaCl dm, homogenizing together with G bubble), in late calcite - 65-80°C. (Abst by A.K.)

VORTSEPNEV, V.V., 1978, Origin of the disseminated ores of the Talnakh deposit: Akad. Nauk SSSR Doklady, v. 239, no. 2, p. 454-426 (in Russian). Author at the Moscow State Univ.

Two hypotheses of origin of the Cu-Ni ores in the deposit Talnakh were proposed: magmatic immiscibility and metasomatic. Ore-bearing olivine commonly contains in melt inclusions ore minerals: sulfides, rarer magnetite, and silicate glass. Sulfide phase consists of pyrrhotite, chalcopyrite and pentlandite. Ore minerals in inclusions are very similar to those in ores, thus ores formed in magmatic conditions. (Abst. by A.K.)

VORTSEPNEV, V.V., 1978, Conditions of formation of the Talnakh ore-bearing intrusive as indicated by fluid inclusion studies: Geol. Rudn. Mest., v. 20, no. 2, p. 64-70 (in Russian). Author at the Moscow State Univ.

The intrusive consists of gabbros and gabbro-dolerites. Clinopyroxene bears melt inclusion 5-70 µm long, filled by G (10-15%) and silicate dms with refractive indices very close to that of clinopyroxene. Sometimes inclusions also bear an ore mineral (1-10%). Solids melt in inclusions at 970-1090°C, Th 1120-1140°C. Inclusions in plagioclase (20-50 µm long) are filled by glass and more rarely by ore minerals; Th 1120-1170°C. Inclusions in olivine did not yield Th values due to the host mineral oxidation at 900-1000°C. Ore dms are pyrrhotite, chalcopyrite, pentlandite and magnetite (by microprobe analyses). So-called gas inclusions in olivine were opened by polishing and it was found that they consist of ore and silicate phases. Quartz bears melt (glass) inclusions with 5-10% of gas. Inclusion size varies from 5 to 40 µm. Th values range from 1060 to 1070°C. (Abst. by A.K.)

VOVK, I. F., 1978, Nature of hydrogen in potassium salt deposits: Geokhimiya, 1978, No. 1, p. 122-127 (in Russian). Author at Inst. Geol. Sci. of Acad. Sci. of Ukrainian SSR, Kiev.

Pertinent to any study of the gas composition of fluid inclusions in salts. (A.K.)

VOZNYAK, D.K., PAVLISHIN, V.I., SHELUKHIN, V.I., 1978, Hydrocarbons in quartz from vein formations of the Donets Basin, in Carbon and its compounds in endogene processes of mineral formation, G.N. Dolenko, ed.: Kiev, "Naukova Dumka" Pub. House, p. 127-134 (in Russian).

This is full paper corresponding to abstract given in COFFI v. 8, p. 190-191, 1975, (ER)

VYNAR, O.N. and REMESHILO, B.G., 1978a, Physico-chemical conditions of post-magmatic mineral-formation (as indicated by the example of the Kirovograd-Zhitomir complex of the Ukrainian shield): Mineral. Sborn. v. 32, No. 1, p. 30-37 (in Russian). Authors at Inst. Geol. and Geochem. of Mineral Fuels of Acad. Sci. of Ukrainian SSR, L'vov.

Granite massifs of the studied complex have zonal structure: the internal parts consist of porphyric or even-grained biotite granites, the external ones - aplitic or pegmatoid granites. The granites bear aplites and weakly differentiated pegmatites. Most inclusions in pegmatitic quartz are of S type; the exceptions are P inclusions "sticking" to accessory minerals trapped in quartz. Such P inclusions (60-70 vol. % of L phase) have Th 340-400°C. S inclusions yield Th 200-350°. Signs of boiling of solutions were found, as well as inclusions filled by LCO_2. P derived from coeval LH_2O and LCO_2 S inclusions is 660×10^5 Pa. Polyphase inclusions are rare, halite is the only soluble dm, the others are probably trapped minerals since they do not dissolve during inclusion heating (Th 320-350°C). The latest S inclusions have Th 150-200°C. Quartz veins bear quartz crystals with P inclusions (Th 180-200°C) and S ones (Th 150-260°C), sometimes of heterogeous origin (boiling). Solutions bear following ions: Na, K, Cl, SO_4, HCO_3 and F; Mg, Ca and CO_3 were found only in individual samples. Total salt content ranges from 20 to 123 mg/kg of sample. The pH value of water leachates was 8.0-9.8. By gas spectrometry (chromatography?), CO_2, CH_4, N_2 and occasionally Ar, C_2H_6 and C_3H_8 were found. CO_2 prevails in pegmatites (60-95%), N_2 - in granites (up to 55%); CH_4 occupies up to 30% in some pegmatites (in Zhitomir massif), C_2H_6 and C_3H_8 average 4.5% each, Ar up to 4% in Zhitomir and Korostyshev massifs. Vein quartz is rich in N_2, up to 61%. The values of $\delta^{13}C$ of CO_2 from fluid inclusions were as follows: -5.4%. (Korostyshev massif), -10.1%. (Uman massif) and -12.4%. (Antonov massif), suggesting deep-seated sources of the hydrothermal fluids ($\delta^{13}C$ for endogenic C is -7.0%.). (Abst. by A.K.)

VYNAR, O. N. and REMESHILO, B. G., 1978b, Fluid regime of post-magmatic mineral formation of Proterozoic intrusive complexes of the Ukrainian shield, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 135-136 (in Russian). Authors at Inst. Geol. Geochem. of Mineral Fuels of Acad. Sci. of Ukrainian SSR, L'vov.

Granites and pegmatites frequently are cut by quartz veins with ore (sulfide and aluminum-fluoride) mineralization. In water leachates always Na>K when post-magmatic bodies occur in granites and K>Na, when in hybrid rocks. Zhitomir granites yield SO_4-HCO_3 solutions, Kirovgrad and Osnitse granites - Cl-HCO_3 solutions, and Perzhanskiy complex - HCO_3-Cl solutions. Granites bear higher F concentrations than pegmatites. CO_2 prevails in acid rocks, whereas N_2 is low. Hybrid rocks are rich in CH_4 but granites are frequently methane-free. Minimum Th interval is 200-500°C, and boiling was observed. (From the authors' abst.)

WALTHER, J.V., 1978, Equilibrium and mass transfer among phases in metasomatic reaction zones adjoining quartz veins in dolomite at Campolungo, Switzerland (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 10, no. 7, p. 511.

Metasomatic reaction zones consisting primarily of calcite and fluorine bearing tremolite, phlogopite, and talc have formed along preexisting hydrothermal quartz veins in dolomite at Campolungo in the Swiss Alps. Observed mineral compositions and relative abundances together with fluid inclusion data define the pressure, temperature, and fluid composition responsible for the metasomatic process. Fluid inclusions occur primarily along annealed fractures in quartz crystals sub-perpendicular to the reaction front. Measured fluid compositions range between 0.10 to 0.25 mole fraction of an aqueous electrolyte solution and up to 0.15 mole fraction CH_4, with CO_2 as the remaining component. Reinterpretation of experimental data reported by Munoz and Lundington (1974, 1977) and Duffy (1977) for OH-F exchange in minerals using a random mixing approximation for OH^- and F^- in the crystal structure provides for fluorine substitution in talc, tremolite, and phlogopite in computed phase diagrams. Calculated equilibrium phase relations combined with textural analysis suggest that reaction between tremolite and the fluid phase is responsible for the localized occurrence of talc in the reaction zone. Constant pressure/temperature activity diagrams generated for the system CaO-MgO-SiO_2-H_2O-HCl-HF together with measured fluid inclusion and mineral compositions permit description and interpretation of variations in $a_{Ca^{++}}/a_{H^+}^2$, $a_{Mg^{++}}/a_{H^+}^2$, and $a_{SiO_2(aq)}$ in the fluid phase responsible for the observed mineral zonation. (Author's abstract)

WATMUFF, G., 1978, Geology and alteration-mineralization zoning in the central portion of the Yandera porphyry copper prospect, Papua New Guinea: Econ. Geol., v. 73, p. 829-856.

Copper mineralization at Yandera is associated with low-K tholeiite-calc-alkaline porphyry intrusives into the middle Miocene Bismark Intrusive Complex. Three episodes of porphyry emplacement are recognized, the youngest generating intrusive breccia pipes.

A broad area of secondary biotite alteration with peripheral epidote-chlorite is superimposed upon the igneous terrian, postdating all igneous events within it. Fracture-controlled calcic and phyllic/argillic alteration zones symmetrically disposed about an elongate central core of sulfide-barren quartz veining overprint the secondary biotite and epidote-chlorite.

Ore-grade mineralization of ≥0.3 percent copper equivalent flanks both sides of the two main centers of quartz veining within the central core and is also localized into breccia pipes.

Inclusions of "hydrosaline melt," homogenizing between 270° and 470°C, occur in vein quartz through the central core and, to a much lesser extent, the calcic zone immediately haloing it. Moderately saline liquid-dominant gas-liquid inclusions homogenizing between 270° and 380°C and vapor-dominant gas-liquid inclusions occur in vein quartz of the quartz core, calcic, and phyllic/argillic alteration zones. The moderately saline fluid probably boiled indicating a hydrostatic depth of 1,200±300 meters for the hydrothermal system.

Electron microprobe analyses of secondary biotite indicate a systematic variation in molecular Mg/Fe ratio across the system, the most phlogopitic coinciding with the central core. This composition zoning correlates with color zoning of the biotite. (Author's abstract)

WATSON, J.C., 1978, Sampling and analysis methods for geothermal fluids and gases: Pacific Northwest Laboratory PNL-MA-572, UC-66d, under Contract EY-76-C-06-1830, U.S. Dept. Energy, with appendixes (available from N.T.I.S., U.S. Dept. Commerce, Springfield, VA, 22151.

Includes an elaborate cross checking of analysis methods and results on the analysis of a single sample of a geothermal brine from Imperial Valley, California by many laboratories, as well as various control samples. Included are pH, Al, NH_3, Sb, As, HCO_3^-, $CO_3^=$, Ba, B, Br, Ca, Cs, Cl, Cu, F, I, Fe, Pb, Li, Mg, Mn, Hg, PO_4, K, Rb, SiO_2, Ag, Na, Sr, SO_4, $S^=$, Zn, total dissolved solids, and several others. The results are in part shockingly discrepant. (ER)

WEI, Chi-Sheng, 1977, Fluid inclusion geothermometry of Tri-State sphalerites: K'uang Yeh, 1977, v. 21, no. 4, p. 66-76 (in English).

Fluid inclusions in successively deposited generations of sphalerite from the Tri-State district were examd. for geothermometry as a function of time. Th was detd. for 272 fluid inclusions. Earlier disseminated, yellow sphalerite has formed in a narrow temp. interval, 120-85°. Main stage, brown sphalerite crystals have formed at 160-90°. Later, small, reddish brown crystals formed at ∿180°. The fluctuations in temps. of deposition between generations of sphalerite and throughout a single period of sphalerite deposition indicate a fluctuating character of the ore-forming fluid. The fluctuations may be the result of multipulse introduction of the ore fluid or of mixing with a cooler fluid. (C.A. v. 88: 194584d, 1978)

WEI, Chi-Sheng, 1978, Studies of Mississippi Valley-type ores from fluid inclusions in the Ozark region (central USA). K'uang Yeh Chi Shu, 1978, v. 16, no. 1, p. 65-71 (in Chinese).

Published data on fluid inclusions of the Mississippi Valley-type ores in the Ozark region are analyzed. The ore-forming fluids responsible for the Pb-Zn mineralization in the Ozark region were chloride-rich with a nearly neutral pH, and contained significant sulfate and negligible sulfide; pptn. was accomplished by an increase in reduced S at the depositional site. The ore-forming fluids were probably derived from metal-rich brines migrating from sedimentary basins. The fluctuation of deposition temp. may be the result of multiple introduction of the ore-forming fluids or of mixing with a cooler fluid. (C.A., v. 89: 132676x, 1978)

WENDLANDT, R.F., and HARRISON, W.J., 1978, Rare earth element partitioning between coexisting immiscible carbonate and silicate liquids and CO_2 in the system K_2O-Al_2O_3-SiO_2-CO_2 (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 10, no. 7, p. 514.

WENDLANDT, R. F. and HARRISON, W. J., 1978, Phase equilibria and rare earth element partitioning between coexisting immiscible carbonate and silicate liquids and CO_2 vapor in the system K_2O-Al_2O_3-SiO_2-CO_2: Carn. Inst. Wash. Yearbook 1977-78, (pub. 1978), p. 695-703.

WETLAUFER, P.H., 1978, Chemical similarities of hydrothermal fluids from diverse sources, Creede Ag-Pb-Zn-Cu district, San Juan Mountains, Colorado (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 10, no. 7, p. 515.

Light-stable-isotope studies in the Creede district suggest a deep (magmatic?) source for carbonate-depositing solutions and meteoric sources for fluids depositing sphalerite, quartz, adularia, illite, and chlorite (P.M. Bethke and R.O. Rye, unpub.). Nevertheless, geochemical studies of the carbonates indicate similar depositional conditions for both carbonate and sulfide assemblages. Mineralogy, mineral association, and paragenetic position define two stages of carbonate deposition. Rhodochrosite, associated with quartz and barite, occurs exclusively prior to main ore deposition; this early occurrence is unusual compared to other epithermal deposits. Siderite and manganosiderite, associated with quartz, fluorite, hematite, and chlorite, are restricted to the only known significant break in mainstage sulfide deposition. The iron-rich composition of these later carbonates is probably due to the fractionation of manganese toward chlorite, which was absent during deposition of the rhodochrosite. Fluid inclusions in rhodochrosite show homogenization temperatures (118°C to 250°C) and salinities (9.5 to 10.6 equiv. wt. % NaCl) similar to those found in inclusions in later sphalerite, quartz, and fluorite (E. Roedder, 1965, 1977, unpub.; J.T. Nash, unpub.). Superposition of calculated stability fields of minerals present during sulfide deposition (Barton et al., 1977) and during carbonate deposition shows that both carbonate assemblages were stable under oxygen and sulfur fugacities similar to those for sulfide deposition. Higher CO_2 pressures during carbonate deposition may have been the main chemical difference. Therefore, although the transporting fluids had different sources, the carbonate and sulfide assemblages precipitated after the fluids had evolved into similar solutions. (Author's abstract)

WETLAUFER, P.H., BETHKE, P.M., and BARTON, P. B., Jr., 1978, The Creede mining district, central San Juan Mountains, Colorado: a fossil geothermal system (abst.), in International Assoc. Genesis Ore Deposits, 5th Symp., Snowbird, Alta, Utah, 1978, Program and Abstracts: (Alta, Utah), p. 203.

The Tertiary silver/base-metal deposit of the Creede mining district has been the focus of an intensive study of the evolution of the physical and chemical environment during ore deposition. The geologic setting and studies of light stable isotopes and fluid inclusions suggest basic similarities between the Creede ore-forming system and the deeper parts of active geothermal systems.

Geothermal systems are typically associated with young, silicic volcanism. In the case of the central San Juan Mountains, eruption of voluminous coalescing aprons of andesitic lavas (38 -28 m.y.b.p.) was followed by a series of at least five major rhyolitic to quartz latitic ash-flow eruptions and formation of their associated calderas (28-26 m.y.b.p.). Although some calderas developed hydrothermal systems, the only known ore-forming system (which deposited the Creede ores 24.6 ± 0.4 m.y.b.p.) was as much as 2 m.y. younger than the final eruptive activity and may have been active over the short span of a few thousand years.

Active geothermal systems are usually dominated by meteoric waters, in some cases (e.g., El Tatio, Yellowstone, Long Valley)from multiple sources. The $\delta^{18}O$ and δD measurements on fluid inclusons and minerals from the Creede deposit indicate that its system was dominated by meteoric waters from at least two different reservoirs. An additional deep-seated water is associated with the two distinct but minor periods of carbonate deposition.

Fluid-inclusion homogenization temperatures at Creede range from 190° C to 268° C (median 250° C), well within, but towards the upper end of, the range of subsurface temperatures in active geothermal systems (e.g., Valles, Yellowstone). The fluid inclusions contain 4 to 12 equivalent weight percent NaCl, clearly on the high side of the salinity range of most geothermal systems not associated with evaporite deposits. The substantially higher metal concentrations in the Creede fluids (tens to hundreds ppm) compared to those in modern geothermal systems may be due to the high salinity. However, such high metal concentrations may not always be required for sulfide deposition in convecting hydrothermal systems (e.g., Broadlands, Arima).

The Creede deposit thus appears to be a viable model for a fossil geothermal system. It is proposed that the ore precipitated along the top of a saline, deeply circulating system which was at times locally vapor dominated, and which was separated from a more dilute, shallow circulating system. The sericitic alteration cap overlying most of the ore at Creede may mark the interface along which heat and possibly fluid components of the two systems exchanged.

Many other base-metal deposits associated with silicic volcanic rocks should be considered in the context of geothermal systems, as should bonanza gold/silver veins and the late-stage veins of porphyry copper deposits. Studies of such ore deposits and of active geothermal systems are mutually complementary. Ore deposits document the detailed evolution in time of a small part of a geothermal system, whereas active geothermal systems reveal the "instantaneous" dimensions and patterns of a system analogous to ones that have formed ores. (Authors' abstract)

WHITE, A.J.R., 1978, Fluid inclusions in igneous rocks--A brief review, in Notes for Workshop on Fluid Inclusions: Melbourne, Dept. Geology, La Trobe Univ. (unpaginated, mimeographed).

A 5-page review of volatile-rich inclusions. (ER)

WHITE, W. B., 1977, Raman spectra in relation to structure of rock-forming minerals (abst): Geol. Soc. Amer. Abstracts with Programs, v. 9, p. 1224-1225.

WILKENING, L. L., 1978, Tysnes Island: An unusual clast composed of solidified, immiscible, Fe-FeS and silicate melts: Meteoritics, v. 13, p. 1-9. Author at Dept. Planet. Sci., Univ. Ariz., Tucson, AZ 85721.

In the Tysnes Island gas-rich, H4 chondrite an inclusion was found which consists of two distinct portions: a tear-drop shaped Fe-FeS eutectic-like intergrowth (0.5 cm greatest dimension) and a silicate consisting primarily of olivine in glass. The boundary between the two portions of the inclusion is smooth. Nickel is enriched in the metal at the metal-sulfide boundaries and in nodules within the metal. The subhedral to skeletal olivine in the silicate portion is forsteritic, Fo_{75-90}. The glass is very rich in SiO_2, up to 70%. The glass is not homogeneous, but a fairly typical analysis is SiO_2, 66.9%; TiO_2, 0.4; Al_2O_3, 0.4; Cr_2O_3, 0.3; Na_2O, 3.3; K_2O, 0.9; CaO, 6.0; Fe, 10.9; Mg, 2.0. The Fe-FeS and silicate portions appear to have separated from one another as immiscible liquids. The modal composition of each portion agrees well with compositions predicted for a total melt of an H-group chondrite. This inclusion seems to be a "snapshot" of the process of metal-silicate fractionation which Fodor and Keil (1976) have previously suggested must exist to explain the presence of metal- and sulfide-free inclusions in brecciated chondrites. (Author's abstract)

WILKINS, R.W.T., 1978, Formation, modification and destruction of fluid inclusions, in Notes for Workshop on Fluid Inclusions: Melbourne, Dept. Geology, La Trobe Univ. (unpaginated, mimeographed).

