FLUID INCLUSION RESEARCH

Proceedings of COFFI

Edwin Roedder, *Editor*

Volume 6

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Fluid Inclusion Research

Volume 6

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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 covering various segments of the literature, preparing abstracts, indexing, and translation (particularly from the Russian). These jobs can be partitioned into as small units as desired; please contact either Edwin Roedder or Andrzej Kozlowski at the above addresses.

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Edited by Edwin Roedder

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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 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 inclusions (aqueous, organic, silicate melt, etc.), causes and mechanisms of trapping (including immiscibility), physical, chemical, and isotopic data, and data on experimental studies. These data are generally given without editorial value judgments except in the case of obviously contradictory or obscure statements. Coverage varies in part as an inverse function of the availability of the original text to the average Western reader, and as a direct function of the availability to the editor of an English translation. In addition to abstracts and citations, we publish English translations of inclusion papers from foreign languages, where available and not otherwise published in English, and notices of meetings and symposia.

The editor is particularly pleased to welcome Dr. Andrzej Kozlowski of the University of Warsaw as associate editor. Dr. Kozlowski has provided most of the translations from Russian sources in this volume. Included among these are many of the 144 translated abstracts (or citations) of papers presented at the Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, held September 24-30, 1973, in Rostov-on-Don, U.S.S.R. Since these are in addition to the normal world literature (332 items in the current volume), this volume is appreciably longer than previous volumes. The balance of the papers presented at Rostov will have to be placed in volume 7. Part of these abstracts were translated through the courtesy of Professor N.P. Ermakov, Dr. E.I. Dolomanova, and Dr. N.I. Andrusenko.

Although each abstract is duly credited, the editors wish to acknowledge, in particular, the help of Dr. M. Fleischer, of the U.S. Geological Survey, who provided two translations of full articles and helped with many citations. Chemical Abstracts, of Columbus, Ohio, has most graciously permitted the use of a limited number of their copyrighted abstracts, as indicated in the abstract citations. Many other individuals, too numerous to list, have helped by sending the editors books, reprints, references, and copies of abstracts. We are particularly indebted to Professor Ermakov for copies of Russian books. We would also like to acknowledge the help of J.W. Clarke and H.E. Belkin in many of the problems of publishing the first five volumes.

To authors of pertinent articles that have been omitted or are misquoted here through haste, or through language difficulties, we extend our apologies and our request to have these things called to our attention; to authors whose original abstracts have been drastically shortened, edited, or revised, we offer a reminder that the following "abstracts" are not intended to be abstracts of the whole paper, but only that part most pertinent to inclusion workers. The obvious inconsistencies in citation, transliteration, abstracting, and indexing are strictly a result of lack of editorial time. A vigorous effort is being made to make future volumes much more current than this one. The editor 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 per page.

Edwin Roedder, Editor
August 6, 1975
Andrzej Kozlowski, Associate Editor

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Notices of Meetings and Symposia

The Fourth All-Union Conference on Thermobarometry met at Rostov-on-Don, September 24-30, 1973. The program (24 pages, 600 copies printed) lists, in addition to the 135 titles, the 5 sponsoring organizations, the membership of various committees, and the resolutions to be considered.

The 236 extended abstracts for this meeting were issued by the Rostov University Press in a separate 351-page volume; many of these abstracts will be found in this volume of Fluid Inclusion Research: Proceedings of COFFI (see Preface for details). The printed Proceedings volume or volumes for this conference may not be issued for several years.

The Ninth General Meeting, International Mineralogical Association was held in Berlin-West and Regensburg (FRG) in September, 1974; abstracts for the two Symposium Sessions on Fluid Inclusions will be given in Fluid Inclusion Research: Proceedings of COFFI for 1974 (Volume 7).

The Fourth General Meeting of the International Association on the Genesis of Ore Deposits was held at Varna, Bulgaria, in September, 1974. The abstracts for the many papers on inclusions at this meeting will also be given in Volume 7, as well as the smaller number of such papers at the International Symposium on Water-Rock Interaction (Prague, September, 1974) and at the Symposium on Metallization and Acid Magmatism (Karlovy Vary, October, 1974).

Future Symposia

Professor N.P. Ermakov of Moscow University has announced that plans are underway for the Fifth All-Union Conference on Thermobarometry, to meet at Ufa (in the Urals), September 20-27, 1976. Abstracts of papers submitted are due by January. 1976.

The 25th International Geological Congress will be held in Sydney, Australia, August 16-25, 1976. Plans have been made to hold the Fifth International Symposium on Fluid Inclusion Research in conjunction with this Congress.

Anyone wishing to submit a paper for consideration for this symposium should contact the editors without delay, and should be aware of the following two published deadlines: September 30, 1975, for a title and a synopsis of the proposed paper; and February 29, 1976, for the submission of the abstract. Abstracts of such papers will be printed by the Congress, and in the next volume of Fluid Inclusion Research: Proceedings of COFFI. Please refer to the Second Circular of the Congress for detailed comments and specific limitations; several of these are not the same as in previous congresses.