An 8-page summary of the processes involved, including the first usage of the term "exsolution inclusions", for inclusions formed by precipitation of material formerly in solution in the host crystal. (ER)

WILKINS, R. W. T. and BARKAS, J. P., 1978, Fluid inclusions, deformation and recrystallization in granite tectonites: Contrib. Mineral. Petrol. v. 65, p. 293-299. First author at C.S.I.R.O. Div. of Mineral., P.O. Box 136, North Ryde, N.S.W. 2113, Australia.

An investigation has been made of the relationships between tectonic processes and fluid inclusions in quartz from variably deformed and syntectonically recrystallized granitic rocks from the Lachlan Fold Belt, eastern Australia. The quartz contains many fluid inclusions which decorate healed fractures introduced as a result of late-stage brittle deformation. The majority of small inclusions however, are associated with deformation band boundaries and deformation lamellae showing that they have been introduced during or subsequent to ductile deformation. Fluid inclusions disappear from the cores of sub-grains during recovery and before recrystallization, and new inclusions which form along sub-grain boundaries coalesce into stringers. Inclusions are eliminated from both sides of low angle boundaries showing that inclusions leak their contents either through the system of dislocations which accompanies grain interior slip, or by a dissolution-condensation process whereby inclusion contents move by lattice diffusion and condense on the boundaries. (Authors' abstract)

WILKINS, R.W.T. and BIRD, J.R., 1978, Characterization of healed fracture surfaces in fluorite by etching and proton irradiation, in Notes for Workshop on Fluid Inclusions: Melbourne, Dept. Geology, La Trobe Univ. (unpaginated, mimeographed).

A 15-page paper on low-angle sub-boundaries, often decorated with inclusions, that can be made visible with the techniques indicated. Mechanisms of crack healing differ with initial crack width. (See next item also). (ER)

WILKINS, R. W. T. and BIRD, J. R., 1978, Decoration of growth and deformation dislocations in fluorite: a new application of proton irradiation, in Proceedings of the Second Australian Conference on Nuclear Techniques of Analysis: Australian Institute of Nuclear Science and Engineering.

A three-page summary of the previous item. (ER)

WILKINS, R. W. T. and SABINE, William, 1973, Water content of some nominally anhydrous silicates: Amer. Mineral., v. 58, p. 508-516. First author at CSIRO, Div. Mineralogy, N. Ryde, N.S.W., Australia.

Quantitative water determintions made by a sensitive electrolytic technique, together with infrared absorption spectra taken through thick single-crystal plates, have established the presence of small and variable amounts of OH ions in the structures of various nominally anhydrous silicate minerals. The OH spectra, consisting chiefly of sharp bands in the region from 3000 to 3700 cm^{-1}, were verified by deuterium exchange. The OH contents found (as wt. percent H_2O) are: kyanite, 0.009 to 0.062 range in 19 specimens; andalusite, 0.048; sillimanite, present; grossular, 0.056 to 2.29 in 4 specimens; andradite, 0.148 to 0.67 in 4 specimens; pyrope, 0.009; diopside, 0.020; rhodonite, 0.008; andesine, 0.55; adularia, 0.080; olivine, 0.008. The structural role of the OH is not entirely certain, but an examination of various possibilities indicates that isolated OH ions occupy oxygen sites associated with vacancies or charge imbalance in cation sites. (Authors' abstract)

WILSON, J. C., 1978, Ore fluid-magma relationships in a vesicular quartz latite porphyry dike at Bingham, Utah: Econ. Geol., v. 73, p. 1287-1307.

See same author, Fluid Inclusion Research--Proc. of COFFI, v. 10, p. 298 (1977).

WOOD, M.I., and HESS, P.C., 1978, The structural role of Al_2O_3 in K_2O bearing immiscible melts (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 10, no. 7, p. 519.

WOODS, T. L., 1978, Chemical and thermal variations accompanying formation of garnet skarns near Patagonia, Arizona: M.S. thesis, Univ. Arizona, 54 pp.

Intrusion of granodiorite into Permian limestones, dolomites, and clastics has resulted in the formation of sulfide-bearing exoskarns near Washington Camp, south of Patagonia, Arizona. Pervasive development of garnet, pyroxene, and quartz required addition of large amounts of iron and silica to clean limestones. The earliest calc-silicates to form were garnet and wollastonite, followed by clinopyroxene; quartz was deposited continuously during skarnification and sulfide mineralization. The later magnesium-rich silicates extensively replaced the

Ca-Fe silicates in areas of abundant sulfide mineralization, requiring addition of large amounts of magnesium. Sulfides are scarce in areas of minimal magnesium-silicate development. Microprobe analyses show that garnets are predominantly andraditic, often with iron-rich cores and aluminum-rich rims; clinopyroxene is of diopsidic-ferrosalitic composition; and tremolite and talc are magnesium-rich. Fluid inclusion evidence indicates that garnets were deposited between 490°C and 350°C and that the maximum pressure during metasomatism was about 500 bars. The depositing solutions were boiling between 480°C and 360°C, contained 10-25 weight percent NaCl equivalent, and were probably near the critical point in the H_2O-NaCl system. The only pyroxene formation temperatures which could be obtained were near 435°C, and quartz homogenization temperatures ranged from 420°C to 210°C. (Author's abstract)

WYLLIE, P. J., 1977, Experimental studies on the influence of CO_2 and H_2O in the upper mantle, p. 77-106 <u>in</u> High Pressure Research, M. H. Manghnani and S. I. Akimoto, eds.: New York, Acad. Press.

WYLLIE, P.J., 1978a, Influence of volatile components on upper mantle processes (abst.): XI General Meeting of International Mineralogical Association, Abstracts, v. 2, p. 54 (in English).

There is good evidence that minerals and magmas derived from the upper mantle contain H_2O and CO_2. It is not clear to what extent these components are derived from primordial material deep in the mantle, or through recycling of the hydrosphere via subduction. The existence of diamonds and graphite in mantle nodules demonstrates that the oxygen fugacity is not high enough to oxidize all carbon at depth, but the depth range within which carbonate coexists with carbon has not been established. The system peridotite-CO_2-H_2O provides a first step for interpretation of processes occurring in the mantle system peridotite-C-H-O. Peridotite reacts with CO_2 and H_2O under pressure. Considering depths of 300 km or less, and temperatures above 800°C, mantle peridotite can be completely hydrated by less than 0.5% H_2O producing amphibole or phlogopite. The mantle is a better potential store-house for CO_2, because it requires about 30% CO_2 to carbonate peridotite completely. At depths of more than 300 km, H_2O if present can be stored in DHMS (dense hydrated magnesian silicates). Divariant subsolidus reaction surfaces for decarbonation, dehydration, and hydration-carbonation reactions buffer mantle vapor phase compositions, if there is a vapor present. The major effects of H_2O and CO_2 in the upper mantle are to lower the solidus temperature, and to cause large changes in composition of near-solidus liquids as a function of pressure, temperature and CO_2/H_2O. This has applications to kimberlites and other continental volcanism. If there is any CO_2 or H_2O in the upper mantle, then incipient melting must be at least partly responsible for the seismic low-velocity layer. The subcontinental upper mantle is probably heterogeneous with respect to incompatible elements, because local melting due to sparsely distributed CO_2 and H_2O is followed by magmatic flushes, as the melt migrates into or through the lithosphere. (Author's abstract)

WYLLIE, P. J., 1978b, Peridotite-CO_2-H_2O and the low-velocity zone:

Bull. Volcanol., v. 41, p. 670-683. Author at Dept. Geophy. Sci., Univ. Chicago, Chicago, IL 60637

The suboceanic low-velocity zone is caused by incipient melting of amphibole-peridotite in the presence of vapor with high CO_2/H_2O, with generation of forsterite-normative liquid. The subcontinental low-velocity zone, where present, is probably caused by incipient melting of dolomite-peridotite, or phlogopite-dolomite-peridotite, either with H_2O-rich vapor or without vapor, with the generation of CO_2-rich, alkalic, SiO_2-poor liquid (larnite-normative) that in extreme conditions may be carbonatitic. (From the author's abstract)

YAGI, K. and AKIMOTO, S. (eds.), 1978, Physics and chemistry of magma genesis, Proc. of Intern. Geol. Conf., Tokyo, March 1978: Bull. Volcanol. v. 41.

Includes a special lecture and 25 papers including several on interactions between magmas and volatiles. (P. Lattanzi)

YAKOVLEV, O.I., PARFENOVA, O.V. and ARKHANGEL'SKAYA, V.N., 1978, Change in rock composition on formation of impact melts: Akad. Nauk SSSR, Doklady, v. 240, no. 4, p. 934-937 (in Russian). First author at Inst. Geochem. Anal. Chem. of Acad. Sci. of the USSR, Moscow.

Pertinent to terrestrial and lunar impact melt inclusions. (A.K.)

YASINSKAYA, A.A., 1978, Genetic classification of inclusions in cosmic minerals, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 115-116 (in Russian). Author at the L'vov State Univ., L'vov.

Proposed classification is as follows:

A. P inclusions formed due to:
  1 - rapid cooling of melt,
  2 - slow cooling of melt with volatiles present,
  3 - immiscibility of silicate Lunar magmas.
B. S inclusions formed due to:
  1 - renewed heating and melting-pyrometamorphic,
  2 - impact phenomena - impact-metamorphic, including: diaplectic glass i.e. products of mechanical disintegration of crystal structure, lunar glass being products of thermal melting of crystals during adiabatic compression, lunar glasses being impact sublimates.

The following compositions were distinguished:

1st. Class - xenogenic solid inclusions, variety - crystalline and detrital minerals, subvariety - protogenetic and syngenetic.

2nd. Class - solidified melts: 2.1 one-phase glass, 2.2 crystallized one- and polyphase, 2.3 crystal-glass or crystal-G, two- and polycrystalline, 2.4 immiscible silicate lunar magmas, two-phase.

3rd. Class - G inclusions: in meteorites 3.1 - G one-phase, 3.2 - glass-G two-phase; in lunar glasses 3.3 - G one-phase of variable number of component (gases). (From the author's abst., by A.K.)

YEN, Chie-Chung, 1978, Studies of fluid inclusions for finding the origin of gold-copper deposits at the Chinkuashih mine (Taiwan). K'uang Yeh Chi Shu, 1978, v. 16, no. 1, p. 54-64 (in Chinese).

Based on studies of fluid inclusions in barite, quartz, luzonite, enargite, famatinite, alunite, and pyrite specimens from the title Au-Cu ore deposits, the temps. (and pressures) of the ore-forming solns. during the early and late stages of the ore formation were 375 (600-1000) and 160-260° (26.1-43.8 bars), resp. The d. of the ore-forming solns. was 0.87-0.91 g/cm^3. (C.A. v. 89: 149669v, 1978)

YERMAKOV, N.P., 1978, Inclusion decrepitation in thermobarogeochemistry and mineral thermometry (abst.) International Assoc. Genesis Ore Deposits, 5th Symp., Snowbird, Alta, Utah, 1978, Program and Abstracts: (Alta, Utah), p. 205.

1. Technical success in 1977 in the USSR in the field of phonic and barometric recognition of the decrepitation of gas-liquid inclusions resulted in additional use of this method for the determination of deep mineral-formation temperatures.

2. Problems with the use of this method for mineral thermometry arise because of differences in the physical properties of minerals used, and in the properties of gas/liquid inclusions themselves, as well as subjectivity in the interpretation of decrepigrams.

3. The mineralogical factor, causing differences of up to 170 C, is related to differences in tensile strength, temperature conditions of stability and polymorphic transformations, cleavage and twinning of the test minerals.

4. Inclusion decrepitation will be related to different age of formation and hence densities of aqueous or CO_2-aqueous filling, differnt sizes, forms, and position relative to the surface of the mineral fragments. All these and other conditions cannot be controlled in opaque minerals and hence there is ambiguity in comparing the results of determinations of the decrepitation temperature of a given mineral and even more so in different minerals

5. Some authors take the beginning of mass decreptation to be the temperature of mineral formation; others take the peak of mass decrepitation, or even the end of decrepitation. There is also subjectivity in the estimation of the interval between these points. All these factors, and also varying sensitivity of the apparatus preclude comparison of the results of mineral-thermometry of different authors.

6. The method of decrepitation of gas-liquid inclusions has importance in its applied use in a series of exploration problems, such as the classification and correlation of barren sedimentary and volcanogenic suites, ascertaining the age relationship of a pair of veins, ascertaining the area of mineralization as revealed by the "steam halo" in the rocks around the ore-bodies, decrepitometric logging of drill core, and evaluation of the possible permeability of shear zones and tectonic fractures on the basis of the decrepitation activity of the disturbed rocks. Decrepigrams may have typomorphic value in the estimation of thin-aggregate rocks and possible productivity of veins with very diffuse and irregular mineralization, and also for the evaluation of some kinds of friable non-metallic raw material (sands and gravel).

7. Decrepitation has great usefulness in laboratory investigations, for extraction and analysis of mineral-forming liquids and gases well preserved in inclusions by determinations on anhydrous minerals, releasing the inclusion contents by crushing or fusion. Decrepitation is now the basis of well-developed new methods of detailed exploration of ore bodies: decrep-

tophonic studies, dehydration studies, the water-CO_2 analytical method and the decrepitation of heavy concentrates. (Author's abstract)

YERMAKOV -- See also ERMAKOV

YIN, Hanhui, 1978, Ore genesis of a polymetallic mine in Hunan Province: Geochimica, 1978, no. 4, p. 270-280 (in Chinese with English abst.).

The polymetallic mine described in this paper contains W, Mo, Bi, Sn, Be, Cu, Pb, Zn, etc. The deposit occurs in Upper and Middle Devonian carbonate rocks and exhibits an apparent zonal arrangement around a small granite body with respect to the elements mentioned above. At least four periods of magmatic intrusion and mineralization are recognized within this district. A comagmatic origin is indicated for all the deposits by geological setting, mineral assemblages, the geochemistry of ore elements, isotopic compositions of lead and sulfur as well as fluid inclusion studies. Ore metals are derived chiefly from the granite while wall rocks cannot be excluded as a minor supplier. (Author's abstract)

Th and/or Td are given for 32 samples. Th range 160-326°C; Td range 134-700°C. (ER)

YOSHIDA, T., 1978, Fluid inclusion studies of the Kuroko deposits in the Iwami Mine, Shimane Prefecture, Japan (abst.) in International Assoc. Genesis Ore Deposits, 5th Symp., Snowbird, Alta, Utah, 1978, Program and Abstracts: (Alta, Utah), p. 206.

The Iwami mine is of the Kuroko-type, situated in the Green Tuff Region of the inner zone of Southwest Japan. The ore deposits are composed of stratiform Kuroko, gypsum and stockwork ore bodies in descending order. The stockwork ore body is economically more important than the stratiform ore body which consists of clayey ores and fragments of stockwork ores. The clayey ores are composed of fine grained sulfide minerals showing colloform texture and aggregates of sphalerite crystals up to 30 mm in diameter. Sphalerite suitable for inclusion studies in the stratiform ores is found in the fragments of the stockwork ores and the aggregates of sphalerite crystals. Sulfide minerals in the stratiform and stockwork ores are sphalerite, pyrite, galena and chalcopyrite, with minor luzonite and tetrahedrite. The wall rocks of the stockwork ores are composed of dacitic pyroclastics and small rhyolitic intrusives of Miocene age.

Samples were collected from five levels (-30 m to -105 m). The filling temperatures of 395 fluid inclusions in sphalerite and quartz from 89 localties were determined with the microscope heating stage. All the inclusions were two-phase and most ranged from 20 to 50u in maximum dimension. Salinities of inclusion fluids in sphalerite were studied with the freezing stage. Many small inclusions were observed in gypsum from the gypsum ore body, calcite from the veins of the stockwork ore body and barite from the stratiform ore body. Most of them were mono-phase (liquid) inclusions and some were extremely liquid-dominant two-phase inclusions.

Most filling temperatures range from 210° to 310°C for sphalerite and from 240° to 290°C for quartz. The range of the temperature values for quartz falls in approximately the same range as that for sphalerite. Salinities of inclusions in spalerite indicate approximately 1 to 5 wt% NaCl equivalent. It is clearly seen that the temperatures for sphalerite increase downward in the stockwork ore body. In the stratiform ore body the temperatures for sphalerite from the fragments of stockwork ores range from 230° to 270°C and correspond to values for the stockwork ores of -30m and -55m levels. The temperatures for sphalerite from the aggregates of sphalerite crystals range from 250° to 270° C.

The ore-forming succession in the Iwami ore deposits is considered as follows. At first, gypsum precipitated on the bottom of a small basin from sea water at the beginning of mineralization at low temperature. The stockwork ore body was formed, probably at a range of 200° to 300° C, in the breccia pipe, at the same time the stratiform fine grained clayey ores were formed on the bottom of the basin of at least 540 m depth. The fragments of the stockwork ores were mixed with clayey stratiform ores due to collapse of the upper parts of the stockwork ore body. After this collapse mineralization continued and coarse sphalerite aggregates were formed from fine grained sphalerite in the clayey sediments. Calcite veins were formed below 100° C in the waning stage of the mineralization. (uthor's abstract)

YPMA, P., 1978a, Destructive determination of gas compositions, in Notes for Workshop on Fluid Inclusions: Melbourne, Dept. Geology, La Trobe Univ. (unpaginated, mimeographed).

A 21-page study of the use of various procedures of gas-chromatography for the analysis of the gases released by decrepitation or crushing, with examples from various quartz veins from ore deposits. (ER)

YPMA, P., 1978b, Water-soluble salts-CO_2 systems, in Notes for Workshop on Fluid Inclusions: Melbourne, Dept. Geology, La Trobe Univ. (unpaginated, mimeographed).

A two-page summary plus 11 figures. (ER)

YPMA, P., 1978c, Notes on phase changes of the system H_2O-CO_2-CH_4-H_2 in fluid inclusions, in Notes for Workshop on Fluid Inclusions: Melbourne, Dept. Geology, La Trobe Univ. (unpaginated, mimeographed).

A four-page summary plus 27 figures of experimental or theoretical P-V-T-X diagrams. (ER)

YU, Fang-Sung, and LIN, Chin Yun, 1978a, The heating microscope stage and its application in mineral exploration. K'uang Yeh Chi Shu 1978, v. 16, no. 1, p. 31-45 (in Chinese).

A review with 8 refs. (C.A. v. 89: 114013z, 1978)

YU, Fang-Sung, and LIN, Chin-Yun, 1978b, Relation between salinity, specific volume, temperature, and pressure of fluid inclusions in minerals. K'uang Yeh Chi Shu, 1978, v. 16, no. 1, p. 2-15 (in Chinese).

A review with 9 refs. is presented on the freezing microscope stage and the relations among the pressure, sp. vol., and temp. (or pressure, compn., and temp.) of fluid inclusions (in the binary systems H_2O-NaCl and H_2O-CO_2 under hydrothermal conditions). (C.A. v. 89: 114011x, 1978)

YU, Fang-Sung and LIN, Chin-Yun, 1978, Application of the crushing microscope stage in fluid inclusion mapping and in mineral exploration. K'uang Yeh Chi Shu, 1978, v. 16, no. 1, p. 22-30 (in Chinese).

A review with 12 refs. (C.A. v. 89: 114012y, 1978)

YU, Tie-Chieh, LI, Ke-Sheng, and YEH, Hsin, 1978, Experimental studies on the evaporation aureoles for use as an exploration method: Izv. K'o Hsueh Tung Pao, v. 23, no. 9, p. 550-553 (in Chinese).

In the area adjacent to a hydrothermal deposit, the fluid-inclusion content in a rock sample increases with decreasing distance between the sampling site and the deposit (a phenomenon known as evapn. halo). Based on studies of 5 known ore deposits (porphyry Cu, Fe, etc.), the use of evapn. haloes for exploring for blind hydrothermal ore deposits was discussed. (Chem. Abstracts 89: 200627j).

YUND, R. A. and ANDERSON, T. F., 1978, The effect of fluid pressure on oxygen isotope exchange between feldspar and water: Geochim. Cosmo. Acta. v. 42, p. 235-239. First author at Dept. Geol. Sci., Brown Univ., Providence, RI 02912, USA.

The rate of oxygen isotope exchange between adularia and 2M KCl solution has been measured at 650°C at pressures from 125 to 4000 bar. Isotropic diffusion coefficients calculated from these data show a positive dependence on the fluid pressure. This dependence is opposite to the predicted effect of hydrostatic pressure and is attributed to the activity of 'water' (H_2O, H^+ or OH^-) in the feldspar. (Authors' abstract)

YURGENSON, G.A., PEREVERTAEV, V.D., and GOROVENKO, V.A., 1978, Water release from quartz during heating under vacuum: Geokhimiya, 1978, no. 1, p. 133-138 (in Russian). First author at Transbaikalian Sci.-Research Inst., Chita, USSR.

Studies of water in quartz (in G/L inclusions and in the structure) were performed by decrepitation, mass spectrometry, IR absorption, and calcination; some Th data are also included. Pertinent to water determination in fluid inclusions. (A.K.)

YUSUPOV, S. Sh., MEL'NIKOV, Ye. P. and KHAYRETDINOV, I. A., 1978, PT conditions of metamorphism of quartz in the Urals, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 149-150 (in Russian). First author at the URALKVARTSSAMOTSVET, Novoalekseevskoe, USSR.

Quartz was studied from 12 deposits of two types: primary crystallized and secondary recrystallized (granulated) quartz. Granulated quartz bears two inclusion groups: early inclusions, only inside quartz grains filled by L H_2O+L CO_2 or only L CO_2, Th 270-525°C, Th of L CO_2 inclusions from -4 to +20°C, specific volume 1.08-1.25 cm^3/g, hence P at 300-500°C was 1.25-3.8 kbar. Late, two-phase, rarely polyphase inclusions (with L CO_2 and dms, G 5-10 to 90 vol. % of inclusion, total salts up to 15 wt. %) occur in intergranular quartz and in fractures of grains, Th 60-390°C, P 120-1100 atm. Such inclusions are connected probably with recrystallization of the earlier-formed amphibolite and epidote-amphibolite facies quartz. Inclusion in primary vein quartz are two- and three-phase (L H_2O + L CO_2 + G), Th 90-380°C, P 20-600 atm (comparable with the green-schist facies of metamorphism. (From the authors' abst.)

ZAGORSKIY, V. Ye., 1978, Chloritization at exocontacts of rare metal pegmatites: Akad. Nauk SSSR Doklady, v. 239, no. 4, p. 959-961 (in Russian). Author at Inst. Geochem. Acad. Sci. USSR, Irkutsk.

In Ta-bearing vein pegmatites with strongly chloritized amphibolite wallrocks, quartz, beryl and block petalite inclusions have Th 320-410°C, quartz and fluorite from micaceous rock -350-405°C, quartz from chlorite rock - 305-420°C. (A.K.)

ZAKHARCHENKO, A. I., 1978, Characteristics of the transition of melts into fluids and the evolution of their composition: Teor. Prakt. Termobarogeokhim., (Dokl. Vses. Soveshch.) 5th 1976, N. P. Ermakov, ed.: Moscow, Izd. Nauka, p. 39-43 (in Russian).

The transition from melts into fluids in minerals was studied on the basis of the primary inclusions in quartz, topaz, and beryl, for various granitic rocks and greisens. In granites and the outer zones of pegmatites 70-90 vol.% of inclusions undergo gas-congealing, and Th is 800-900°. The inclusions in pegmatites have Th 600-50°. For void-filling minerals Th ~150-450°. Transport of the heavy metals Sn, W, and Mo occurs in aq. chloride-fluoride solns. at 520-450°; the polymetals (Pb, Zn, Cu, etc.) are transported in chloride solns. at 150-300°. (Chem. Abstracts 91: 60541r, 1979)

ZAKHAROVA, Ye. M., VORTSEPNEV, V.V. and FILITSINA, T.A., 1978, Thermobarogeochemical studies for identification of ore-bearing quartz: Acad. Sci. USSR Doklady, v. 238, no. 5, p. 1177-1180 (in Russian). Authors at the Moscow State Univ.

In the area of occurrence of gold deposits of the Au-quartz formation in eugeosynclinal rocks of Caledonian age and older basement, following features of ore-bearing quartz were found: very abundant tiny G/L inclusions, polyphase with large G bubble, including L CO_2 (up to 60-80 vol. %) as well as dms (halite and sylvite); Th (and Td) prove high and partly moderate T of origin (380-220°C). Minute inclusions of solid coal-type substance are also very common. (Abst. by A.K.)

ZALISHCHAK, B. L., 1978, Conditions of formation of anorthitized granitoids — new type of metasomatites, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 141-143 (in Russian). Author at Far-East Geol. Inst. of Far-East Sci. Center of Acad. Sci. of USSR, Vladivostok, USSR.

During greisenization of granitoids (300-600°C, 0.5-1.0 kbar, pH 3-5) under conditions of low volatile concentration and high activity of Ca, anorthite formation was observed in early-Mesozoic granitoids from the Upper Priamurie. (From the author's abst.)

ZANVILEVICH, A.N. and PRIKHOD'KO, G.G., 1978, Experience in revealing the genetic connection of ores with acid intrusions, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. II, Thermobarogeochemistry and ore genesis: Vladivostok, Acad. Sci. USSR, p. 26-27 (in Russian). Second author at Buryatian Territorial Geol. Office, Ulan-Ude, USSR.

The studied area of 450 km^2 is in the region of Selenga River and consists of granites, quartz syenites and syenites, and acid and intermediate volcanites. Geochemically anomalous areas (Mo, Sn, Pb and Zn) in the rocks also bear high content of secondary crystallo-fluidal or LCO_2-rich inclusions. (From the authors' abst.)

ZAREMBO, V.I., PUTCHKOV, L.V., FEDOROV, M.K., 1977, Calculations of the activity coefficient of dissolved electrolytes based on measuring vapor pressure over solutions at 423-623 K, (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. 3, p. 11-12 (in Russian).

ZAW, U. K., 1978, Fluid inclusion studies on the Hermyingyi tungsten-tin deposit, Southern Burma: Reg. Conf. Geol. Miner. Rescur. Southeast Asia. Proc. 1978, ISS: 3, p. 393-397.

ZAW, U. K. and CLARK, A. H., 1978, Fluoride-hydroxyl ratios of skarn silicates, Cantung E-Zone scheelite orebody, Tungsten, Northwest Territories: Can. Mineral. v. 16, p. 207-221. Authors at Dept. Geol. Sci., Queen's Univ., Kingston, Ontario K7L 3N6.

In the major Cantung E-Zone exoskarn orebody, scheelite was deposited in equilibrium with, successively, clinopyroxene+garnet, actinolite and biotite, at mean temperatures (from fluid inclusion homogenization) of 487°, 433° and 415°C, respectively, and under a confining pressure of 1000 bars (from sphalerite geobarometry). The fluorine contents of skarn biotites and actinolites are in the ranges 0.82-2.99 and 0.25-0.90 wt.%; Mg/Mg+Fe and F/OH+F ratios are positively correlated in both minerals. Application of the experimental data of Ludington and Munoz (1975) for fluoride:hydroxyl exchange between biotite and fluid yields a value for $\log f(H_2O)/f(HF)^{fluid}$ of 4.5 ± 0.3; thus $f(HF)$ was approximately 0.009 bars during the final stage of mineralization. The compositions of Fe- and Al- rich magmatic biotites from a nearby pluton are inferred to have equilibrated at ca. 550°C with fluids which generated clinopyroxene+garnet skarns; this suggests that $f(HF)$ was maintained at this low level throughout the evolution of the E-Zone orebody. The comparative F:OH exchange in actinolitic amphiboles is in broad agreement with published estimates, but is not tightly constrained by the Cantung assemblages. Although not ruling out the possibility of tungsten solution in the form of an aqueous fluoride complex, the low HF fugacity inferred for the E-Zone hydrothermal fluids lends no support to this mode of transport. (Authors' abstract)

ZHOVTULA, B.D., KALYUZHNYI, Vl. A. and SAKHNO, B.E., 1978, On conditions of crystallization of amphibole and plagioclase from deposits of volcano Shiveluch (Kamchatka), (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivostok, Acad. Sci. USSR, p. 96-97 (in Russian). Authors at Inst. Geol. and Geochemistry of Natural Fuels of Acad. Sci. of the Ukrainian SSR, L'vov.

Amphibole (osannite) bears P and S glass inclusions 10-40 m in length. Part of inclusions contain variable amounts of glass and G, proving the retrograde „boiling" of melt during certain stages of crystallization. P inclusions rarely contain the third, crystal phase. Glass becomes plastic at 950-980°C, at 1080°C G bubbles begin to diminish, at 1120°C G bubbles start to move in vacuole; further heating causes the darkening of osannite precluding observations. Refractive index of glass is 1.660±0.002, i.e. SiO_2 content is ca. 42%. G phase in osannite contains mostly N_2 (56.89-84.6%) plus H_2O (11.7-16.0%), CO_2 (3.6-20.16%), CH_4 (4.4-10.17%) and C_2H_4 (1.0-3.9%).

Anorthite also contains two-phase glass + G inclusions with Th 1270-1330°C, most commonly 1280-1290°C, refractive index of glass 1.511, i.e., about 67% of SiO_2. N_2 prevails in G phase (28.1-65.9%). The balance is water (10.91-31.7%), CO_2 (2.61-17.04%), CH_4 (8.0-29.13%), C_2H_6 (1.5-4.25%) and C_3H_8 (2.0-3.6%). Hydrogen was not included in analysis. The presence of C_2H_4 in osannite but not C_2H_6 and C_3H_8 may be connected with presence of Fe^{2+}. Presumably hydrocarbons and other gases are juvenile. (Authors' abst., translated by A.K.)

ZIDAROVA, B., MALEEV, M. and KOSTOV, I., 1978, Crystal genesis and habit zonality of fluorite from the Mičhalkovo deposit, Central Rhodope Mountains: Izv. Geokhim., Mineral. Petrol., v. 8, p. 3-26 (in Bulgarian).

Fluorite from the Mičhalkovo deposit crystallizes in 33 simple forms including 16 vicinal forms. A morphol. description of all cryst. forms is given. The homogenization temp. of the gas-liq. inclusions is 110-35° for those from the cubic crystals and 140-80° for those from the octahedral crystals. The habit, zoning, and the genesis of fluorite was discussed. The crystallogenetic processes were discussed based on the sequence of the habit forms {111} - {110} - {100}, the supersatn., and the temp. (Chem. Abstracts 91: 60345e)

ZOLOTAREV, B.P., TRIFONOV, V.G., VOITOV, G.I., and CHEREVICHNAIA, L.F., 1977, On gases enclosed in igneous rocks of Iceland: Akad. Nauk SSSR, Doklady, v. 237, no. 5, p. 1163-1166 (in Russian).

Presents 11 analyses, for H_2, CO_2, CH_4, C_nH_{2n+2}, and C_nH_{2n}. (E.R.)

ZOLOTAREV, B.P., VOYTOV, G.I., SARKISYAN, I.S. and CHEREVICHNAYA, L.F., 1978, Gases from basaltoids of the Mid-Atlantic range (materials of the Leg 45 of "Glomar Challenger"): Akad. Nauk SSSR Doklady v. 243, no. 4, p. 1032-1035 (in Russian). First author at the Geol. Inst. of Acad. Sci. USSR, Moscow.

Pertinent to G composition of fluid inclusions. (A.K.)

ZOLOTAREV, V. G. and YAKOVLEV, G. F., 1977, Origin of pyrite-polymetallic deposits of the Belouba Synclinorium (Rudnyy Altay): Sovetskaya Geologiya, 1977, no. 2, p. 15-29 (in Russian; translated in Intern. Geol. Review, 1978, v. 20, no. 4, p. 464-476).

A stratabound deposit in a "volcanogenic-sedimentary" type of section. Inclusions in quartz show that deposition of the main Cu-Zn ore took place from cold-water solutions; some sphalerites show Th of $\leq$90°C. (ER)

ZORIN, B.I., GALKINA, G.A., GROMOV, A.V., KARSKIY, B.Ye. and TARASOV, Ye.V., 1978, Typomorphism of minerals from the Maura pegmatites, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. 1, Thermobarogeochemistry in geology: Vladivistok, Acad. Sci. USSR, p. 53-54 (in Russian). Authors at MGRI, Moscow.

Th of P inclusions in quartz decreases from the side to the center of the pegmatite veins, from 620 to 480°C. Decrepigraphs have peaks at 600-620°C for fine-grained quartz, 560-580°C - quasi-graphic quartz, & 480-500°C for pegmatoid and block quartz. Th of S inclusions in quartz similarly decreases from 220 to 100°C. Th of inclusions in muscovite changes from 500 to 180°C, and in garnet from 600°C in the contacts to 200-220 in zones of overlapping albitization. Spessartite content changes from 35-45% in low-T garnets to 14-15% in high-T ones. (From the authors' abst., by A.K.)

ZORIN, B.I., GROMOV, A.V., ISAYCHEV, V.V. and KUZNETSOV, I.V., 1978, Mineralogical-decrepitometric mapping during prospecting for hidden commercial mica-bearing pegmatitic veins, (Abst.): Abstracts of the Sixth All-Union Meeting, Vladivostok, Sept. 15-18, 1978, v. II, Thermobarogeochemistry and ore genesis: Vladivostok, Acad. Sci. USSR, p. 23-24 (in n). Russian). Authors at Mineral.-Geol. Prosp. Inst., Moscow.

The optimum network of sampling for decrepitation mapping of the mica pegmatites in the Mama-Chuy province is 10x40m. Two T ranges of decrepitation were studied: Total from 60-540 or 560°C and "relative" from 60 to 180 or 280°C. Preferences for decrepitation prospecting and mapping and successes of the method are listed. (A.K.)

ZYRYANOV, V.N. and PERCHUK, L.L., 1978, Nature of the sodic and potassic magmas with excess silica: Akad. Nauk SSSR Doklady, v. 242, no. 1, p. 187-189 (in Russian). Authors at Inst. Exper. Mineral. of Acad. Sci. of the USSR, Chernogolovka near Moscow.

Paper discusses alkali feldspar equilibria with water-salt (NaCl+KCl) solutions and water-free salt melts at T 800° and P 1000 kg/cm^2, and at 1000, 1100, 1300°C, 6 kg/cm^2. Pertinent to fluid inclusion studies. (A.K.)

ZYRYANOV, V.N., PERCHUK, L.L., and PODLESSKII, K.K., 1978, Nepheline-alkali feldspar equilibria: I. Experimental data and thermodynamic calculations: Jour. Petrology, v. 19, pt. 1, p. 1-44. Authors at Inst. Exper. Min., USSR Acad. Sci., 142432, Chernogolovka, Moscow district, USSR.

Nepheline-alkali feldspar equilibria with alkali chloride aqueous solutions have been determined for the temperature range 400 to 700°C at 1000 bars pressure. Nepheline-alkali feldspar equilibria with alkali chloride melts have been determined for the temperature range 800 to 1100°C at approximately 6 bars pressure.

The effect of pressure on these equilibria has been determined by comparing the experimental data for 1000 and 5000 bars (t = 500°C) and thermodynamic calculations. It has also been shown that the effect of excess silica in nepheline solid solution on the K-Na distribution between nepheline and alkali feldspar is substantial and opposite to that of temperature. In the high temperature region an increase in silica content in nepheline of 2 wt. per cent eliminates the effect on the redistribution of a temperature increase of 100°C. These cation exchange data and unit cell data for the crystal phases are used to calculate thermodynamic mixing properties of nepheline solid solution and alkali feldspar solid solution for a wide range of temperature and pressure. (From the authors' abstract)

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.

ASHIKHMINA, N.A., GORSHKOV, A.I. MOKHOV, A.V. and OBRONOV, V.G., 1978, Sylvite and halite in lunar soil: Akad. Nauk SSSR, Doklady, v. 243, p. 1258-1260 (in Russian; translation courtesy A.Kozlowski). Authors at Inst. Geol. Ore Deposits, Petrog., Mineral. and Geochem. of Acad. Sci. USSR, Moscow.

During investigation of regolith sample AS-24 under binocular (50X) and under the microscope (160X), inclusions were found in pyroxenes, and a white fine-crystalline substance was found in vacuoles in glass and in small crystal-forming intergrowths with pyroxene.

Inclusions in pyroxenes have irregular or globular shape and are transparent, rarely opaque. They are nonuniformly distributed, forming clusters and chains. A fine-crystalline substance occurs on the walls or completely fills relatively big (0.01mm) vacuoles on the surfaces of the glass chips, opened during crushing.

The crystals have a flat (sic. A.K.) rectangular habit, width 0.15 mm and height 0.2 mm. Well-developed faces intersect at 90°. The crystals have a milky-white color and fatty luster; they crush easily, forming flat minute chips.

For elucidation of the composition and structure of the white fine-crystalline substance, the crystals, and the inclusions in pyroxenes, transmission electron microscopy and SEM analysis were used. In the first case studies were performed by the suspension method, applying electron microdiffraction and x-ray microspectral analysis made with use of the electron microscope JEM-100C with ±60° goniometer tilt and "Kevex Ray" microprobe unit (energy dispersive spectrometer). Suspension preparations were prepared in a "clean" room. Wet dispersions of the specimens were first made in an agate mortar and next in an ultrasonic apparatus UZDN-2, using 16 kHz for 5-7 min. As the dispersion liquid, double distilled (water?) and double distilled ethanol were used.

For each particle the electron image and diffraction patterns for various inclinations were obtained at 100kV, as well as x-ray analysis (at 40kV).

The x-ray analysis of the fine-crystalline substance from vacuoles in glass and the crystal-forming intergrowth with pyroxene revealed that they are identical and consist mostly of Na, K, and Cl. Electron diffraction patterns prove without doubts that they are sylvite and halite (Fig. 1a, b).[*]

Fig. 1a - Aggregate of sylvite and halite from vacuole in glass, b - sylvite and halite in microvacuoles in glass inclusions in pyroxene. Transmitted electron microscope images. Insets show electron diffraction pattern of sylvite and halite related to planes (001) and (110).
Fig. 2 - Glass with microvacuoles. Scanning electron image.
Fig. 3 - Potassium (a) and chlorine (b) in microvacuoles. Image in characteristic x-ray radiation, superposition with image in backscattered electrons.