Organization of COFFI

The Bureau of COFFI consists of five officers as follows: Chairman--E. Roedder, U.S.A.; First Vice-Chairman--H. Imai, Japan; Second Vice-Chairman--F.P. Mel'nikov, U.S.S.R.; Third Vice-Chairman--M. Solomon, Australia; and Secretary--G. Deicha, France. A series of Regional Representatives have also been established to provide foci for coordination and exchange of information on COFFI activities. The following list is still tentative and incomplete and will be revised in future issues.

Africa: Dr. H.M. El Shatoury, Associate Professor of Geology, Egyptian Atomic Energy Authority (presently at Dept. of Mineral Development Engineering, Univ. of Tokyo, 7-3-1 Hongo, Bunkyo-Ku, Tokyo 113, Japan

Australia: Dr. Ronald W.T. Wilkins, CSIRO, Minerals Research Labs, P.O. Box 136, North Ryde, NSW 2113, Australia

Belgium: Dr. Paul Bartholomé, Laboratoires de Géologie Appliquée, Université de Liège, 45, Avenue des Tilleuls, Liège, Belgium

Brazil: Dr. J. Cassedanne, Chief Researcher, Conselmo Nacional de Pesquisas, Avenida Marecmal Câmara 6^{o} aud 350, Rio de Janeiro (G.B.) Brazil

Canada: Dr. S.D. Scott, Dept. of Geology, Univ. of Toronto, Toronto 5, Canada

Czechoslovakia: Ing. Jána Ďurišová, Ústřední ústav Geologický, Malostranski Nam 19, Praha 1, ČSSR

Denmark: Dr. John Rose-Hansen, Universitetets Mineralogisk-Geologiske Institut, Mineralogisk Museum, Østervoldgade 5-7, København K., Denmark

E. Germany: Dr. Ludwig Baumann, Bergakademie Freiberg, Sektion Geowissensch, 92 Freiberg, Brennhausgasse 14, DDR

France: Dr. Bernard Poty, Centre de Recherches Petrographiques et Geochimiques, Case Officielle no. 1, 54 - Vandoeuvre, France

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U.S.S.R.: Professor F.P. Mel'nikov, Dept. of Geology,
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Abstracts, Translated Abstracts, or Annotated Citations to World Literature, 1973

Note — This section includes a few earlier items that were not available in time for inclusion in the previous volume. In part of these abstracts the following abbreviations are used: T or Temp = temperature; T_H = temperature of homogenization; T_D = temperature of decrepitation; F = degree of fill; G/L = gas-liquid; (...) = part of author's abstract omitted.

ABAKIROV, Sh.A., GROSHEV, A.K., and KIM, V.F., 1973, Mineralogical zoning and its connection with temperature conditions of formation of a rare-metal deposit: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 270 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Inst. of Geol. of Acad. Sci. of Kirgiz, SSR.

Hydrothermal Be-rare-earth-Th mineralization, forming an ore deposit connected with Permian subalkaline granites, may be divided into 3 groups:

I. High-temp. Zr-Be (phenacite, beryl, bavenite, cyrtolite) - 420-350°C.

II. Moderate-temp. Th-rare earth (cerium), (ferrithorite, monazite, bastnaesite, parisite) - 350-250°C.

III. Moderate-low-temp. Th-rare earth (yttrium), (ferrithorite, xenotime) - 300-180°C.

Character of ore-bearing solutions changed from alkaline (potassium)-fluoride in the high-temp. stages to fluoride-carbonate at moderate and low-temp. stages.

Depending on specific conditions of ore formation (T and chemistry of solutions), rare metal mineralizations are specialized and individualized even in one ore field. Mineralization of various compositions concentrate in a zonal mode. From the top to the bottom Be mineralization is replaced by Th-yttrium and the latter by the Th-cerium one. (Authors' abstract)

ABE, Hiroshi, and AOKI, Morihiro,1973, Artificial hydrothermal alteration of Miocene tuffs in sodium hydroxide solution at 200°C and 20 kg/cm^2, with special reference to analcimization (hydrothermal studies on the wall-rock alteration-2-): J. Japan. Assoc. Min., v.68, p. 161-169. First author at Miyagi University of Education, Sendai, Japan. (In English)

Natural rhyolitic tuff and green tuff (Miocene age) were subjected to alteration in sodium hydroxide solutions under 200°C and 20 kg/cm^2. When these were treated at 200°C for 50 hours, analcime ($NaAlSi_2O_6.H_2O$) was formed as an alteration product, whose X-ray reflections were gradually intensified with the duration of treatment. From the diffraction intensities, it was found that the alteration products of green tuff contained about 3 times more analcime than in the case of rhyolitic tuff. A comparison of chemical compositions between the original green tuff and its alteration products showed that SiO_2 was much dissoved out in the process of analcimization. On the basis of the present result, it is considered that the analcime zone surrounding Kuroko deposits is formed by the reaction between highly saline alkaline solution and tuffaceous sediments of middle Miocene age. The solution are considered to have been heated by submarine volcanism and/or exhalative activities, thus accelerated the alteration. (Authors' abstract)

ABE, Hiroshi, AOKI, Morihiro and KONNO, Hiroshi, 1973a, Synthesis of analcime from volcanic sediments in sodium silicate solution; experimental studies on the water-rock interaction: Contr. Mineral and Petrol., v. 42, p. 81-92. First author at Institute of Earth Science, Miyagi University of Education, Sendai, Japan.