Crystals of those minerals occur in close intergrowths; individual crystals are much rarer. In the suspension preparations formed using doubly distilled water, dendrites typical of halite and sylvite were observed. They formed during crystallization on the preparation surface.

Scanning images obtained with the "Camebax" microscope showed that the glass vacuoles varied in size from 1 to several tens of μm (Fig. 2). Numerous vacuoles bear crystals of sylvite and halite. Images in K K_α radiation (Fig. 3a), and ClK_α (Fig. 3b), definitely prove the connection of K and Cl with the vacuoles (determinations of Na were not performed). The presence of excess Cl indirectly confirms the presence of Na in addition to K atoms.

Electron microscopic study of substance taken from the vacuoles in glass permitted recognition, in addition to sylvite and halite, of oldhamite (calcium and sulfur were found, and the size of the face-centered cubic unit cell was 5.7A) and kamacite (α-iron) grains with a body-centered unit cell of 2.87A. Kamacite bears some nickel. From the fact of maintenance of the symmetry of the face-centered (sic. A.K.) cubic lattice of kamacite we concluded that Ni replaced iron atoms in the α-Fe structure in a disordered array.

Pyroxenes bearing the inclusions vary from pale-yellow to dark-brownish in micrometers. Brownish pyroxenes consist mostly of augite with subordinate pigeonite. Inclusions in pyroxenes are platy glass drops, distributed irregularly between pigeonite blocks.

The glass inclusions bear microvacuoles containing sylvite and halite (Fig. 1b). The chemical composition of the glass is variable, but generally close to pyroxene composition. These facts suggest that pyroxenes formed from a melt enriched in volatile components under conditions of rapid cooling. Formation of glass inclusions bearing halite and sylvite may be connected with impact phenomena. During partial melting of pyroxenes the Na and K concentrated in melt and then, as a volatile phase, into vacuoles and micro fractures.

Thus, during studies of regolith sample A5-24, the first occurrence of halite and sylvite in lunar pyroxene and glasses was found. Oldhamite and kamacite also occurred with the halides.

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[*] Ed. note: the photomicrographs are too poor in the original to be reproduced here.

DOLGOV, Yu.A. and SHUGUROVA, N.A., 1974, Results of studies of gases from inclusions in Lunar glasses: Lunar soil from Mare Serenitatis:"Nauka" Publ. House, pp. 357-362 (in Russian). Translation by A. Kozlowski (Editorial note - wherever the text is obscure, assume a "sic." has been added, as translation was word-for-word)

Abstract

Gases from glass chips and spherules, collected by "Luna-16", were studied by use of the absorption-volumetric method. Gases were determined in inclusions in eight particles rarely exceeding 500μm in size whereas inclusions themselves were of tens of μm in length. Eighteen analyses were performed. Gas mixtures in inclusions are of two-, three-, and four-component types, CO_2+H_2; CO_2+H_2+(N_2, and rare gases) or(H_2S,SO_2, NH_3)+H_2+(N_2, rare gases); (H_2S, SO_2, NH_3)+CO_2+H_2+(N_2, rare gases), respectively. Sulfur-bearing gases and possible ammonia in 12 analyses range from 8 to 53.5 vol.%. Carbon dioxide in 12 analyses - 3 to 61 vol.%. Nitrogen and rare gases in 13 analyses - 9.4 to 77 vol.%. Hydrogen in all eighteen analyses - 10-15 vol.%. Diffusion influence of the Earth's atmosphere was absent, since in numerous vacuoles oxygen and nitrogen haven't been found. Inexpectable high density of gases in vacuole was ascertained. Initial volume of bubbles on opening of vacuoles even increased 2.5 times or it decreased from 2.3 to 54.5 times. Such density does not correspond with Lunar atmosphere. Various ways of forming of glass chips and spherules are discussed.

Amongst various particles of Lunar soil brought by "Luna-16", chips of transparent greenish and brownish glass less than 1 mm in size were found. In moderate or fine grain classes of Lunar soil, separated in the Vernadskiy Institute of Geochemistry and Analytical Chemistry, round and slightly deformed glass spherules were found; they were of various color and transparency and rarely >500μm in size. In transparent glass spherules and chips of glass, spherical or slightly deformed vacuoles were observed (Figs. 1-3). Vacuoles have dimensions of some tens of micrometers and they were filled with homogeneous substance (gas). Some vacuoles close to the surface of particle, were opened or they had thin fractures invisible in microscope, but connecting them with the Earth's atmosphere. Inclusions of gases in spherical vacuoles of Lunar glasses were very similar to those in tektites and obsidians, which have been studied earlier (5).

We had an opportunity to pick up particles bearing inclusions with gas. Nine particles were taken from three specimens: five glass spherules, three chips of glass and one chip of gray fine-grained rock.

Description of particles of Lunar soil. First spherule. Pale-yellow, translucent with a large number of bubbles of various size (see Table, analyses 1-6). Three inclusions were obviously opened, with cracks visible under microscope. The others did not leak. The surface of spherule is slightly rough, likewise numerous minute particles have been sealed to the surface. Shape is not perfectly spherical, but slightly flattened. In one cross-section it is a circle with dia. 350μm, in the perpendicular one-ellipse with the short axis 280μ m (Fig. 1).

Second spherule. Pale-brown, translucent with small number of tiny gas bubbles and with clear smooth surface. Its shape is perfectly spherical, dia. 400μm, analyses 7-9 (Fig. 2).

Third spherule - dark-brown, weakly translucent, surface smooth and shiny. G bubbles can be seen with difficulty in special illumination. It bears one big and several small bubbles. The shape almost perfectly spherical, dia. 400 μm (analysis 10).

Fourth spherule -ellipsoid, heterogeneous; in yellow-green glass there are included angular particles of opaque mineral without any traces of melting. In the end of this drop-like particle, a "nose" of transparent glass with broken edge is visible. It is similar to a dumb-bell broken in the thin part. Dimensions 530 by 400 μm. There are no inclusions visible in transmitted light.

Fifth spherule is dark, opaque and smooth, with several minute holes in the surface. Inclusions were not found since spherule is opaque; on crushing gas bubbles were not observed (analysis 11).

First glass particle is an angular chip, translucent in transmitted light in brown color. It bears numerous gas bubbles of various size. On broken surfaces the cavities from opened vacuoles are visible. Glass is homogeneous, on the basis of the distribution of color. Broken surface is angular, sometimes shell-like. Surface with traces of melting is absent, the whole surface of the chip is attributable to cracking or breaking. Dimensions 700 x 420 x 400 μm (analyses 12-13).

Second glass is a chip of nearly rectangular shape. Its color is dark-brown, with weakly translucent edges. Outer surface is slightly rough, inner one with easily visible curvature is completely smooth, even and shiny. Broken (side) surface is shell-like or angular. The chip is similar to a layer of sphere, its dimensions are 700-400 μm at outer side, 550-420 μm at inner one, its thickness has average value 200 μm. Near the inner surface rare tiny gas-filled inclusions are visible.

Third glass is a chip of light, transparent, pale yellow-greenish substance, bearing numerous spherical vacuoles with gas. Part of large vacuoles occurring near the surface are broken and inclusions are filled with air. This chip has triangular cross-section (430 x 490 x 420 μm) and it resembles a sectorial part of large sphere. Outer surface and inner cleavage surfaces are shiny and smooth. Cleavage surfaces bear numerous traces of opened spherical vacuoles (analyses 14-17, fig. 3).

Fine-grained porous rock forms angular chip; it consists of gray highly porous substance. Fine-crystalline structure is recognizable; supposedly it is basalt. Maximum dimensions >1000 μm.

Absorption-volumetric method. Earlier papers dealing with studies of Lunar rocks collected by American crew of "Apollo-11" contain suppositions on composition of common gases. Some authors (13), during searching for hydrocarbons in the Lunar surface, have stated that main part of carbon as CO_2 in lunar material is trapped as gas in bubbles occurring inside glass spherules. Semiquantitative data on nitrogen and hydrogen were gotten by use of microprobe technique (15). During studies of particle tracks, on heating under vacuum following gases were found among products of decomposition: H, He, Ne, Ar, N, traces of Kr and Xe. Also common gases were observed: CO_2, CH_4, H_2S, HCl, C_6H_6 etc. (14). Vacuum and low-density gas inclusions were found in Lunar olivines, but their composition was not analyzed (17).

Concluding the earlier studies of gases in Lunar rocks, it may be mentioned that rare gases in the "Apollo-11" samples are studied remarkably better than common ones. Numerous quantitative measurements of rare gases were performed with high accuracy for small amounts of gases, whereas common gases were only supposed to be present or they were determined qualitatively at best.

Use of the absorption-volumetric method for studies of gases from inclusions in terrestrial minerals (4) is based on experience of analyses of more than 3000 specimens. Some attempts were made also for cosmogenic material - tektites and cosmic dust. This permitted the application of the established scheme of analyses for small volumes of gases, which supposedly were in inclusions in Lunar glasses.

Absorption-volumetric method was applied for analytical purposes by A. Kroh (1911, 1913), I. Ens (1935), V.G. Voano (1937), V.T.Slavyanskiy and Ye.I. Krestnikova (1956), V.T. Slavyanskiy (1957), N.A. Pankova (1961) and by authors of this paper (Yu.A. Doglov, N.A. Shugurova, 1966; N.A. Shugurova, 1965) - see (16, 12, 1, 9, 10, 8, 11). For purposes of demonstration, without analysis of gas mixture, this method was applied by Deicha (1950) and E. Roedder and Weiblen (1970). In the method used by the authors, inclusions are opened under the microscope in an inert liquid by way of crushing in the stage with special lenses. Lower bowl-like lens bears inert liquid, which covers specimen with inclusion. G as individual phase or dissolved in liquid goes from inclusion to the inert liquid. Then, G bubble by use of micropipette is selectively adsorbed by various reagents (...). By use of the proposed scheme, the following component of G mixture may be determined: 1) H_2S+SO_2+NH_3+HCl+ HF; 2) CO_2; 3) hydrocarbons; 4) O_2; 5) CO; 6) H_2; 7) N_2+rare gases. Sensitivity of the method is 0.5-1%, mean arithmetic deviation 4%, mean square deviation - 0.4%.

After sorption of each gas or gas group, the determination of gas bubble volume is made and content of each component is calculated in vol.%. More detailed data on the method may be found in papers (4, 11). Results of analyses were published in numerous articles. Studies of G inclusions in tektites are most comparable with studies of inclusions in Lunar glasses (5, 7).

Opening of vacuoles with gas and measurements in inert liquid. Before the opening, vacuoles in all particles were essentially spherical voids. After opening the G volume decreases 2.32-54.5 times. In two cases volume increased (2.64 and 2.50 times). When a fracture intersects vacuole bubble of G easily comes out into inert liquid. If the fracture only opens the vacuole without complete crushing, liquid flows into the inclusion, making it a two-phase one. The second case needed additional efforts to put G bubble into inert liquid for analysis.

On crushing of brown glass specimen chip type No. 1, in addition to a G bubble a transparent light spherule of 14 μm dia. was found between glass chips; this spherule had been inside a mass of brown glass. It contained one inclusion of dia. < 1 μm. On crushing specimen No. 2 consisting of brown substance, together with tiny G inclusions, also dark opaque ball of dia. 22.6 μm was found. It resembled, by its behavior, a kind of porous substance, developing slow emanation of gas. In inert liquid a radial translucent fracture was observed in this ball. On the edge of this fracture G bubble has begun to appear, which reached 16 μm in dia. in several minutes; this G. bubble has been analyzed. On the opposite side of the ball, another G bubble has formed, but after reaching dia. 2-3 μm it stopped its growth. Pressing in the crushing stage caused deformation of the ball and appearance of new G bubbles and, after complete crushing, nine bubbles have been found in inert liquid.

Two specimens were not crushed (grain of basalt and glass chip No. 2). One spherule crushed with forming of surprisingly tiny chips. Crushing of the largest of the obtained chips did not give further G bubbles. Spherule No. 6 was dark, glassy, with poorly visible inclusions. It was heterogeneous, with dark inclusions (solid?-A.K.); in essential glass matrix it did not bear inclusions; G bubbles in inert liquid also were not found.

Absence of dissolving properties of inert liquids. One of the main remarks concerning method is that there exists no liquid which will preserve a gaseous mixture, for a long enough time without absorbing gases. Experiments performed with liquids of appropriate viscosity revealed two liquids: the first one (L-1) begins to absorb gas slowly in 25 min.; the second one (L-2) - in 20 min. Liquids may be prepared which only absorb gases in several hours or more, but total time of presence of the gas bubble in the inert liquid is less than 5-15 minutes (measurements of dia.; sometimes taking photos).

Possibility of diffusion into vacuole and from vacuole. Terrestrial minerals contain inclusions of $P > P$ atm due to presence of CO_2. Hence, after crushing, gas bubble volume always increases, excluding rare cases of small decrease of G volume from bubbles in volcanic glasses (obsidians). In presumably cosmic objects (tektites, cosmic dust) G mixture always decreases in volume on crushing (5, 7).

Thus, there exist inclusions with $P > P$ atm and with $P < P$ atm. The diffusion rate of gases through various solids may be very different, and this causes the possibility of change of primary gas composition in inclusions. In spite of exact data on the possibility and rate of diffusion in artificial materials, for geological objects this question is still nebulous, especially from the point of view of long periods of geological time.

Two examples cited below may support the opinion that diffusion of gases from inclusions through solids (minerals, glasses) in fact is not measurable, even for long (geological) periods of time.

1. Inclusions in moldavites (tektites) were studied (5). Those glasses of problematic origin bear inclusions - spherical or ellipsiodal vacuoles with gas. On crushing, gas volume decreases up to 3000 times, and gas does not contain the components of air; it consists of small amounts of sulfur bearing gases (3-4%); CO_2 (50-70%), H_2 (20-40%), and N_2 (0.18-6.1%). Composition of gas mixture from inclusions is essentially different than air and it did not alter chemically due to presumed diffusion in 15 million yr. Physical state of G mixture is characterized by low density ("high vacuum"), which also did not appear in equilibrium with P atm in 15 million yr.

2. In metamorphic rocks of SE Altay (6) in kyanite, tiny inclusions of L nitrogen were found. At 20°C N_2 in inclusions has a density (corresponding to) $\geqslant$ 1000 atm. Age of the rocks often is higher than 200 million yr. Neither diffusion nor time could achieve equilibrium of those inclusions (in chemical or physical sense) with air or pore gases of different composition. There is no necessity to generalize those studies, and to use them as the examples against diffusion at all. However they indicate that in a number of cases diffusion into or from vacuole is absent or it is so small even in ranges geological time, that it cannot be measured with sufficient accuracy.

Obtained results of composition of gases in glasses of Lunar soil. Results of analyses performed for 6 Lunar particles (3 glass spherules, 1 black spherule from glass spherule and 2 glass chips) are listed in the Table. From 18 opened and analyzed inclusions, five were not measured before crushing (analyses 11-13). One gas bubble came from the opaque internal spherule (analysis 9), and its initial volume was not measured.

Other G bubbles came from vacuoles which were not supposed to crush but they were crushed together with the studied vacuole. Initial dia. of four G bubbles were measured and their decrease was calculated; however, due to the lack of time, analyses were not performed (bubbles were in inert solution more than 25 minutes). It was when G bubble after crushing decreased inside vacuole.

Conclusions are as follows:

1. G mixtures in inclusions consist of two, three and four components: CO_2, H_2; CO_2, H_2, (N_2 + rare gases); (H_2S+SO_2+NH_3), H_2, (N_2 + rare gases) and H_2S+SO_2+NH_3), CO_2, H_2, (N_2 + rare gases).

2. Sulfur-bearing gases plus possible NH_3 occur in 12 of 18 analyses occupying 8 to 53.5 vol.%.

3. CO_2 occurs also in 12 analyses (3 to 61 vol.%).

4. H_2 is present in all analyses (except air bubble), its content equals 10-95 vol.%.

5. N_2 + rare gases occur in 13 analyses - 9.4 to 77 vol.%.

6. Accuracy of analyses is illustrated by results obtained from two bubbles of identical volume released from the same inclusion (analyses 4 and 5). The analyses show insignificant differences.

7. Volume decrease of gas on crushing is small (much smaller than, e.g., for inclusions in some tektites) and it ranges from 2.32 to 54.5.

8. Two G bubbles (analyses 14 and 15) were in vacuoles under $P > P$ atm (2.5-2.64).

9. One air bubble released from inclusion that leaked, was analyzed.

Very different cosmic material falls both on the Earth's and Lunar surfaces. It is assumed to consist of cometary, meteoric, protoplanetary and Lunar, (indigenous) particles.

Discussion of the results. Relatively high density of gases is the most surprising result, since this differs strongly from the Lunar atmosphere. If Lunar glass spherules are the result of meteoric impacts, melting and cooling as droplets, in this process very complete escape of gases from melting substance may be expected. However, inclusions in Lunar spherules do not confirm this suggestion. Another explanation is that in Lunar soil spherules of various origin accumulated: Lunar ones - of impact origin, without gas inclusions; and extralunar, cosmic ones - formed under conditions different than those on the Lunar surface. The writers picked spherules bearing gas inclusions, although bubble-free spherules made up most of the material.

Some analogies may be made for glass spherules found by the writers in deep-water sediments of Pacific Ocean (Tonga Trough). Those spherules also are very variable, mostly without inclusions and it is possible, that they came from the Moon to the Earth's surface.

The second group of spherules that bear inclusions, presumably originated from other than the Lunar surface, on the basis of the density of gas in the inclusions.

2. Presence of H_2 may be a typical feature of all Lunar spherules. This same feature appears in certain spherules collected in deep-water oceanic sediments, part of the spherules from the peat layer corresponding to the year of fall of the Tungusskiy phenomenon, and in some tektites (moldavites).

3. Significant amounts of N_2 + rare gases were found in inclusions in Lunar spherules. There is no data on the relative amounts of N_2 or

rare gases in the mixture determined by group reagents; it may consist only of N_2, only of rare gases or of mixture with any ratio of both components.

4. Certain analyses revealed very high contents of CO_2 and sulfur-bearing gases or NH_3.

Consequently, one may suppose very different sources of material of Lunar soil. Spectrophotometric studies of comets reveal prevailence of hydrogen. Hypotheses on formation of the Moon from the Earth's ring also suggest the important role of H_2.

Possibility of intact preservation of gases, taking into account both their composition and amount, is the most difficult problem. Certain facts and examples were given above. Lunar material was under special conditions. Rapid transport from Lunar to terrestrial conditions results in no necessity of considering long time intervals for diffusion. However, time and place of melting of Lunar particles is still unknown. We can suggest only doubts on late formation of all particles. If some particles formed late (some million yr), undoubtedly diffusion with Lunar atmosphere did not occur. Short period of terrestrial existence of the particles and absence of the air components in inclusions also exclude contamination with terrestrial atmosphere. Leaked inclusions were distinguished easily by presence of air components, under the aegis of an organizing collaboration of academicians A.P. Vinogradov, A.A. Trofimuk, and V.S. Sobolev, and practical help of GEOKHI workers; Yu.I. Stakheev, V.B. Naumov, L.S. Tarasov, the worker of IKI - A.V. Ivanov and workers of IGiG, G.M. Ivanova, N.M. Popova, S.G.Motorina. The help of all these persons is graciously acknowledged.

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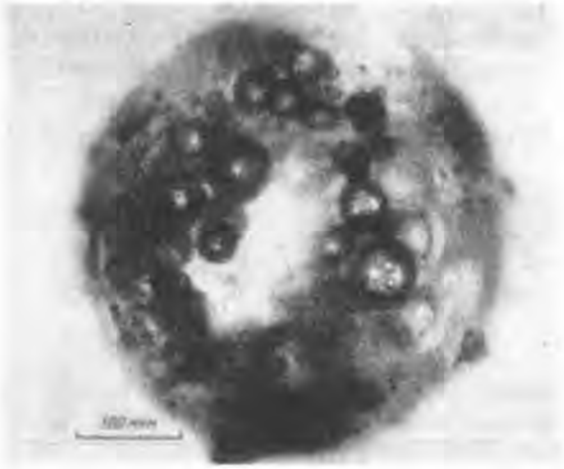

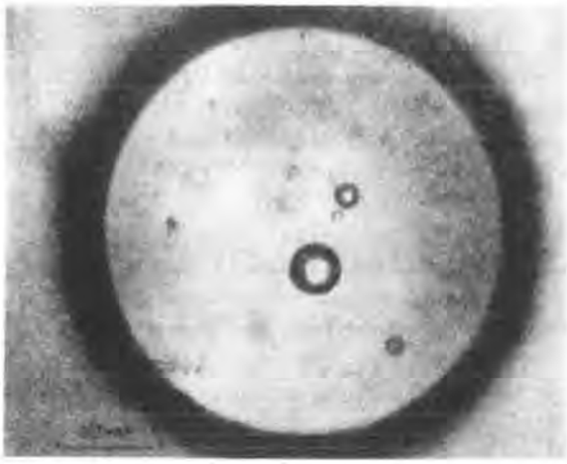

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Fig. 1. Spherule No. 1, glassy, pale-yellow with large number of inclusions

Fig. 2. Spherule No. 2, glassy, pale-brown with minute G bubbles.

Fig. 2. Chip no. 3 of yellow-green glass with numerous inclusions.

Table. Results of quantitative analysis of gas phase of individual inclusions

No. of analysis	No. of sample	Dia. of gas bubble after crushing, mm	Increase (+) or decrease(-) of bubble vol.	Concentration, vol. %				
				$H_2S+SO_2+NH_3$ $+HCl+HF$	CO_2	H_2	N_2 + rare gases	Total Volume
1	Spherule No.1	0.126	-	15.9	0.0	74.4	9.7	100.0
2		0.040	-	13.6	0.0	75.7	10.7	100.0
3		0.042	1.59(-)	23.0	28.2	28.4	20.4	100.0
4		0.017	6.90(-)	53.5	35.5	11.0	0.0	100.0
5		0.017	-	53.0	35.0	12.0	0.0	100.0
6		0.029	-	19.3	30.7	22.8	27.2	100.0
7		0.018	14.80(-)	11.0	61.7	not analyzed		
8		0.035	-	0.0	29.8	14.9	55.3	100.0
9		0.016	-	52.2	32.2	15.6	0.0	100.0
10	spherule No.3	0.014	16.6(-)	0.0	4.5	95.5	0.0	100.0
11	spherule No.5	0.084	-	0.0	0.0	0.0	80.1	100.0
12	glass No.1	0.034	14.3(-)	9.7	21.7	29.2	39.4	100.0
		0.009	17.7(-)					
		0.013	54.5(-)					
		0.021	4.67(-)					
13		0.005	7.22(-)	21.0	21.7	27.7	29.6	100.0
		0.006	6.37(-)					
14	glass No.3	0.156	2.64(+)	0.0	3.9	15.4	80.7	100.0
15		0.090	2.5(+)	0.0	3.0	17.7	79.3	100.0
16		0.080	-	0.0	13.0	10.0	77.0	100.0
17		0.004	17.7(-)	8.0	20.2	30.5	41.3	100.0
18		0.030	20.7(-)	19.9	45.3	34.8	0.0	100.0

Anal. notes: 9 - Black ball 22.6µm; 11 - Leaked inc. with air; 12 - Sample 3 (?-sic.); 12(4) - Transparent ball 14µm; 14 - Sample 12(sic.). Hydrocarbons not analyzed; no CO found in any sample; O_2 found only in analysis 11 (19.9%) - all others 0.0%

LEMMLEIN, G.G., 1952, Migration of liquid inclusions in a crystal toward a source of heat: Akad. Nauk SSSR Doklady, v. 85, no. 2, p. 325-328 (in Russian). Author at the Inst. of Crystallography of the Acad. Sci. of the USSR, Moscow. (Translation courtesy A. Kozlowski).

In the paper on healing of fractures I showed that that process may be realized by saturated solution under isothermal conditions (1). Substance necessary for healing is taken from the walls of fracture, and energy needed for that process of reconstruction of part of crystal is derived from the released surface energyof the system crystal-solution in the capillary fracture. Remnant portions of the saturated solution trapped during fracture healing (liquid inclusions) continue to change their habit to achieve a minimum surface and crystallographically stable shape with minimum energy surface. Especially this process is remarkable for strongly elongated inclusions, with habit inherited from the shape of embayments of solution between branches of dendrites healing the fracture. Such an elongated inclusion with essentially excess surface tends to diminish the vacuole surface. During this process part of the released energy is radiated in form of heat.

If the inclusion length exceeds the width and height no more than 2-3 times, the length decreases and two other dimensions increase slowly, and the vacuole achieves strictly isometric habit. Of course the rate of change is very small. Thus, the full cycle of alteration of a vacuole until it achieves the equilibrium habit, may be observed only on very small inclusions (up to 0.01-0.05 mm). T increase makes this process much faster.

If the length of inclusion exceeds significantly its width and height, usually in both ends of the elongated inclusion a sequence of small almost isometric inclusions separates. Rarely long inclusions divide into several shorter ones.

This process was studied in detail during healing of fractures in a crystal of $NaNO_3$, using a motion picture technique.

Process of separation goes exclusively as follows: at first the end of the elongated inclusion becomes wider, and dissolved material redeposits in the neighborhood of the tubular part of the vacuole, making it more narrow, and this capillary becomes hardly visible under high magnifications. Sealing of the capillary goes from both ends: from the end adjacent to the newly separated inclusion and from the end adjacent to the parent vacuole, with simultaneous widening of the end of parent vacuole. The small inclusion separates completely and a new inclusion is already formed. On the other hand, cases were observed when two inclusions, which almost separated and seemingly were almost ready for formation of two daughter vacuoles, have begun to change their habit by the opposite course, the capillary diameter increases and its length decreases, and two vacuoles join in one equant inclusion.

Further development of the tiny capillary channel existing between parent and daughter inclusion is extremely interesting. Its separation is at first in one end, and next it is either "sucked" by inclusion still joined with it, or it separates also at the other end of the channel. Consequently, an extremely small (5-10um) elongated inclusion forms between the two separated inclusions. This "intermediate" tiny inclusion changes its habit very quickly and obtains equilibrium shape long before the large inclusions get their equilibrium habit.

Dimensions of the intermediate inclusions in my experiments with healing of fractures in $NaNO_3$ crystals did not exceed a few µm. Such small inclusions and the solubility of $NaNO_3$ strongly increasing with T increase permitted observation of the dramatic phenomenon of migration of small liquid inclusion in a crystal toward the heat source. Local heat source was in this case the separated large inclusion, continuing the dimunition of their vacuole surface and thus radiating as heat the excess of surface energy. (sic). Around such an inclusion altering its habit, a temperature gradient appears. The tiny intermediate inclusion is sensitive even to so small a gradient. On the walls of the small inclusion facing the heat-radiating large inclusion, substance dissolves and then precipitates on the opposite walls. This fact results in migration of tiny inclusion toward the inclusion altering its habit. Migration of the tiny inclusion was observed to a distance exceeding several times the length of inclusion itself. When the altering inclusion achieves its equilibrium habit, the migration of tiny inclusion, in fact, is precluded. In a few cases, migration of the tiny inclusion continued until joining with large inclusion radiating heat.

Fig. 1 presents the series of micrographs, showing formation and migration of the tiny inclusion. The experiment was carried at 20°C. The micrographs are strongly magnified fragments of pictures of 16 mm movie film, some of which were published in a paper in 1951 (1). Here, formation of two tiny inclusions is presented. One, formed in the left part of the view field, appeared in the middle between inclusions developed by dividing of large inclusion in half. This tiny inclusion does not change its position (Fig. 1, a-c). The second tiny inclusion, in the right part of the view field, formed somewhat later than the first one. The inclusions between which it appeared are some different in size (Fig. 1, d-f). The lower, smaller one, earlier achieved the equant equilibrium habit, but the upper, elongated one, with large volume, radiated heat on altering of its habit. The tiny inclusion, existing between these two inclusions, began thus to migrate toward the inclusion changing its habit (Fig. 1 g-h). When the large inclusion achieved more or less equant stable habit, the small inclusion stopped its migration (Fig. 1,i)

Fig. 2 presents the short series of micrographs showing the "preparation" of an inclusion for separation (a), formation of the intermediate tiny inclusion (b) and the moment when the tiny inclusion, due to migration toward the altering inclusion, joins the latter and ceases to exist (c).

It would be difficult to set up a better special experiment than that shown here, which would present better the emanation of excess energy on decrease of surface: crystal-saturated solution. The described phenomenon of migration of tiny inclusion is the undoubted evidence of the endothermic character of the fracture healing process in crystals. Moreover, under conditions of decreasing T, the process of fracture healing in a crystal is faster due to decrease of excess of dissolved substance.

Tiny inclusions formed between large separated inclusions are very common among P, and especially S inclusions in crystals of easily soluble substances like halite (NaCl). In minerals of low solubility like quartz, topaz, beryl, etc., tiny inclusions are observed only in fractures healed at relatively high T, when inclusions achieved a more or less equilibrium habit. In fractures healed at lower T, although various phenomena connected with the process of transformation of inclusion habit were observed, usually that process did not lead to the equilibrium shape, and the inclusions have the "frozen" intermediate habits pertinent to various stages of necking-down. Such forms include inclusions with long, very narrow channels or "tails," with an interrupted junction with the other inclusion.

(Figures on page 254)

Institute of Crystallography of the Academy of Science of the USSR

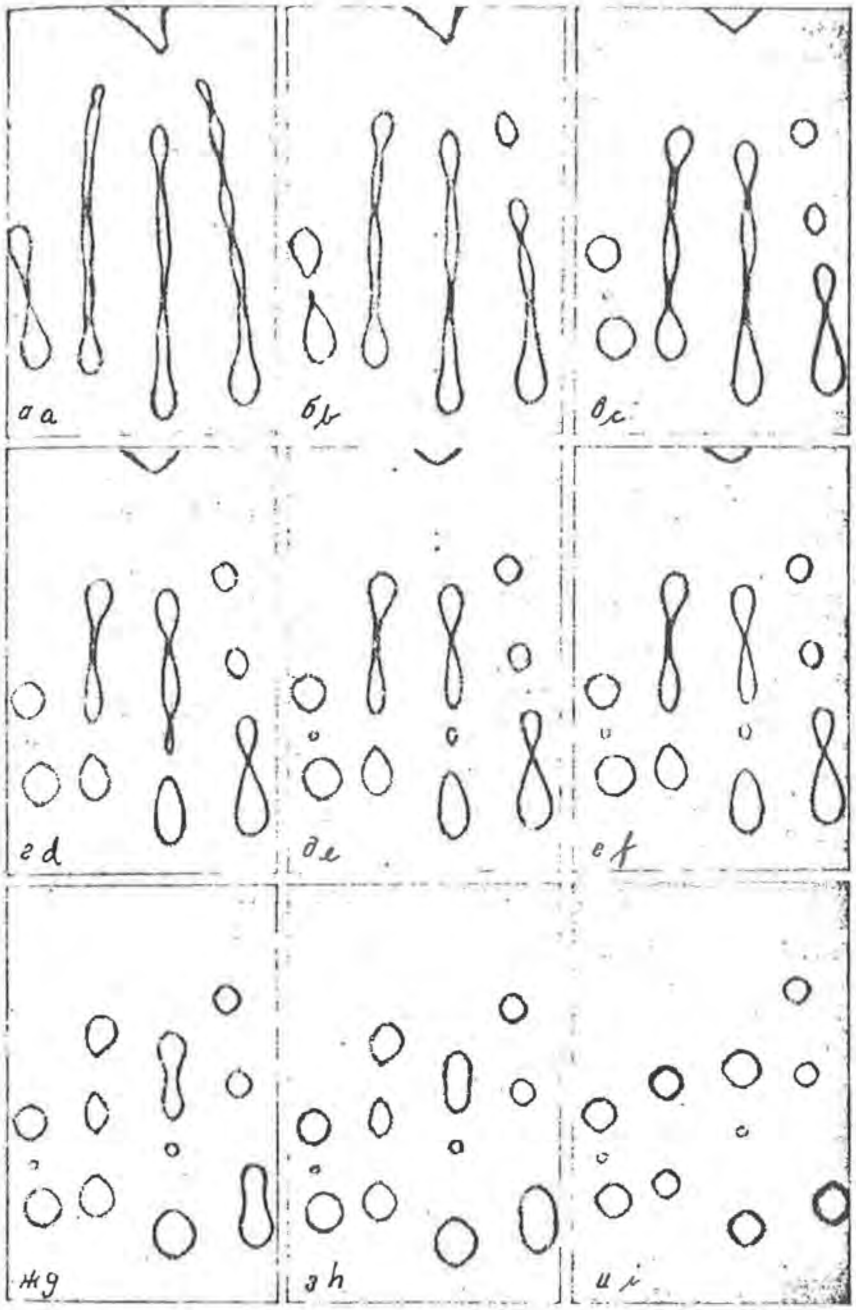
21.V.1952

LYAKHOV, Yu.V., 1973, Errors in determining pressure of mineralization from gas-fluid inclusions with halite, their causes and ways of eliminating them: Zapiski Vses. Mineral. Obsh., v. 102, no. 4, p. 385-393 (in Russian; translation by D.B. Vitaliano, with editing by A.K. and E.R.)

(Editor's note: The conclusions in this paper were disputed in a recent publication (Roedder and Bodnar, 1980, Ann. Rev. Earth Planet. Sci., v. 8, p. 263-301), and hence this translation is published, even though old.)

In the course of investigating inclusions of solutions in minerals from a number of endogenetic deposits of East Transbaikalia, it was established that high-temperature hydrothermal solutions, in which the sodium chloride content often reached 25-50% or more, took part in the formation of gold and molybdenum deposits, following gaseous solutions. The phase composition of pseudo-secondary inclusions at room temperature

(continued page 255)



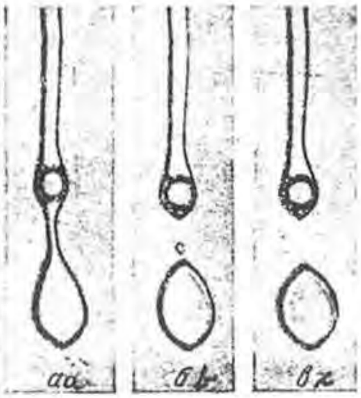


Fig. 1. (left) Formation and migration of a tiny inclusion, x450. Time intervals between photos: a-b 16 min., b-c 20 min., c-d 11 min., d-e 75 sec., e-f 105 sec., f-g 31 min., g-h 18 min., h-i 3 days.
Fig. 2. Formation and disappearance of a tiny inclusion, x400.

Figures for Lemmlein, 1952

varied as follows: gas --15-30%, halite--15-30%, fluid aqueous solution--50-60%. Pulverization of pure quartz samples in a vacuum showed that in contrast to quartz bearing essentially gaseous inclusions, after freezing of the water they are characterized by only very insignificant liberation of gas. Evidently in this case the gas phase of the inclusions with halite consists mainly of vapors of the aqueous solution. The presence of any appreciable amounts of carbon dioxide or other gases was not observed in cooling and freezing.[1] Families of such inclusions are common in the early generations of minerals in the Kariyskoye (tourmaline, scheelite, quartz) and Darasunskoye (quartz associated with molybdenite and tourmaline) gold deposits, and also, judging from the data of A.V. Piznyur, for the early generations of quartz in many molybdenum deposits (Zhireken, Shakhtama, Bugdaya, and others).

A typical feature of inclusions of this type is the fact that when they are heated, first the gas phase disappears (partial homogenization), and only after that does final solution of the halite take place (complete homogenization). Disappearance of the gas phase of such inclusions occurs in the temperature range of 200 to 370°C, and the halite is dissolved at a temperature of 300 to 450°C. When specific associations of such inclusions are studied, the temperature range of their complete homogenization usually is much narrower and does not exceed 5-10°. This enables us to consider the solid phase of halite to be daughter minerals, not "satellites" in the usage of Ermakov (1950; i.e., not accidental solid inclusions). In this case the temperature of solution of halite is somewhat reduced compared to the temperature of isolation of the inclusion and therefore can be taken only as the minimum temperature of mineralization.[2] The difference between the temperature at which the gas phase disappears and the higher temperature of solution of the daughter mineral is the minimum value of the pressure correction (Smith, 1956). Such a course of homogenization of multiphase inclusions, permitting us to judge the internal pressure of the inclusion at the moment of its complete homogenization with sufficient confidence, brings us much closer to an estimate of the true pressure existing during mineralization (Dolgov et al., 1968). For this, we need to know the precise temperature of complete homogenization of the inclusion and its density at that moment, and also to have information on the concentration of the solution for a correct choice of PTV diagram. In the given case the pressure is determined by the characteristic point lying in the plane of the chosen PTV diagram (Fig. 1) at the intersection of the T isotherm and the D_T isochore, corresponding to the moment of complete homogenization of the inclusion. However, reliable determinations of the concentration and density of the

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[1] This becomes understandable in the light of experiments by S. Takenouchi and G.C. Kennedy (1968) which showed that the solubility of CO_2 in sodium chloride solutions decreases rapidly as the salt concentration increases and therefore "there is no reason to expect that the hydrothermal solution will contain large amounts of dissolved CO_2 if its salt concentration is high." The latter has also been confirmed by study of natural objects (Lyakhov and Piznyur, 1969).

[2] Some investigators regard this temperature as that of mineralization. That will be valid only with respect to solutions saturated at the moment of isolation of the inclusion. Therefore it must be kept in mind that trapping of halite as a "satellite" mineral is possible in this case.

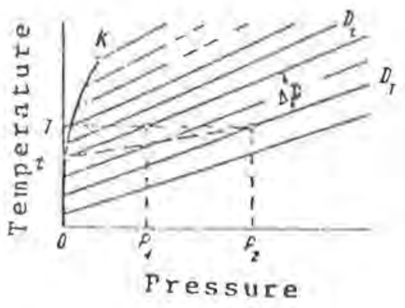

Fig. 1. Isochores of the fluid phase of an inclusion homogenizing by solution of halite.