Analcime has been synthesized from natural rhyolitic tuff and green tuff (Miocene age) at 200°C and 20 kg/cm^2 with solution of Na_2SiO_3 (12%) in 50- to 260-hr runs. From the diffraction intensities, it was found that the alteration products of green tuff contained more analcime than those of rhyolitic tuff. It has been concluded that the lithological character of starting materials and the chemical behavior of reaction products are important controlling factors in analcimization. (Authors' abstract)

ABE, Hiroshi, AOKI, Morihiro, and KONNO, Hiroshi, 1973b, Hydrothermal alteration of Miocene tuffs in NaOH-KOH solutions, with special reference to chemical behavior (hydrothermal studies on the wall-rock alteration-3-): Jap. Assoc. Min. Pet. Econ. Geol. Jour., v. 68, pp. 269-276. (In Japanese with English abstract).

Natural green tuff and rhyolitic tuff (Miocene age) were subjected to alteration in sodium hydroxide and potassium hydroxide solutions under 200°C and 20 kg/cm^2. Various chemical behaviors were shown under the influence of running times and chemical conditions. Al_2O_3 content in the alteration product shows an apparent increase. However, Al_2O_3 is absent from the present hydrothermal solutions. It is assumed that during hydrothermal alteration, fresh rock has decreased in weight so that Al_2O_3 has apparently increased. Column A in Table 5 shows the calculated weight in grams of each oxide remaining from the alteration of 100g of fresh rock, on the assumption of constant Al_2O_3. It may be concluded from the present experiments that the amount of analcime in the alteration product depends upon mineral association of starting material and contents of SiO_2 in alteration products. (Authors' abstract).

ABRAMOV, V.A., and VOLYNETS, O.N., 1973, On the study of glass inclusions in the phenocrysts of volcanic rocks: Akad. Nauk SSSR, SO, Geolog. i

Geofiz., 1973, no. 8, p. 126-131 (in Russian).

An attempt was made, using the microanalizer MS-46 (electron microprobe) to compare qualitatively the glass inclusions from plagioclase phenocrysts and those of the groundmass for two samples of Quaternary volcanic rocks of Kamchatka. The studies were carried out on transparent thin sections in preplanned profiles showing the Ca, Fe, and Mg contents. In the two cases there was a similarity in the compositions of the glass inclusions in plagioclase and that of the groundmass of the rock. (Authors' abstract)

ADDY, S.K., & YPMA, P.J.M., 1973, Metamorphism of sulfide deposits and the metamorphogenic circulation of pore water at Ducktown, Tennessee (abst): Geol. Soc. Amer. Abstracts with Programs, v. 5, no. 7, p. 529-530. First author at Marine Biomedical Institute, Galveston, Texas 77550.

The rocks in the alteration zone around the massive sulfide ore bodies at Ducktown, Tennessee are depleted in O^{18} by approximately $2^0/00$ compared to the unaltered country rocks, Based on the average δO^{18} values the following depletions are observed: quartz from 11.0 to 8.9, muscovite from 7.5 to 5.5 garnet from 7.0 to 4.7, biotite from 5.0 to 3.4 and calcite from 8.7 to $7.7^0/00$ SMOW. The δC_{13} values of calcite in the ore zone range from -13.9 to -17.4 $^0/_{00}$ PDB and are similar to the values obtained in the country rocks, i.e. -15.2 to -20.2. The minerals in the alteration zone and in the country rock show identical δD values; -68 to -77 for biotite, -62 to -69 for chlorite and -49 to -54 $^0/_{00}$ SMOW for muscovite. This is suggestive of a situation in which the pore waters maintained isotopic equilibrium with the metasediments throughout metamorphism and have been recycled. However, in the ore zone part of the pore waters escaped through the shear zones during the regional metamorphism and effectuated the alteration. The isotopic composition of this water is as follows: δO^{18}=6.8 to $7.6^0/_{00}$ SMOW, δC_{13}-10 to $-16^0/_{00}$ PDB, and δD-28 to $-38^0/_{00}$ SMOW. Isotopic exchange with rocks at depth at higher temperatures and/or preferential loss of CO_2 from the solutions are suggested as the processes causing the oxygen shift in the water.

The results of this isotopic study along with the fabric studies indicate that the sulfides are partly pretectonic, probably syngenetic, and partly hydrothermal formed by the remobilization of trace sedimentary sulfides in the rocks during the period of regional metamorphism. The alterations around the ore bodies took place in the descending stage of metamorphism as the influx of the O^{18} depleted water continued. (Authors' abstract)

AGAFONOV, L.V., and ANDREYEVA, G.A., 1973, Gases in the alpine-type ultramafics of the Anadyr-Koryak fold system: Akad. Nauk SSSR Doklady, v. 210, p. 689-692 (in Russian; translated in Doklady Acad. Sci. USSR, v. 210, p. 232-234 (1974)). Authors at Institute of Geology and Geophysics, Siberian Department of the USSR Academy of Sciences, Novosibirsk.