K - critical point; t and T - temperatures of partial and complete homogenization; D_t and D_T - isochores corresponding to density of fluid phase at temperatures t and T; D - change in density of solution in the interval t-T; P_2 and P_1 - pressure in homogeneous inclusion with and without correction ΔD.

solution of the homogeneous inclusions are attended by known difficulties. Therefore, apparently, some authors arbitrarily take the density of the solution of the homogeneous inclusion as equal to the density of the fluid phase of the inclusion at the moment of its partial homogenization, and the NaCl concentration in the solution as equal to 30%.

In view of the fact that that method of determining pressure is being used more and more often (Piznyur, 1968a, 1968b), it is necessary to assess its precision and ascertain the sources of the most typical errors and ways of overcoming them.

The error in this method is a combination of errors of experimental and interpretational character. Errors of the first type include determinations of the temperature of partial and complete homogenization of the inclusions, which usually are very insignificant (2-3° in a well-calibrated microthermal chamber) and therefore have little effect on the size of the total error. Much more important is the interpretational source of error, which includes assumptions as to the composition and concentration of the solution of the inclusion needed for choosing the PTV diagram, and also establishment of the density of the solution in the inclusion at the moment of complete homogenization.

The solution in the inclusions being analyzed has a very high NaCl concentration. Therefore the presence of a much smaller amount of other components[3] affects the variation in physical properties of such solutions only insignificantly. In the given case it is quite permissible to use the PTV diagrams for aqueous solutions of NaCl, but, this is very important, of appropriate concentration. The concentration of the solutions preserved in the inclusions can be established with known error from the temperature of their partial homogenization (Dolgov et al., 1968) or by the mathematical method proposed below.

Thus the question of the reliability of determination of pressure from multiphase inclusions in essence comes down to the precision of establishing their density in the homogeneous state, i.e. to a correct choice of isochores on the PTV diagram. Choosing the isochores on the basis of the temperature at which the gas phase of the inclusion disappears, as many authors do (Dolgov et al., 1968; Piznyur, 1968a, 1968b), considering the density of the fluid phase to be unchanged from that moment on, obviously is not altogether correct, as subsequent

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[3] In the composition of aqueous extracts from quartz from some gold deposits of East Transbaikalia (Kariyskoye and others), the amount of sodium and chlorine reaches 80-75% and 78-71% equiv., respectively; according to determinations by Zh. A. Simkiv, potassium, lithium, calcium, magnesium, iron, sulfate- and carbonate-ions, etc. are minor.

solution of the solid phase inevitably leads to a change in density of the solution. On the other hand, it increases due to the increase in concentration of the solution, and on the other it decreases as a result of the increase in volume of the fluid phase at the expense of the dissolving solid phase.

Calculation of the correction of the density of the fluid phase of an inclusion, caused by complete solution of halite. This amounts to determination of the density of the fluid phase of gas-fluid inclusions with halite at the moments of their partial (disappearance of the gas phase) and complete (solution of halite) homogenization. This problem can be solved analytically with the necessary precision, on the basis of experimental data for the system H_2O-NaCl.

Let us assume that a certain gas-fluid inclusion containing a halite solid phase reached the state of partial homogenization at a temperature t. The fluid phase of that inclusion is a saturated aqueous solution of sodium chloride. To describe this closed system[4] we will use the following designations: V = volume of the whole inclusion at temperature t (in cm^3); B = volume of the halite solid phase left at the moment of partial homogenization of the inclusion at temperature t (in volumetric%); m_{pt} = weight of saturated NaCl solution found in the inclusion at temperature t (in g); m_{NaCl_t} = weight of NaCl remaining in the crystalline state at temperature t (in g); $d_{H_2O_t}$ = density of water at temperature t (in g/cm^3); d_{NaCl_t} = density of NaCl at temperature t (in g/cm^3); ΔV_{NaCl_t} = thermal expansion of NaCl when heated from 20° to t (in volumetric %); C_t = concentration of aqueous solution of NaCl saturated at temperature t (in wt.%); C'_t = amount of NaCl in 1 cm^3 of water in C_t% solution at temperature t (in g); $\bar{V}_{Ct}$ = decrease in volume of system upon solution of 1 g of salt in the amount of water needed to obtain a C_t% solution (in g/cm^3); V_t = volume occupied in the inclusion by C_t% aqueous solution of NaCl at temperature t (in cm^3).

The density D_t of the solution at the moment of partial homogenization of the inclusion (at temperature t) is determined by the relationship

$$D_t = \frac{m_{pt}}{V_t}.$$

The volume of saturated C_t% solution can be represented as the sum of the volumes of solvent $\frac{m_{pt}\left(1-\frac{C_t}{100}\right)}{d_{H_2O_t}}$ and dissolved matter $\frac{m_{pt}C_t}{100 d_{NaCl_t}}$, decreased, as follows from the work of G.G. Lemmlein and P.V. Klevtsova (1956) by the quantity $\frac{m_{pt}C_t}{100}\bar{V}_{C_t}$. Hence

$$D_t = \frac{m_{pt}}{\frac{m_{pt}\left(1-\frac{C_t}{100}\right)}{d_{H_2O_t}} + \frac{m_{pt}C_t}{100 d_{NaCl_t}} - \frac{m_{pt}C_t}{100}\bar{V}_{C_t}} = \frac{100 d_{H_2O_t}}{100 - C_t + \frac{d_{H_2O_t}}{d_{NaCl_t}}C_t - C_t\bar{V}_{C_t}d_{H_2O_t}}. \quad (2)$$

These same authors concluded that it is possible "to extend the monotonic change V(C) to solutions with concentrations exceeding the solubility of salts at room temperature," which makes it possible to determine the value $\bar{V}_{Ct}$ for saturated NaCl solutions with concentrations of 31.5-43.9% (see table.

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[4] In view of the lack of reliable data on any perceptible deposit of consanguineous material on the walls of the inclusions, the possibility of solution of such material is not taken into account.

Taking into account the volumetric thermal expansion of NaCl, the size ΔV_{NaCl_t} of which has been established for temperatures 100, 200, 400, and 600° (Skinner, 1969), we have $\Delta V_{NaCl_t} = \frac{V_{NaCl_t} - V_{NaCl}}{V_{NaCl}} 100\%$, where V_{NaCl} and V_{NaCl_t} are the volumes of different amounts by weight of sodium chloride at room temperature and at the given temperature. Hence

$$V_{NaCl} = V_{NaCl}\left(1 + \frac{\Delta V_{NaCl_t}}{100}\right),$$

$$d_{NaCl_t} = \frac{d_{NaCl}}{1 + \frac{1}{100}\Delta V_{NaCl_t}}, \tag{3}$$

and

$$D_t = \frac{100 d_{H_2O_t} d_{NaCl}}{d_{NaCl}(100 - C_t - C_t \bar{V}_{C_t} d_{H_2O_t}) + d_{H_2O_t}\left(1 + \frac{1}{100}\Delta V_{NaCl_t}\right) C_t}. \tag{4}$$

To ascertain the error permissible in such calculations, we calculated the density of saturated solutions of NaCl at temperatures of 100 and 200°. Comparison of the results obtained with the experimental results showed that the relative error is quite acceptable and does not exceed 4%.

The density of the fluid phase of the same inclusion at the moment of complete homogenization at temperature T can be expressed as follows:

$$D_T = \frac{m_{p_t} + m_{NaCl_k}}{V} = \frac{\left(V - V\frac{B}{100}\right) D_t + V\frac{B}{100} d_{NaCl_t}}{V} = \left(1 - \frac{B}{100}\right) D_t +$$

$$+ \frac{B}{100 + \Delta N_{NaCl_t}} d_{NaCl_t}. \tag{5}$$

The change in density ΔD of the fluid phase of the inclusion in the temperature range from t to T from the moment of its partial to its complete homogenization is expressed by the equation

$$\Delta D = D_T - D_t = \frac{B}{100 + \Delta V_{NaCl_t}} d_{NaCl} - \frac{B}{100} D_t. \tag{6}$$

Substituting expression (4) for D_t, we find that

$$\Delta D = B d_{NaCl}\left[\frac{1}{100 + \Delta V_{NaCl_t}} - \right.$$

$$\left. - \frac{d_{H_2O_t}}{d_{NaCl}(100 - C_t - C_t \bar{V}_{C_t} d_{H_2O_t}) + d_{H_2O_t} C_t\left(1 + \frac{1}{100}\Delta V_{NaCl_t}\right)}\right]. \tag{7}$$

Calculation of the concentration of the solution of the homogeneous inclusion. The concentration of the solution isolated in the inclusion is one of the main parameters on which the precision of barometric determinations depends to a substantial extent. First and foremost, it is necessary to know this value in order to choose the PT projection, which is the basis of direct measurements. Therefore we will attempt below to show the possibility of establishing the total concentration of the solution (C_T) analytically, bringing in the same raw data as in determining the density. The necessity for this lies in the fact that the temperature of complete homogenization of inclusions of the type in question (T) makes it possible to judge only the minimum possible concentration of the solution, inasmuch as at present the experimental data available for the system H_2O-NaCl are limited just to the pressure range of the vapor phase (up to 380 kG/cm^2). But in the inclusions in which we are interested, considerably higher pressure is developed after the gas phase disappears, i.e. under conditions of higher temperature than the temperature of partial homogenization.

In view of the fact that the inclusion is a hermetically sealed system, the amounts by weight of the components contained in it remain unchanged under all possible phase transformations. At the moment of partial homogenization of the inclusion (at temperature t) the total amount of NaCl is determined by the total weight of the salt: dissolved $D_t\left(V\frac{100-B}{100}\right)\frac{C_t}{100}$ and crystalline $\frac{d_{\mathrm{NaCl}}}{1+\frac{1}{100}\Delta V_{\mathrm{NaCl}_t}}\left(V\frac{B}{100}\right)$. It is obvious that in a homogeneous inclusion the weight of the sodium chloride dissolved at temperature T in a cm^3 of solution (concentration C'_t, in g/cm^3) is determined by the ratio of the whole amount of salt to the volume V of the inclusion:

$$C'_T=\frac{1}{100}\left(\frac{100-B}{100}D_tC_t+B\frac{d_{\mathrm{NaCl}}}{1+\frac{1}{100}\Delta V_{\mathrm{NaCl}_t}}\right). \qquad (8)$$

On the other hand, the weight of NaCl in the inclusion can be represented as VC'_T, and the weight of the whole solution of the inclusion at temperature T as VD_T, and then

$$C_T=\frac{C'_T100}{D_T}\%, \qquad (9)$$

or (after substituting the value C'_T)

$$C_T=\frac{1}{D_T}\left(\frac{100-B}{100}D_tC_t+B\frac{d_{\mathrm{NaCl}}}{1+\frac{1}{100}\Delta V_{\mathrm{NaCl}_t}}\right). \qquad (10)$$

Thus, to calculate the densities D_t and D_T of the saturated solution of NaCl at the moments of partial and complete homogenization of the inclusions and the total concentration C_T it is enough to know the volume B, occupied by the solid phase of halite at the temperature of partial homogenization t, the density of the water ($d_{H_2O_t}$), and concentration C_t of the solution saturated at the same temperature. From the experimental work of G.C. Kennedy, W.T. Holser (1969), B.J. Skinner (1969), M.A. Styrikovich and I. Kh. Khaybullin (1956), and other investigators, it is comparatively easy to establish the values of the last two parameters from the temperature of partial homogenization (disappearance of the gas phase) of the inclusion. Determination of the volume of the halite solid phase is accomplished in the course of thermometric analysis of the inclusion using micrometric accessories.

From equations (2), (4), and (5) it follows that the density of the fluid phase of an inclusion with halite and the temperature of its partial homogenization are related by a nonlinear dependence. The same can be said of the character of variability of the correction ΔD. The changes in $d_{H_2O_t}$ and C'_t as temperature rises are in different directions: the density of the water decreases monotonically, but the solubility of NaCl on the contrary increases, and after 320° drops abruptly (see Table; Fig. 2). Therefore it is to be expected that as the temperature of partial homogenization of inclusions of the type in which we are interested increases, the relatively moderate decrease in

Parameters of the solution of gas-fluid inclusions with halite

t (°C)	$d_{H_2O_t}$ (g/cm^3) Kennedy Holser '69	C_t (wt.%) Handbook 1961	C'_t (g/cm^3)	ΔV_{NaCl_t} (%) Skinner '69	V_{Ct} (cm^3/g) Calc'd after Lemmlein, Klevtsov, 1956	D_t (g/cm^3)	B = 5%			B = 10%			B = 15%		
							D_T (g/cm^3)	ΔD (g/cm^3)	C_T (wt/%)	D_T (g/cm^3)	ΔD (g/cm^3)	C_T (wt/%)	D_T (g/cm^3)	ΔD (g/cm^3)	C_T (wt.%)
200	0.864	31.5	0.397	2.288	0,095	1.097	1.148	0,051	37.8	1.198	0.101	43.6	1.249	0.152	48.9
210	0.855	31.9	0.400	2.436	0.094	1.090	1.141	0.051	38.2	1.192	0.102	44.0	1.243	0.153	49.3
220	0.840	32.3	0.401	2.584	0.091	1.075	1.126	0.051	38.7	1.178	0.103	44.5	1.230	0.155	49.7
230	0.826	32.8	0.403	2.733	0.090	1.064	1.116	0.052	39.1	1.168	0.104	44.9	1.220	0.156	50.2
240	0.814	33.3	0.406	2.881	0.090	1.055	1.107	0.052	39.7	1.160	0.105	45.4	1.212	0.157	50.7
250	0.798	33.8	0.407	3.030	0.089	1.041	1.094	0.053	40.2	1.147	0.106	45.9	1.199	0.158	51.2
260	0.784	34.4	0.411	3.178	0.088	1.030	1.083	0.053	40.8	1.137	0.107	46.7	1.190	0.160	51.7
270	0.766	35.2	0.416	3.326	0.086	1.016	1.070	0.054	41.5	1.124	0.108	47.3	1.177	0.161	52.5
280	0.751	35.8	0.419	3.475	0.086	1.005	1.059	0.054	42.2	1.113	0.108	47.9	1.167	0.162	53.1
290	0.731	36.6	0.422	3.623	0.085	0.988	1.043	0.055	42.9	1.098	0.110	48.6	1.152	0.164	53.9
300	0.712	37.5	0.427	3.772	0.083	0.974	1.029	0.055	43.9	1.085	0.111	49.5	1.140	0.166	54.7
310	0.688	38.4	0.429	3.920	0.082	0.954	1.010	0.056	44.8	1.067	0.113	50.4	1.123	0.169	55.5
320	0.667	39.3	0.432	4.068	0.080	0.936	0.993	0.057	45.7	1.050	0.114	51.3	1.107	0.171	56.4
330	0.637	40.2	0.428	4.217	0.079	0.908	0.966	0.058	46.6	1.024	0.116	52.3	1.083	0.175	57.4
340	0.610	41.1	0.426	4.365	0.077	0.883	0.942	0.059	47.6	1.001	0.118	53.3	1.061	0.178	58.4
350	0.569	42.0	0.412	4.514	0.076	0.840	0.901	0.061	48.7	0.963	0.123	54.5	1.024	0.184	59.6
360	0.528	43.0	0.398	4.662	0.074	0.796	0.859	0.063	49.9	0.923	0.127	55.8	0.986	0.190	60.9
370	0.48	43.9	0.376	4.810	0.072	0.741	0.807	0.066	51.1	0.873	0.132	57.2	0.939	0.198	62.4

Remark: The value C'_t is the weight of NaCl (in g) in 1 cm^3 of H_2O in a C_t% solution (at t°C), calculated by the formula $c'_t = \frac{d_{H_2O_t} C_t}{100 - C_t}$

density of their fluid phase is replaced by an intensive drop after 320°C. This pertains to the density at the moments of both partial and complete homogenization of the inclusions regardless of the degree of concentration of the original solutions.

As follows from equation (6), the correction ΔD will always have a positive value (inasmuch as $d_{NaCl} >> D_t$). In this case ΔD is directly proportional to B, i.e., it is directly dependent on the concentration of the original solution. Therefore any determination of pressure based on estimation of the density of the solution from the temperature of partial homogenization of the inclusion which does not take ΔD into account all the more so gives too-low results, the more so, the higher the concentration of the solution.

From equation (6) it also is seen that at the temperature of partial homogenization of inclusions increases and thus $d_{H_2O_t}$ decreases, the values of the correction ΔD should increase. However, as a result of the compensating effect on C'_t the ΔD correction apparently will not increase significantly to a temperature of 320°. Under higher-temperature conditions the importance of ΔD should increase more intensively, the more markedly, the lower the density of the solution.

The results of analysis of the equations are completely confirmed by the mathematical data,[5] which made it possible to refine certain details of the regularities cited above (see Table), which are fairly clearly manifested in Fig. 2-4. Actually, the most intensive decrease in density of preserved fluid solutions is observed for inclusions partially homogenized under high-temperature conditions (more than 320°). It is to this temperature range that a rather significant increase in values of ΔD corresponds, apparently caused by a sharp decrease in the solubility of sodium chloride in water (Fig. 3). In the lower-temperature region (200-300°) the ΔD values are distinguished by a certain stability (on the average 0.05 g/cm^3 for B = 5%, 0.11 g/cm^3 for B = 10%, and 0.16 g/cm^3 for B = 15%). The character of the curves reflecting the dependence of ΔD on temperature of partial homogenization of the inclusions practically does not change with the concentrations of the original mineralizing solutions. In addition, the absolute values of ΔD in the

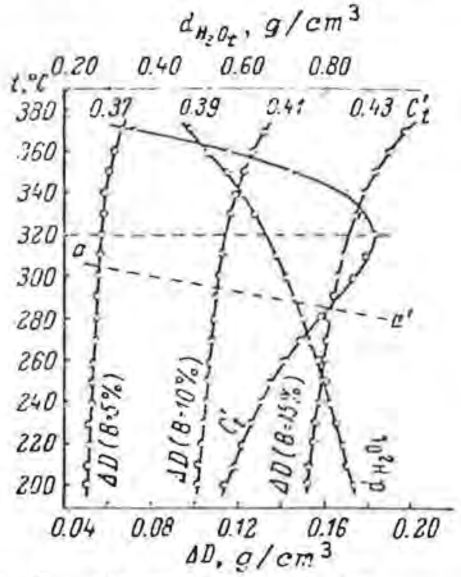
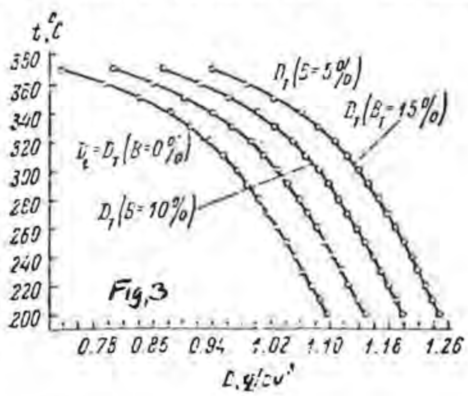


Fig. 2. Dependence of the parameters ΔD, $d_{H_2O_t}$, and C'_t on temperature of partial homogenization t.