Numerous analyses for H_2, CH_4, C_2H_6, C_3H_8, and (CO_2+SO_2), as well as bitumen content. (E.R.)

AHRENS, A.H., DUNCAN, A.R., and ERLANK, A.J., (Eds.), 1973, Internat. Conf. on Kimberlites, Extended Abstracts of Papers: Univ. of Capetown, Rondebosch, Cape, S. Africa. 332 pp.

These abstracts (approx. 90 papers) present information on a wide variety of subjects, particularly kimberlites and associated peridotites, carbonatites, and ultrabasic nodules from many areas of the globe. These include extensive mineralogical data, isotopic data (Rb, Sr, Pb, C, O), distribution of elements between coexisting phases, much evidence and discussion of kimberlite gas-solid intrusion phenomena, solid inclusions in diamonds, and a variety of synthetic experimental studies of systems including H_2O and CO_2; all are pertinent to any study of the fluid inclusions in such materials. Unfortunately there is no index; presumably the full Proceedings volume will have an index. A few of the most pertinent papers have been entered alphabetically by author. (ER)

AKIMTSEV, V.A. AND GORDEEVA, V.I., 1973, Temperature conditions of topaz crystallization in apogranites: Abstracts of papers from the Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 130-131 (in Russian; translation through the courtesy of A. Kozlowski). Authors at Inst. of Geology and Geochemistry, Siberian Branch of Academy of Sciences USSR-IGiG SO AN SSSR, Novosibirsk.

1. Inclusions in topaz from quartz-beryl-topaz veinlets of apogranies were investigated by the homogenization method.

2. In topaz three types of inclusions occur: primary, pseudosecondary and secondary.

3. Primary inclusions bear gas and liquid and sometimes (a?) solid phase. Phase ratios vary widely.

4. T_h interval of topaz = 400-260°C, in liquid. Presence of homogenous liquid CO_2 in pseudosecondary inclusions (2 liquids at 25-29°C) precludes reaching homogenization.

5. The data are comparable with data on inclusions in quartz and beryl of those veinlets. (Author's abstract)

ALEKSEENKO, V.A., GOLIKOV-ZAVOLZHENSKIY, I.V., KOLOMENSKIY, G.Yu., and ERMEKOV, O.M., 1973, Test of the application of vacuum-decrepitometric investigations during studies of some polymetallic and rare metal deposits of S and Central Kazakhstan: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973, Rostov, Rostov Univ. Press, p. 265-266 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Karaganda Polytechnical Inst., Central Caucasian Geological Office, Karaganda, and Rostov Univ.

The following regularities were recognized:

1. For each group of deposits the T of origin was found to be similar to other deposits of the region. For stratiform deposits of Dzhungaria, occurring up to 200 km apart, it appears that the general T conditions of mobilization of primary dispersed ore substances was similar.

2. Based on the T of mineral origin, some stages of ore mineralization may be distinguished at the investigated deposits. Each stage is accompanied by a specific complex of elements, either as minerals, or as substituting elements in minerals. Such stages and elements at the Solnechnoe rare-metal deposit are: Pb, Cu, Zn - 340-270°C; Ge, F - 280-270°C; F, Be, Ag - 290-90°C; and Mo, Sn, W, Bi, Ag - 330-270°C. In the group of polymetallic deposits of Dzhungarian Alatau the groupings are: Sb, Cd, Bi - 110-130°C; Ge, Ag - 280-330°C.

3. For rare-metal deposits a distinct temperature zoning was detected. Vertical T gradients vary from 5-100°/100 m, horizontal, from 10-20°/100 m. Spatial agreement was found between these temperatures and the geochemical and ore zoning.

4. Clear distinction of rocks that have been impregnated during the process of ore-formation indicates the applicability of decrepito-

metric methods for prospecting for hidden polymetallic and fluorite-rare-metal ores in carbonate rocks. (Authors' abstract, abbreviated by A.K.)

AL-KHATIB, Ramzy, and TOURET, Jacques, 1973, Carbon dioxide fluids in granulite facies rocks from southern Norway. Semiquantitative utilization of the crushing stage: Soc. Géol. de France, Bull., v. 15, no. 3-4, p. 321-325 (in French with English abstract). First author at Laboratoire de sédimentologie, Université de Nancy I, C.O. no. 140, 54037 Nancy Cedex, France.

The crushing stage is a practical instrument to confirm the abundance and specificity of CO_2 in fluid inclusions from granulite facies quartzites of southern Norway. From the number and volume of bubbles released by crushing in anhydrous glycerine, it is estimated that 0.034 mm^3 CO_2 is released at 1 atm. for 1 mm^3 quartz. (Authors' abstract)

ALLEN, Leland, 1973, The rise and fall of polywater: New Scientist, v. 59, p. 376-380.

A review of the history of polywater (starting in 1961), the evidence for it, and the final disproof of it by its original proponent, B.V. Derjaguin as well as others (see Fluid Inclusion Research - Proceedings of COFFI, v. 3, p. 15-16, 1970),(E.R.)

ANDERSON, A.T., Jr., 1973a,An estimate of the before-eruption H_2O content of a high alumina basalt (abst.): Amer. Geophys. Union Trans. (EOS), v. 54, p. 493. Author at Dept. of the Geophys. Sciences, Univ. Chicago, Chicago, Ill. 60637.

Electron microprobe analyses of some glass inclusions in phenocrysts have considerably lower oxide sums than contemporaneous analyses of either the vesicular host glass or an anhydrous glass standard (from Kilauea, Hawaii). This difference is best explained as H_2O dissolved in the trapped glass inclusion but absent from the vesicular glasses. The analyses are performed such that Na is completely retained. Probably, H_2O is retained, too. Since sulfur is demonstrably 5 to 10 times higher in trapped glass inclusions than in host vesicular glass, it is reasonable to expect that H_2O also is kept at before-eruption concentrations in the included glass. With a two s.d. uncertainty of 1.4 percent the oxide sum differences (approx. H_2O) and K_2O contents of glasses included in olivine phenocrysts from a high-alumina basalt near Medicine Lake Highland, Calif. are (weight percent):

H_2O	0.8	0.6	1.7	3.7	2.5	3.6	4.3	2.4	0.9	1.0	1.4
K_2O	0.26	0.27	0.29	0.42	0.41	1.07	0.45	0.32	0.37	1.27	0.23

Thus, the before-eruption H_2O content was 2.1 ± 1.4%. Studies of other lavas from Medicine Lake to Mt. Shasta will be reported. (Author's abstract)

ANDERSON, A.T., 1973b,A volatile-rich picritic parent of andesites, Mt. Shasta, California (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 5 no. 7, p. 532-533. Author at Univ. of Chicago, Chicago, Ill. 60637.

Glasses trapped in olivine megacrysts (Fo94-79) from Holocene and Pleistocene tephra erupted within 20 kilometers of Mt. Shasta summit range in composition from high-alumina basalt to andesite (anal. 1-4 below). The glass inclusions in the most magnesian olivines have about 8% of their volume occupied by vapor bubbles, and are surrounded by broad Fe-rich zones in the olivine host and by ghost outlines within the olinine host. These facts indicate that the melt which was initially trapped within the olivine contained 24% MgO (anal.5 below). Analogy with experimental data suggests an initial entrapment temperature of 1400°C. K_2O in glass inclusions increases regularly with Fe_2SiO_4 content of olivine host exactly as predicted by equilibrium crystallization whereby early magnesium-rich olivine reacts with successive liquid derivatives. H_2O,Cl and S decrease or remain approximately constant with increasing K_2O suggesting vapor-saturated differentiation at a depth of a few kilometers or less. These facts suggest that volative-rich parental picrite stagnates at a few kilometers beneath Mt. Shasta because of saturation with an H_2O-rich gas. The loss of gas promotes equilibrium crystallization which inhibits Fe-enrichment. Representative microprobe analyses of glasses follow (all Fe as FeO, H_2O estimated by difference ±1.4% absolute error).

No.	Host	SiO_2	Al_2O_3	FeO	MgO	CaO	Na_2O	K_2O	TiO_2	H_2O	Cl	S	Sum
1	Fo94	54.6	15.6	3.8	5.3	12.6	2.6	0.49	0.68	2.2	0.19	0.21	98.3
2	Fo89	58.9	16.1	5.4	4.1	7.9	2.7	1.05	0.66	0.8	0.11	0.05	97.9
3	Fo90	50.0	17.4	6.1	6.8	12.2	2.3	0.25	0.56	2.0	0.07	0.11	97.8
4	Fo85	56.4	15.1	7.2	4.2	7.1	4.0	0.93	1.20	1.4	0.06	0.01	97.6
5	Fo94	48.6	8.9	6.7	23.9	7.2	1.5	0.28	0.39	1.2	0.09	0.10	98.9

(Author's abstract)

ANDERSON, G. M., 1973a, The hydrothermal transport and deposition of galena and sphalerite near 100°C (abst.): Geol. Soc. Amer. Abstracts with Programs, no. 4, p. 293-294. Author at Department of Geology, University of Toronto, Toronto 181, Ontario, Canada.

Measurements of aqueous complex stability constants and sulfide solubilities near 100°C have allowed construction of a model which predicts galena and sphalerite solubilities in subsurface brines of various compositions. This in turn allows calculations of the amounts of galena and sphalerite which will be precipitated due to given changes of conditions in the solution, such as cooling, neutralization by limestone, dilution or sulfate reduction. Taking Roedder's estimate of an average fluid inclusion composition for Mississippi Valley type ores (∿ 3m NaCl; .03m SO_4^{2-}), the model indicates that if ore precipitation is by any process that requires reduced sulfur and metals to be transported in the same solution (e.g. cooling, neutralization), then the solution is more acid than pH 5, will actively dissolve calcite and dolomite, and that chalcopyrite cannot be precipitated with galena and sphalerite. If precipitation is caused by sulfate reduction or mixing with an H_2S solution, then chalcopyrite, calcite and dolomite may or may not be stable during deposition, depending on pH, and mineral zonation should be much less distinct. Observations on paragenesis of ore and gangue minerals, particularly if combined with knowledge of the fluid inclusion compositions, may therefore enable depositional mechanisms to be deduced. (Author's abstract)

ANDERSON, G.M., 1973b, The hydrothermal transport and deposition of galena and sphalerite near 100°C: Economic Geology, v. 68, p. 480-492.