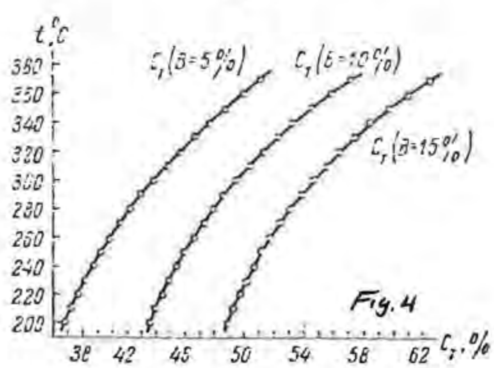


Fig. 3. Density of fluid inclusions D_T as a function of temperature t of their partial homogenization and concentration C_T of sodium chloride.

Fig. 4. Concentration C_T of the sodium chloride solution of a homogeneous inclusion as a function of temperature of partial homogenization t.

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[5] Variations in the variable parameters entering into the calculations were limited by experimental data obtained by the author and A.V. Piznyur in investigations of multiphase inclusions of highly concentrated (25-50%) sodium chloride hydrothermal solutions in quartz, scheelite, tourmaline from gold (Kariyskoye, Darsunskoye, Golgotayskoye) and molybdenum deposits (Zhireken, Shakhtama) in East Transbaikalia: t = 200-370°, B_{NaCl} = 5-15%. The calculations were made by B.I. Smirnov on a "Mir-1" computer in the Laboratory of Mathematical Methods of the Geology Department of L'vov University.

200-370° temperature range show a directly proportional dependence on concentration. Thus, for B = 5% ΔD varies from 0.05 to 0.07 g/cm^3, for B = 10% from 0.10 to 0.13 g/cm^3, and for B = 15% from 0.15 to 0.20 g/cm^3. The importance of taking into account ΔD for estimating pressure is particularly evident in conversion to the temperature of partial homogenization of the inclusions. As follows from the calculated values of D_t (see Table), a reduction of density by 0.07 or 0.20 g/cm^3 for the 350-370° range will be equivalent to an increase in temperature of disappearance of the gas phase by 15 or 40°, respectively. For the 200-250° range an error of 0.05-0.15 g/cm^3 is equivalent to increasing the temperature by 50-150°. It is quite obvious that this inevitably leads to a substantial underestimation of the pressure value (Fig. 1). This error is aggravated as a result of arbitrary or, in any case, poorly substantiated choice of PTV diagram, without taking into account the degree of concentration of the solution in the inclusions. As the calculation showed, the concentration C_T of homogeneous solutions of NaCl in real inclusions of the type examined can be very substantial and varies widely (37-62%). It is much higher than the concentration of the solutions for which experimental data are available at present (up to 30%). It is easy to show that in the case of a 30% solution, the PTV diagram of which is usually used (Piznyur, 1968a, 1968b), a reduction of density by 0.05-0.20 g/cm^3 is equivalent to raising the temperature of partial homogenization of the inclusions by 70-280° respectively, and thus greatly underestimating the pressure. Actually, on the basis of the PTV diagram for a 30% solution an inclusion with t = 310° and T = 400° is characterized by an internal pressure of the order of 1100 bars. In this case it is erroneous to presume that the density of this inclusion does not vary after 310° and is equal to 0.83 g/cm^3. However, as follows from the table, the density of a sodium chloride solution saturated at t = 310° (C_t = 38.4%) is much higher (0.95 g/cm^3), and after the solid halite phase (5%) is dissolved it becomes even higher -- 1.01 g/cm^3 (C_T = 44.8%). Therefore the internal pressure in that inclusion at T = 400° will not be 1100, but about 5000 bars. The relative error (80%) in this case is an additive one due both to the error ΔD in the determination of density, and to the incorrect use of the PTV diagram for a 30% solution.

Thus the method of choosing isochores used in barometric practice (on the basis of the temperature at which the gas phase disappears) without taking the density correction (ΔD) and concentration of the solution into account is fraught with considerable distortion of the parameter sought. And the higher the concentration of the solution, the more significant the error in estimating its density. The maximum value of this error is reached in the high-temperature region, but in the medium-temperature region too (300-200°) the ΔD error leads to a substantial underestimation of barometric determinations.

The mathematical method of determining the density and concentration of the initial solutions proposed in this work can, in our opinion, give a more rigorous estimate of such an important parameter of endogenetic mineralization as pressure. The seeming awkwardness of the method is compensated by the fairly high precision of the calculations and relative simplicity of conversion with the appropriate graphs (Fig. 2 and 4), which vastly facilitate the final stage of barometric determinations, which on the whole comes down to the following: by means of deep cooling in a freezing chamber we ascertain that there is no appreciable amount of carbon dioxide in the inclusion; by heating the inclusion in a microthermal chamber we determine the raw data: temperatures of disappearance of the gas (t) and solid (T) phases, and also the volume B occupied by halite at temperature t; on the basis of the values of t and B and using the graph (Fig. 4) we determine the concentration C_T of the solution of the homogeneous inclusion and thereby provide the basis for choosing the PTV diagram, and from the graph (Fig. 2) we determine the density D_T of the solution of the homogeneous inclusion; on the chosen PTV diagram we find the point of intersection of the D_T isochore with the T isotherm, which corresponds to the thermobaric conditions of complete homogenization of the inclusion and minimum values of the main mineralizing parameters (temperature, pressure).

In view of the lack of experimental data, curves of the dependence of the change in density of saturated highly concentrated (more than 30%) solutions of sodium chloride on temperature can be calculated using equation (4). This can partially make up for the lack of experimental data, which is responsible for the main limitation of the method of barometry -- the lack of PTV diagrams for solutions of high concentration. We note that equation (4) in its total expression evidently is applicable to saturated solutions not only of sodium chloride but also of other salts of the same type.

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Abstract

On the basis of studies of fluid inclusions in artifical quartz, an equation was derived for the dependence of the difference between Td and Th (Δt) on inclusion size, thickness of inclusion walls and pressure of quartz formation. Analysis of the equation and plots of Δt versus each of the above listed factors made on the basis of this equation shows that Td depends linearly on P and on the log of inclusion wall thickness, and it is inversely related to log of inclusion size.

Influence of the factors named in the title on the Td of G/L inclusions is undoubted, and was established in a number of articles (Naumov et al., 1966; Khetchikov et al. 1968, 1970, etc.). However, the influences found were described only qualitatively.

We planned to find the quantitative relations, to express these relations by one equation, and to establish the relative role of each of the factors. In solution of the above problem, the methods of regression analysis may help. Influence of inclusion composition was not taken into account, because the studied quartz specimens were grown from Na_2CO_3 solutions of approximately the same concentration, and moreover, this problem already was considered (Khetchikov et al. 1968; Tugarinov and Naumov 1970).

Characteristics of the investigated material

Studies of fluid inclusions in synthetic quartz grown in laboratory from Na_2CO_3 solutions under variable P (170-1800 atm) but relatively stable T (usually > 300°C), were the basis of further considerations.

Studies of parallelepiped (sic.) plates cut from the crystals showed that the inclusions have essentially elongated shapes and the same orientation, parallel to the Z axis. For obtaining useful data on Td, the visual method of determination in the microscope heating stage (Ermakov 1950) was applied. On heating, the rate was 5°C/min, and Th was determined.

Table 1. Results of thermometric measurements of G/L inclusions in synthetic quartz.

Measurement No.*	P of synthesis, atm	Th, °C	Td, °C	The largest inclusion dimension, mm	Minimum thickness of the inclusion wall, r, mm	Difference between Td and Th ΔT = Td-Th, °C		
						measured	calculated**	deviation
1	174	318	349	0.128	0.016	31	48	-17
100	1800	248	331	0.240	0.160	83	96	-13

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* See original for the remaining 98 measurements (ER).

**Calculated difference Td-Th was obtained from the equation (2) and rounded off to 1°C.

Over 500 individual inclusions were studied. For statistical analysis one hundred of the best measurements were chosen, more or less uniformly distributed within the studied P interval of synthesis (Table 1).

The chosen form of connection

Before finding of the dependence of Td on all the named factors together, it was necessary to choose the form of dependence on each individual factor and to investigate whether the factors are interconnected.

First, following the other authors (Naumov et al. 1966, Khetchikov et al. 1968) we shall limit our analysis to the value $\Delta T = Td - Th$**, but not to absolute Td.

Dependence of ΔT on P of synthesis. One supposed hitherto that ΔT and P are inversely connected, i.e., P increase causes decrease of T.

Such a conclusion was made from the P necessary in an inclusion to break the quartz, which equals $\sim$830 atm (Naumov et al. 1966) and is defined only by the strength of the quartz. The latter is constant and does not depend on the conditions of quartz formation. In autoclaves, where quartz is grown, P is controlled by the appropriate degree of filling (F). At a given T in an autoclave with high F, P is also high. From PT plots for Na_2CO_3 solution (Khetchikov et al. 1968) it appears that ΔT is lower for high F values than for low F values. Since F in inclusion reflects the initial F value for the autoclave, the conclusion of a negative relation of ΔT vs P seems to be evident.

The analyzed data show that the above conclusion is in general wrong. In one of our former papers we gave the point plot ΔT vs P (Fig. 1 in Dorogovin et al. 1975), where as positive ΔT-P relation was clearly apparent. The following two reasons may be tentatively listed for such positive relation: 1.) Quartz breaking resistance decreases with T increase; and 2.) Quartz formed at higher P has higher resistance, as compared with quartz crystallized at lower P (Dorogovin et al. 1975):

Dependence of ΔT on inclusion size (in our case-length) "l". If P and distance of inclusion from the grain wall are constant, the above relation may be elucidated on very simple basis. It is evident that minute inclusions need larger overheating for decrepitation. The larger an inclusion is in size, the closer Td is to Th. This relation may be characterized by a logarithmic function. Fig. 1 presents the point plot ΔT vs log l. Deviation of points is large, but a linear negative connection is visible.

Dependence of ΔT on the thickness of inclusion wall "r". This relation, on the basis of autoclave theory (Tsiklis 1965), should be logarithmic-linear: ΔT should be positively proportional to logarithm of "r" (Fig. 2). A large scattering of the points does not prevent recognition of the linear relation of ΔT vs log r.

Thus, the general equation describing ΔT dependence on the above factors may be as follows:

$$\Delta T = a + b_p P + b_l \ln l + b_r \ln r;$$

where a - free regression factor, b_p, b_l and b_r - regression coefficients of ΔT depending respectively on P, l and r.

The best values of the parameters may be obtained by the least squares method, if p, l and r are really independent values. To our experience, they are in fact independent. This is confirmed

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**Here in the original paper the expression $\Delta T = Td \cdot Th$ is used; this is obviously a misprint.

by the calculated pair correlations (Table 2).

Correlation of such variable value pairs as P-lnl (-0.02), P-lnr (0.10) and lnl-lnr (0.14) are insignificant at the 5% level, for which the critical value of correlation coefficient equals 0.19. The ΔT value significantly correlates with each of the studied factors.

Table 2. Matrix of pair correlation.

	Δt	P	$\ln l$	$\ln r$
Δt	1,00	0,51	−0,33	0,48
P		1,00	−0,02	0,10
$\ln l$			1,00	0,14
$\ln r$				1,00

The square correlation coefficient multiplied by 100% clearly reveals the relation between the values of the variables--it shows which part of the scattering may be explained by the influence of the studied factor. The factors influencing the ΔT scatter are P 26%, inclusion length 11%, and wall thickness 22%. Under condition of statistical independence between the factors, there may be assumed that all the factors together, should determine about 60% of the variation of the ΔT values.

The following values of the parameters in equation (1) were calculated using a program by N.N. Shatagin (1972).

$\Delta T = 67.4 + 0.018P - 10.97 \ln l + 10.89 \ln r;$

The multiple coefficient correlation between ΔT and the independent variable equals 0.77, and its square is 0.59, i.e., total influences of P, l and r, as was expected, is ∿60%.

Because the discussed factors make up the greater part of variations of ΔT values, they mainly determine the difference between Td and Th. Of course, a relatively large part of ΔT variability (∿40%) is caused by factors which were not taken into account by the authors. These additional factors may be, e.g., the roughness of the break surfaces of quartz, invisible fractures (and other defects) in quartz, and anistropy of the physico-mechanical properties of quartz (...) (Silaeva and Delitsyn 1970; Dorogovin et al. 1975).

Using equation (2), the values of ΔT may be anticipated with the known error. Thus, within the 5% significance level; one may say that in 95 events per 100 the error would not exceed 27.2°C. This is confirmed by data listed in the Table 1.

Plots of dependence

The relations found permit the dependence of ΔT on the listed factors to be expressed graphically. Fig. 3 presents ΔT dependence on inclusion size under constant P of 400 atm. Each curve in the plot reflects the ΔT change under influence of l for the determined inclusion wall thickness r. Difference between Td and Th (under constant P and r) increases strongly with decrease of inclusion size below 0.5 mm. Decrease of ΔT with increase in l from 1 mm develops more or less uniformly.

Fig. 3 is made from data in the Table 3. In this table the negative ΔT values for P=100 and 400 atm are notable. The corresponding part of the curve in Fig. 3 is plotted by the dashed line, corresponding to cases where $Td<Th$.

In Fig. 4, based on the data of Table 3, the dependence of ΔT on inclusion wall thickness (r) is presented. A decrease in $r < 0.5$ mm causes an abrupt decrease of ΔT, when ℓ is constant. An unlikely increase in $r > 1$ mm causes a less distinct increase of ΔT.

Dependence of ΔT on P under various values of ℓ and r is shown in Fig. 5; T increases, with both ℓ and r constant, at approximately 2°C per 100 atm.

On the two-dimensional plots one line may express dependence of ΔT on one of the studied factors. A series of lines permits the demonstration of one additional factor. But, obviously, such a plot is less clear than a three-dimensional plot. Fig. 6 presents the basic scheme of common influence of ℓ and r on ΔT: It is not possible to present four-dimensional space in a plane, but using the fact that ΔT depends linearly on P, the same plot may conditionally present also the action of that factor. On increase or decrease of P, the surface will move upward or downward.

Calculation of the decrepitation temperatures

Using only ΔT in the present considerations, we removed the unnecessary variable Th. If needed, equation (2) may be expressed as follows:

$Td = 67.4 + 0.018P - 10.97 \ln \ell + 10.89 \ln r + Th$;
Equation (3) permits an immediate calculation of Td, assuming, of course, that Th, P, ℓ and r are known.

Decrepitation of numerous inclusions

The above considerations were performed for simple inclusions. Usually the decrepitation methods work by causing mass decrepitation in large numbers of quartz grains. In a sample of 1 cm^3 there are 5-8 thousand grains of 0.5-1 mm size, and each grain contains some tens or some hundreds of inclusions (some quartz varieties bear $n \cdot 10{,}000$ to $n \cdot 100{,}000$ inclusions in each grain). Undoubtedly, our results should be reinterpreted, taking into account that such samples bear many inclusions.

Thus, the rules of probability begin to work and hence one should anticipate that inclusions of the most probable size for this specific sample will occur in the minimum distance from the grain edge. From this simplest probabilistic statement some very important conclusions can be made; some of them are surprising and paradoxical and others are already known and were explained earlier.

In the explanations of Fig. 3 it was said that first breaks in the sample may be registered by decrepitometers at $T<Th$. Due to probability, in the sample there will always be some large inclusions with very thin walls. To break this wall, the inclusion does not have to develop an internal P exceeding the quartz breaking resistance (~800 atm). However, it was formerly stated that quartz decrepitation may occur only after homogenization. Applying the theory of resistence of autoclaves and empty cylinders (Feodos'yev 1974, Tsiklis 1965), it is possible to prove that breaking of inclusions with thin walls may occur also under significantly lower P, even < 100 atm. Such P may develop before homogenization in inclusions with low filling coefficients ($F = 0.6$ or 0.7).

From the above statement one may conclude that the best characteristics of decrepigraphs is undoubtedly the temperature of the beginning of sample decrepitation. This conclusion is easy to understand and it is already known, and seemingly it does not need additional explanations, but simultaneously it contains a contradiction which should be considered.

Let us suppose that due to the huge number of inclusions in a sample, the wall of one or few inclusions is very thin. These inclusions should break either below Th or close to it. But it is well known that a significant difference between the T of the beginning of decrepitation and Th, occurs in the great majority of samples; for quartz this is equal to even some tens of degrees. Here we meet a contradiction: ΔT should be close to zero or even negative, but this occurs extraordinarily rarely.

Table 3. Calculated values of ΔT (^{o}C) for various P, l and r.

l, мм	r, мм					
	0,001	0,01	0,1	0,5	1,0	5,0
			P = 100 b			
0,001	69,7	94,8	119,8	137,4	144,9	162,4
0,01	44,4	69,5	94,6	112,1	119,7	137,2
0,1	19,2	44,2	69,3	86,9	94,4	111,9
0,5	1,5	26,6	51,7	69,2	76,7	94,3
1,0	—6,0	19,0	44,1	61,6	69,1	86,7
5,0	—23,6	1,3	26,4	43,9	51,5	69,0
			P = 400 b			
0,001	75,1	100,1	125,2	142,7	150,3	167,8
0,01	49,8	74,9	100,0	117,5	125,0	142,6
0,1	24,5	49,6	74,7	92,2	99,8	117,3
0,5	6,9	32,0	57,0	74,6	82,1	99,6
1,0	—0,6	24,4	49,4	67,0	74,5	92,0
5,0	—18,3	6,7	31,8	49,3	56,9	74,4
			P = 2000 b			
0,001	103,7	128,8	153,9	171,4	178,9	196,5
0,01	78,4	103,5	128,6	146,1	153,7	171,2
0,1	53,2	78,3	103,3	120,9	128,4	145,9
0,5	35,5	60,6	85,7	103,2	110,8	128,3
1,0	27,9	53,0	78,1	95,6	103,1	120,7
5,0	10,3	35,3	60,4	77,9	85,5	103,0

From the reasons causing this contradiction we shall name only three, the most important in our opinion. First, only inclusions with small F≲0.7 have a good chance to break at T≈Th. Second, relatively large inclusions in samples are a great rarity. Distribution of the number of inclusions versus size is described by an exponential rule, such that a sample bearing millions of inclusions of 0.00n mm size has only individual inclusions exceeding 1 mm in size. As we see in Table 3 and Fig. 3, only inclusions >1 mm may decrepitate at T≈Th. Such inclusions should be located near the grain edge and should have small F. Probability of coincidence of these events is an extremely small value, which shows that such inclusions would be single in a sample. (sic.).

Third, those single inclusions may be destroyed during sample grinding. Let us suppose that due to one of the blows, a grain formed bearing an inclusion with a very thin wall; but grinding is a series of repeated blows causing the breaking of such thin walls with a large probability. This was confirmed by our observations. No one of the studied inclusions (Table 1) was closer to the grain edge than 0.016 mm.

In Table 2 and in Fig. 3 one may see that decrease of inclusion size <1 mm quickly causes a difference between Td and Th, equal to tens of degrees Centigrade. Thus, recording the T of beginning of decrepitation, we get a T most close to Th, but almost always somewhat higher than Th.

It was stated before (Khetchikov et al. 1968), that the whole decrepitation interval may be explained by variations of inclusion size and inclusion wall thickness. Often the decrepitometric measurements give decrepitation intervals 200-300°C. Sometimes that interval is explained as the T interval of the whole mineralization process. Such interpretation may be erroneous. Let us suppose that quartz formed under almost isothermic and isobaric conditions, and decrepitation analysis recorded a decrepitation interval 200-400°C. This entire decrepitation interval may be explained by independent variations of inclusion size from 0.001 to 1 mm and inclusion wall thickness from 0.001 to 1 mm (Fig. 5).