Using experimental data on the solubility of galena and calculated solubilities of sphalerite, some of the consequences of assuming that the ore-depositing fluid has the composition indicated by fluid inclusion evidence are examined. Assuming that at least 1 ppm Pb or Zn must be deposited as sulfide from the solution before an ore body can form, it is concluded that there is no difficulty in transporting and depositing sufficient metal and sulfur from a slightly acid, chloride-rich brine with a fairly low sulfate content. If the reason for sulfide precipitation is cooling, neutralization, or dilution, the ore-forming brine will actively dissolve calcite and dolomite and the sulfur fugacity is quite high. This means that, among other things, chalcopyrite is not stable during deposition of PbS and ZnS. If increase in reduced sulfur is the reason for sulfide precipitation, then calcite, dolomite, and chalcopyrite may or may not be stable during precipitation, but it is more difficult to account for zoning of galena and sphalerite. (Author's abstract)

ANDERSON, G.M., & HAMILTON, D.L., 1973, Sub-solidus phase relations in the sub-silicic part of the system Q-Ne-Ks-NaCl-KCl-H_2O and application to the York River, gneisses, (abst.): Geol. Soc. Amer. Abstracts with Programs v. 5, no. 7, p. 533. First author at Dept. of Geology, University of Toronto, Toronto, Ontario.

Phase relations involving albite and K-spar solid solutions (Ab,Or), analcite (Anl), leucite (Lc), nepheline and kalsilite solid solutions (Ne,Ns) have been determined by ion-exchange experiments at 2Kb, using 2m and 3m alkali chloride solutions and crystallized gels as starting materials. At 500°C, stable 3-solid-phase assemblages (with analytical K/(K+Na) ratio of the associated aqueous phase in brackets) are Ab+Or+Anl Anl+Or+Ne (0.44) and Or+Lc+Ne. At 600°C, they are Ab+Or+Ne (0.25) and Or+Lc+Ne (0.66). Two-solid-phase assemblages always have K/(K+Na) values consistent with those of the adjoining 3-solid-phase areas. The cross-reaction Ab+Ne=Anl+Or takes place near 600°C.

York River nepheline gneisses in the Bancroft area usually contain the assemblage Ab-Or-Ne, and analcite has never been observed. Phase compositions indicate temperatures of less than 500°C, but the above results indicate that this temperature the rocks should contain analcite if water was available. The observed assemblages and the metasomatic textures (chiefly nepheline replacing albite) are therefore thought to have originated at much higher temperatures. Since little or no melting of the gneiss has occurred, fairly narrow limits on the metamorphic conditions are imposed. (Author's abstract)

ANDRUSENKO, N.I., 1973, Siberian Platform pyroxene-sphene-zeolite altered traps connected with pegmatite-formation (according to results of experiments with inclusions): Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 216-217 (in Russian; translation through the courtesy of N.I. Andrusenko) Author at TSNIGRI, USSR, MG, Moscow.

1. Among the metasomatically altered intrusive traps of the Central Siberian Platform (Dmitriev, 1958; Kudrjashova, 1957; Yudina, 1963: Andrusenko, 1965) there are peculiar pyroxene-sphene-zeolite rocks enriched by sphene (30%) and zeolites (60%) from the natrolite and heulandite group. These rocks also contain analcime. The newly-formed diopside and sphene crystals are case- and enevlope-shaped and measure 1-2 cm. The sphene contains close to 0.33% lanthanides. The original dolerites have a pegmatoid structure. These rocks are frequently connected with valuable Iceland spar deposits.

2. Our studies of the inclusions have shed new light on the debatable problem of the genesis of such pegmatoid traps, transformed into pyroxene-sphene-zeolite rocks. Diopside and sphene contain glassy and crystallized inclusions with homogenization temperatures of 830-

750°C, crystal-gas inclusions (750-680°C) and gas-liquid inclusions (420-180°C). This warrants the assumption that the pegmatoid dolerites formed from residual melt of basic magma saturated with volatiles. The diopside and sphene completed their growth from gaseous and liquid solutions which had much titanium.

3. It has been found that zeolites may be used in thermometric studies which depend on the behaviour of water in these hydrated minerals. If the temperature of homogenization of the inclusions in the zeolites is below that of the endothermic effects on their thermograms, the heating will cause no leakage of their inclusions. (Author's abstract)

ANDRUSENKO, N.I., GODLEVSKY, M.N, AND YUDINA, V.V., 1973, Some data on the temperature conditions of mineral formation in connection with nickel-bearing intrusions of the Talnakh ore district: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 198-199 (in Russian; translation thourgh the courtesy of N.I. Andrusenko). Authors at TSNIGRI, USSR, MG, Moscow.