Inclusion decrepitation in quartz occurs over a wide P interval developed inside the inclusion at the moment of the break. This appears from the fact that the P increase inside inclusion on overheating has a straight-line relation with ΔT, which, on the other hand, depends on widely variable ratios of inclusion size and wall thickness. This conclusion is the consequence of the theory of empty cylinder strength (Feodos'yev 1974).

Probably the range of quartz strength depends on the P of quartz growth. Positive connection of ΔT on the one hand with P of decrepitation, and on the other hand with P of formation, suggests that higher pressures are needed to break inclusions formed under elevated P; probably quartz formed under higher P has higher strength. Results of studies of the elastic properties of quartz and their dependence on quartz formation P confirmed this suggestion (Dorogovin et al. 1975).

Conclusions

1. Methods of regression analysis proved that Td depends linearly on P and log r, and it is inversely related to log ℓ. A regression equation was obtained, reflecting the quantitative common influence on Td of the above named factors, as well as each of them separately.

2. It was shown mathematically that all decrepitation intervals of a sample may be explained by variations of inclusion size and thickness of the inclusion walls.

3. Analysis of the equation derived here with use of the data from resistance theory shows that decrepitation of inclusions appears in a wide P interval, increasing in the inclusion until the moment of breaking.

We are indebted to V.I. Starostin and Yu. A. Dolgov, with whom certain topics of this paper were discussed.

(Continued on next page)

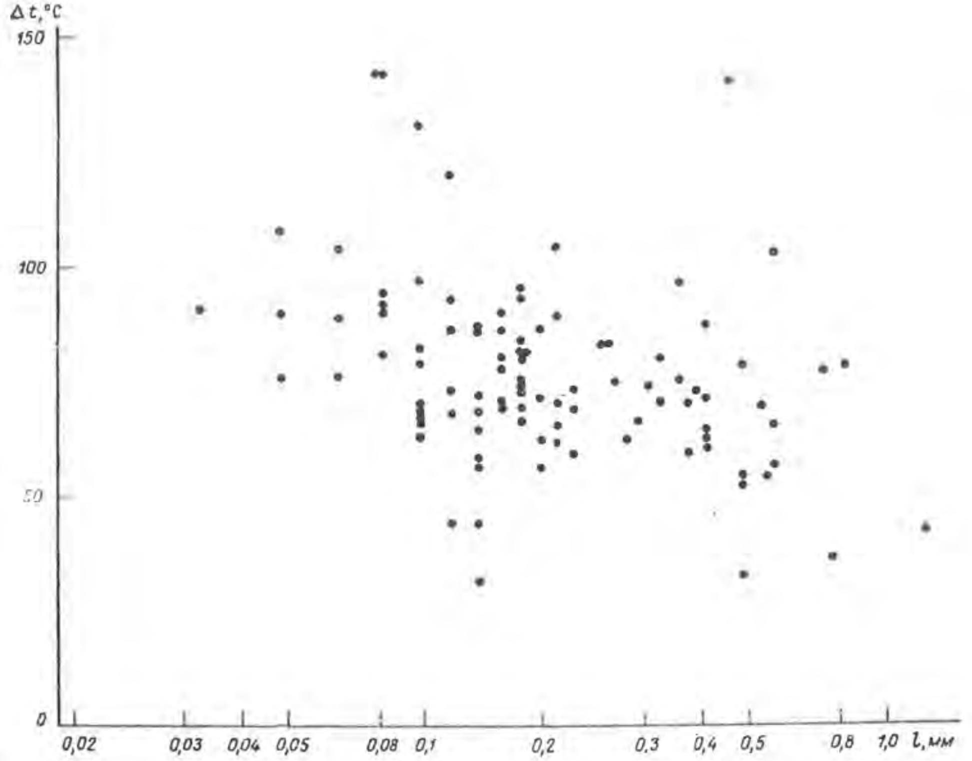


Fig. 1 Point plot of relation ΔT versus length of inclusions l.

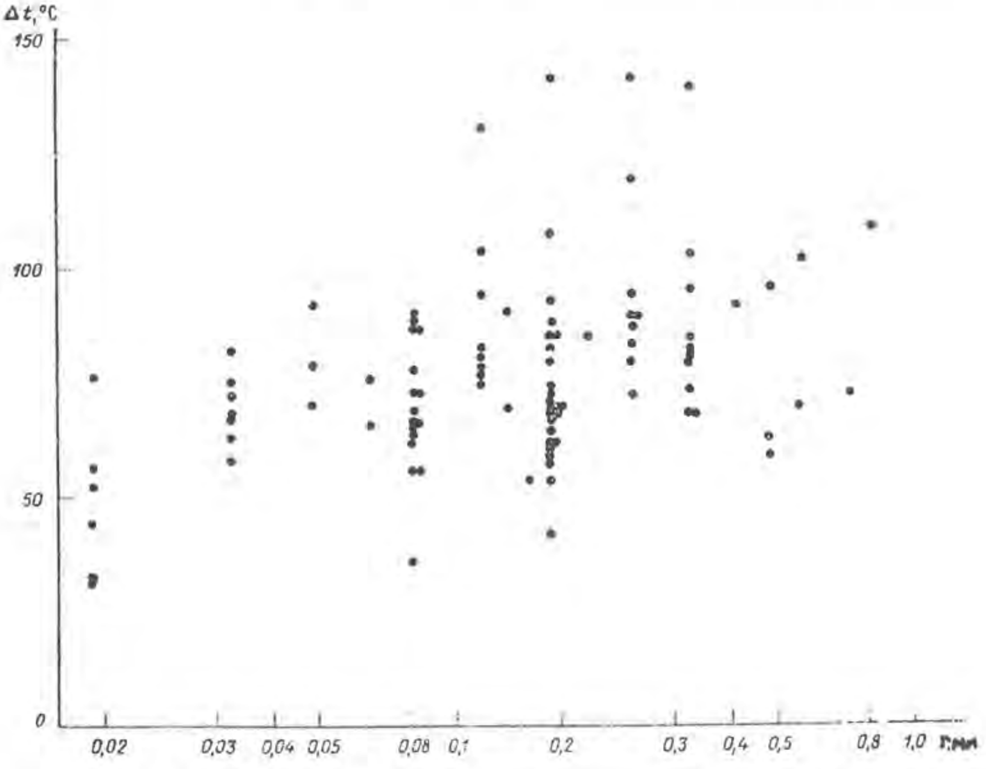
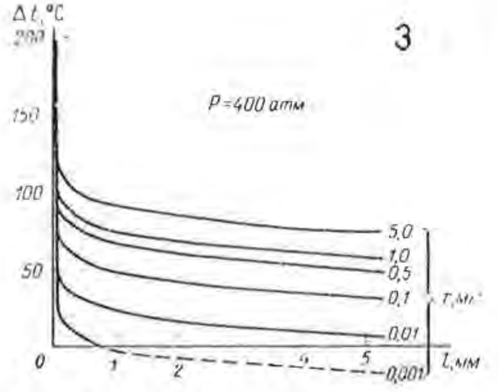


Fig. 2 Point plot of relation ΔT versus thickness of inclusion walls r.



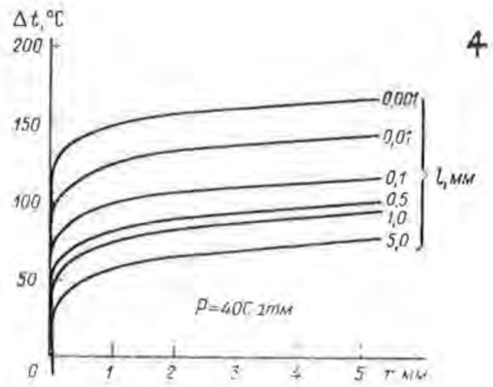
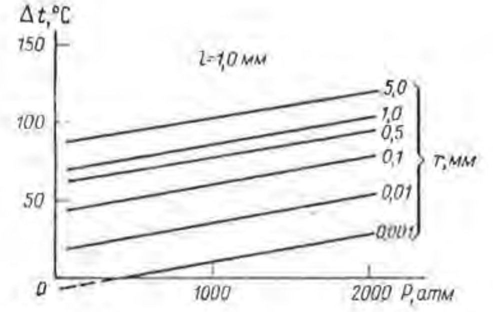


Fig. 3 Dependence of ΔT on inclusion length (l) for various values of inclusion wall thickness (r) under constant pressure P = 400 atm.
Fig. 4 Dependence of ΔT on inclusion wall thickness (r) for various values of length (l) under constant P = 400 atm.



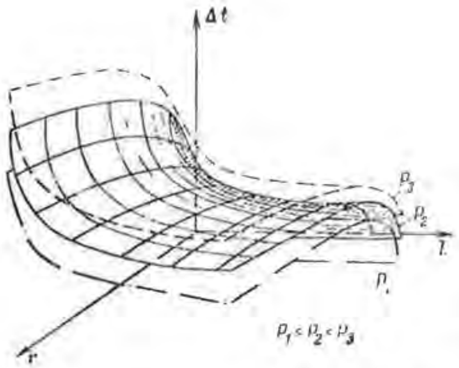


Fig. 5 Dependence of ΔT on pressure of the quartz formation process (P) for inclusions with various wall thickness (r); constant value of inclusion length l = 1 mm.
Fig. 6 Basic scheme of dependence of ΔT on inclusion length (l), wall thickness (r) and pressure (P).

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TALANTSEV, A.S., 1978, Equation of isochores of solutions from gas-liquid inclusions, homogenizing in liquid phase: Akad. Nauk SSSR Doklady, v. 240, no. 1, p. 185-188 (in Russian). Author at Inst. Geol. and Geochemistry of the Ural Sci. Center of the Acad. Sci. USSR, Sverdlovsk. (Translation courtesy A. Kozlowski).

Usually Th of G/L inclusions is lower than T of crystal growth, the difference appears due to P of mineral-forming medium and it may achieve 100-200°C (1). Th means only the T of initial point of isochore for PTF diagram of solution in inclusion, whereas true PT conditions of healing of inclusion are defined by another point on the same isochore.

Recently, the composition of fluid may be approximately evaluated by cryometry and using the appropriate PTF diagram of water-salt system (2-5); with isochore beginning at Th, further determinations may be made (6). However, the number of existing diagrams is still scarce. Thus, determination of position and slope of isochores in the PT plots is a major source of error in such determinations.

It was found that between measured Th and T frz, and evaluated Ph (i.e. pressure at homogenization; Ed.) and slope of isochores (dP/dT), quite distinct relations exist. An attempt of mathematic expression of those relations is made in this paper.

Solution of this problem is easier when started from precise PTF plot for pure water (3), i.e. system with T frz = 0°C. For this plot like other similar ones, the position of isochore in the area of homogeneous liquid phase is determined by the basic relation:

$$T = Th + \frac{dT}{dP}(P - Ph), \qquad (1)$$

which holds when $T \geqslant Th$ and $P \geqslant Ph$. Values Ph and (dP/dT) for that plot are connected with Th by empirical equations

$$Ph = 4.32 \cdot 10^{-9} Th_{6} \qquad (2a)$$

$$(dP/dT) = 18.4 - 4.07 \cdot 10^{-6} Th^{2.52} \qquad (2b)$$

Data in Table 1 prove that errors of equations (2a) and (2b) in T interval 100-350°C are not significant and they cannot cause any significant errors in results of thermobarogeochemical determinations, but at $Th > 370°C$, in the range of critical phenomena and when homogenization appears in G not in L phase, those equations are not applicable.

Joining equations (1) and (2) for G/L inclusions with very small salt concentrations (T frz close to 0°C) we get the relation:

$$T = Th+(P-4.32\cdot 10^{-9}Th^{4.162}):(18.4-4.07\cdot 10^{-6}Th^{2.52}), \quad (3)$$

yielding the position of isochores in the P/T plot for any measured Th, if the inclusion homogenized in L phase. Thus, the problem is solved for this specific case.

If the L phase of the studied inclusion consists of water solution of salts, its Tm will be $< 0°C$. For elucidation of the influence of Tm on the value Ph on the basis of experimental data for solutions with changing concentrations of various salts, a series of plots were made for the named values, at constant Th. Only the best results were used (3-5). Two of the plots are presented in Fig. 1. Correlation of Tm verses Ph is very good, practically within the range of measurement errors for Ph shown with dashed lines. It is a natural relation since decrease of Tm and Ph are caused by the same reason: interaction between H_2O molecules and salt ions. Elaboration of all the plots for Th interval 100-370°C yielded the equation, in which Ph^{H_2O} is calculated from equation (2a):

$$Ph = Ph^{H_2O}(1+0.01Tm). \quad (4)$$

Similar results were obtained by construction of plots $(dP/dT) = f(Tm)$ when Th is fixed. Also here the deviation of points (Fig. 2) from the correlation line does not overstep the dashed lines showing probable errors in measurements of values of (dP/dT). At Th = 265°C the line is parallel to the Tm axis. All peculiar plots are summarized in Fig. 3, analysis of which leads to following equation with $(dP/dT)^{H_2O}$ derived from equation (2b):

$$\frac{dP}{dT} = \frac{dP}{dT}^{H_2O} - \frac{265-Th}{465}\,Tm \quad (5)$$

Joining equations (3)-(5) we get equation:

$$T = Th + \frac{P-4.32\cdot 10^{-9}Th^{4.162}(1+0.01Tm)}{18.4-4.07\cdot 10^{-6}Th^{2.52} - \frac{265-Th}{465}\,Tm} \quad (6)$$

in which temperatures are in °C and P in atm. This equation establishes the isochore of any given inclusion if the L phase freezes at T between 0 and -20°C and homogenizes at $T < 370°C$. This equation is true also for solutions of more than one salt, as seen from point No. 16 in Figs. 1 and 2. It is not applicable for inclusions filled with pneumatolytic solutions (homogenizing in G phase), LCO_2+LH_2O, and inclusions bearing crystals of salts.

Equation (6) may be applied not only for thermobarogeochemical purposes, but also for other problems needing PTF plots in the homogeneous area of L phase of water-salt systems still not studied experimentally.

A check of the equation (6) was made with use of PTF plots from reference (5), bearing a) 6 wt. % of NaCl + 4 wt. % of KCl and b) 10 wt. % of LiCl, not used during finding of the equation (6). All calculated isochores and lines of heterogeneous equilibrium agreed almost exactly with the experimental ones up to T = 360°C. This fact proves that the accuracy of the equation is sufficient.

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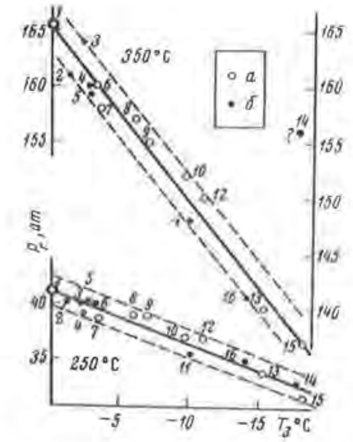

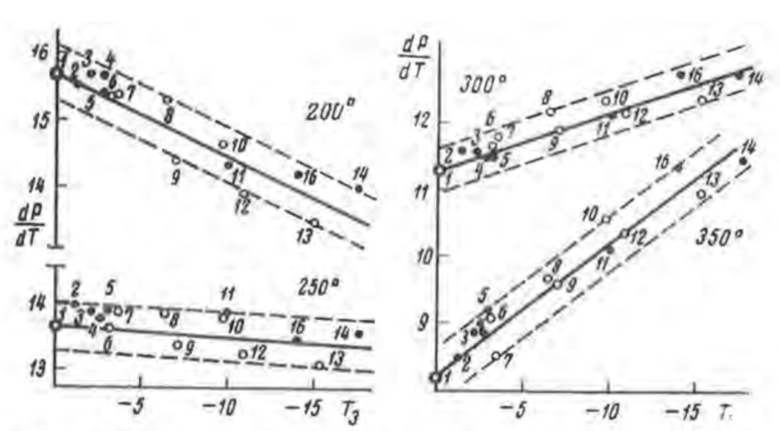

Fig. 1. Relation between Ph and Tm for water-salt systems at Th = 250 and 350°C; a - data from (4), b - data from plots from (5). Figures next to points refer to solution composition (wt. %): 1 - pure water, 2 - K_2CO_3, 5%, 3 - $CaCl_2$, 5%, 4 - Na_2CO_3, 7%, 5 - K_2CO_3, 10%, 6 - NaCl, 5.5%, 7 - KCl, 7%, 8 - KCl, 13%, 9 - NaCl, 10.5%, 10 - KCl, 18.3%, 11 - NaOH, 10%, 12 - NaCl, 15%, 13 - NaCl, 19%, 14 - $CaCl_2$, 20%, 15 - NaOH, 15%, 16 - NaCl 12%+KCl 8%. Values of Tm from reference (7).

Fig. 2. Relation (dP/dT) and Tm at Th 200 to 350°C for water-salt solutions, for explanations, see Fig. 1.

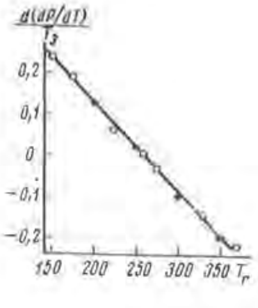

Fig. 3. Relation of slopes of the estimated lines on plots of the type shown in fig. 2 and Th value for the same plots.

Table 1
Comparison of the experimental values Ph and (dP/dT) for pure water from reference (3) with calculated values by use of equations (2a) and (2b)

Th, °C	Ph, atm		(dP/dT), atm/°C	
	experimental	after (2a)	experimental	after (2b)
100	1.033	0.91	18.0	18.0
150	4.854	4.92	17.1	17.2
200	15.86	16.30	15.8	15.8
250	40.56	41.26	14.0	13.9
300	87.61	88.13	11.3	11.3
350	168.63	167.49	7.7	7.9

Indices

The user should keep in mind the following features of these indices. The indexing procedures and entries are evolving (particularly with this volume) 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.

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 possibly 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 277. 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. The editors would appreciate notice of any other errors or omissions.

TEXT

Volume	Page	Item†	Line	
6	153	2	1	Change to 1973a
6	153	2	23	Change to porphyry
7	1	1	1	Change Adryanova to Andrianova and move item to p. 5.
8	50	2	3	Change to deposits
8	117	3	1	Change to MAZOR, Emanuel, 1975,
9	94	1	16	Change to 216° to 308°C
9	95	2	4	Add: Translated in Intern. Geol. Rev. v. 13, no. 4, 1976.
10	79	5	2	Change to Downingtown
10	106	1	2	Change to Altai-Sayan
10	140	2	4	Change pages to 56-61
10	168	2	1	Entry under Madsen, 1977, should be moved to p. 132, under Konnerup-Madsen
10	175	3	1	Add entry MEL'NIKOV, F.P., 1975 - See Borodaev et al., 1975, p. 32)
10	269	3	4	Change to Dept. Geol. Sci.

INDEX

Volume	Page	Item
10	347	Inclusions in rocks, pegmatites - add p. 302

†Partial items are also counted.

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