1. The temperatures of formation of successive mineral associations belonging to the magmatic and postmagmatic stages may be estmated because anhydrite is present in all the associations as a rock-forming and vein mineral.

2. Our numerous findings in the thermometry of inclusions show a wide range of anhydrite-forming temperatures (685-100°C), divided into several intervals a) 685-400°C - temperature of anhydrite formation from anhydrite marbles belonging to the quartz pyroxene facies of contact metamorphism; b) 570-340°C - anhydrite belonging to magnesium and calcium-skarn parageneses; c) 380-340°C - anhydrite belonging to veins containing datolite and apophylite; d) 260-230°C - anhydrite from hydrogarnet-serpentine postskarn rocks; 3) 140-100°C - temperatures of secondary solutions in sedimentary anhydrite.

3. The presence of the concomitant metasomatic copper-nickel ore in all the postmagmatic formations of the Oktyabrsky deposit makes it possible to indicate the approximate temperature limits of the ore associations: a) 570-340°C - early chalcopyrite-pentlandite-pyrrhotite which accompanies magnesium and partly calcium skarns; b) 260-230°C essentially chalcopyrite with bornite and valeriite.

4. According to the homogenization of inclusions in quartz occurring in the continuous deposit of injection-magmatic chalcopyrite-pentlandite-pyrrhotite ores the temperature of formation of the marginal part of the ore body is 520-300°C, while that of bornite-talnakhite ores is 240-180°C.

5. According to several aqueous extracts of anhydrite the mineral-forming solutions are composed of bicarbonate-chloride-sulfate with a predominace of fluorine over chlorine (ratio F/Cl from 3/1 to 8/1). Alkalies are absent in samples of solutions from sedimentary and metasomatic anhydrite and a sharp predominance of calcium over the sum of alkalies is found in the sample of anhydrite marble. According to individual analyses of the gaseous phase of inclusions both in the anhydrite and quartz, carbon dioxide predominates strongly. (Authors's abstract)

ANDRUSENKO, N.I., KOSOVETS, T.N., KONSTANTINOV, M.M., 1973, Thermodynamic conditions of formation of gold ore deposits in Transcaucasus: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 47-48 (in Russian; translation provided through the courtesy of N. I. Andrusenko). Authors at Central Scientific-Research Geological-Prospecting Institute of Geology Ministry, USSR, Moscow - TSNIGRI MG SSSR.

The thermodynamic condition of formation of Transcaucasian gold deposits was established on the basis of systematic studies of inclusions of seven deposits in the Sevan-Akerin and Miskhan-Zangezur structural zones. The deposits belong to different stages of mineralization: gold-copper-molybdenum and gold proper. The results place the deposits in the mesothermal group formed within the range 450 to 60°C.

The thermodynamic condition of formation of most of the deposits with an extended mineralization process is characterized by relatively wide temperature ranges for individual stages, with sharp interstage changes (≤ 180°C) and less strongly pronouced intermineralization changes (≤ 50-100°C).

The productive stages were formed at fairly high temperatures (360-200°C) that remained stable for a long period of time and covered several successive gold-bearing associations. The slow rate of cooling of the ore-forming solutions is due to the formation of these deposits at intermediate depths for the cooling intrusive body. The state of aggregation of early portions of the solutions was gaseous or near critical; the fluids condensed at temperatures ranging from 360-320°C and later in the deeper seated deposits.

The deposits of the gold-copper-molybdenum stage are characterized by a chloride composition and highly concentrated solutions, while chloride-carbonate solutions of moderate mineralization are typical of gold proper deposits, owing to the peculiarities of the structural and tectonic regime of their formation and the different magmatic sources feeding the solutions. (Authors' abstract)

ANTHONY, T.R., and CLINE, H.E., 1973, The stability of migrating droplets in solids: Acta Metallurgica, v. 21, p. 117-122. Authors at General Electric Research and Development Center, Schenectady, New York.

The stability of water droplets migrating in a thermal gradient in a single crystal of KCl was studied as a function of droplet size, droplet shape, droplet velocity and the applied thermal gradient in the solid. Droplet breakdown starts with the growth of protrusions from the rear corners of the droplet and is followed by the release of a thin trailing liquid veil from the rear peripheral edges of the droplet at a somewhat higher thermal gradient. Droplets with a velocity to applied thermal gradient ratio less than 9.4×10^{-8} cm^2/sec °C are stable while droplets with a greater ratio are unstable. This stability criterion is shown to be consistent with the idea that droplets disintegrate when the bulk droplet velocity exceeds the maximum theoretical velocity of droplet edges. The velocity difference arises from the difference between the thermal gradients in the center and the edges of a droplet. (Authors' abstract).

ANUFRIYEV, Yu.N., AND MOSKALYUK, A.A., 1973, Some comparative data on composition of solutions from inclusions in quartz of rock-crystal-bearing and gold-ore deposits of Ural: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 156-157 (in Russian; translation through the courtesy of A. Kozlowski). Author at All-Union Scientific-Research Institute for the Synthesis of Mineral Raw Materials, Aleksandrov, VSEGEI, Leningrad.

Over 150 water leachates of quartz from three hydrothermal gold deposits and three hydrothermal-metamorphic deposits of rock crystal from Ural were investigated, giving results as follows:

Quartz type	Cl^-	F^-	HCO_3^-	SO_4^{2-}	K^+	Na^+	NH_4^+	Ca^{2+}	Mg^+	Solution type
Gold Ore Deposits										
1.Ore-bearing	18	3	62	15	5	23	3	64	5	1
2.Barren	39	3	45	12	6	39	1	50	8	2
3.Rock crystals	44	4	44	8	3	40	1	53	2	2
Rock Crystal Deposits										
1.Rock-crystal bearing	62	2	28	9	3	62	not detmnd	37	3	3
2.Rock-crystal-free	40	3	47	11	5	42	"	51	3	2
3.Rock crystals	68	3	20	9	6	68	"	25	1	4

Note: Ion amounts in %-equivs. Solution types are as follows: 1 - chloride-calcium, 2 - bicarbonate-chloride-calcium-sodium, 3 - chloride-sodium-calcicum, 4 - chloride-sodium. (Authors' abstract)

ANUFRIYEV, Yu.N., STUPAKOV, G.P., and MOSKALYUK, A.A., 1973, Characteristics of quartz from the Kochkar gold ore deposit: Akad. Nauk SSSR, Izv., Ser. Geol., no. 3, p. 68-81 (in Russian).

Includes numerous decrepigrams and 12 analyses of water leachates for K, Na, Mg, Ca, Li, NH_4, Cl, F, SO_4, and HCO_3. (E.R.)

ARKHIPCHUK, R.Z., and VOVK, P.K., 1971, Crystallomorphology of fluorite from the Kharasunskoe deposit (Western Transbaikal region): Mineral. Mineral. Kristallogr., Tr. Soveshch. 1969 (Pub. 1971), p. 70-71: Edited by Vertushkov, G.N., Sverdlovsk. Gorn. Inst.: Sverdlovsk, USSR (In Russian) Chem. Abst., v. 79, (12), 138468 w, 1973.

Phys. properties of various forms of fluorite crystals and their aggregates in quartz-fluorite veins of the Kharasunskoe deposit such as habit, color, size, and mosaic structure were described in detail. A study of internal zonality of the crystals and also relation among their different habit forms proved that the octahedral crystals appeared first during the mineral formation. From the octahedral forms, the fluorite crystals of rhombododecahedral, cubic, and more complex habits were gradually developed. The evolution of crystallog. forms resulted from changes in both supersatn. and chem. compn. of the crystg. medium during a successive decrease in the crystn. temp. The data on homogenization of gas-liq. inclusions indicated that the fluorite crystals were probably formed from homogeneous hydrothermal solns. at 190-75°.

ASHLEY, R.P., and KEITH, W.J., 1973, Occurrences of alunite in hydrothermally altered rocks and ores at Goldfield, Nevada: Geol. Soc. Amer. Abstracts with Programs, v.5, no. 1, p. 6. Authors at U.S. Geol. Survey, Menlo Park, Calif. 94025.

The Goldfield mining district is a classic locality for alunite-bearing altered rocks associated with epithermal precious metal ores. Alunite at Goldfield appears in at least five different settings: (1) Alunite replaces constituents of silicified volcanic and plutonic rocks in many silicified zones throughout the 15-square-mile altered area at Goldfield. Silicified wallrocks and wallrock breccia fragments associated with the ore bodies carry this replacement alunite. (2) Alunite is intergrown with quartz near the margins of quartz veins or breccia fillings which bear sulfide ore minerals. (3) Alunite forms veins in unoxidized ore-bearing veins or breccia fillings. (4) It forms platy crystals as much as 1 cm wide, intergrown with jarosite crystals. These alunite-jarosite aggregates fill fractures and brecciated areas in some silicified zones. (5) Fine-grained alunite forms veins that crosscut both argillized and silicified zones. All these veins contain quartz, and some have kaolinite and minor K-mica as well.

Petrographic and field relations, as well as mineral assemblages, suggest that alunite in the first three settings is hypogene. Sulfur isotopic data also support a hypogene origin. Petrographic relations and minor element data suggest that the coarse-grained alunite-jarosite aggregates are also hypogene. Field relations and sulfur isotopic data suggest that the fine-grained vein alunite is supergene or possibly late hypogene, developed during hot-spring activity at the end of the hydrothermal episode at Goldfield. (Authors' abstract).

AUGUSTITHIS, S.S., 1973, Atlas of the textural patterns of granites, gneisses and associated rock types: Elsevier, Amsterdam, 378 pp.

An atlas of 687 photographs, mainly photomicrographs, plus 96 pages of text and an extensive bibliography, on the title subject. Of interest to inclusion workers in the many details of solid inclusions, mineral growth, replacement, shearing and recrystallization illustrated that may well be involved in any attempt to understand the fluid inclusions in such rocks. Although the photomicrographs are excellent, this reviewer disagrees with many of the interpretations made. Fluid inclusions are not listed in the index, but are mentioned briefly in the text (e.g., p. 54). Many photomicrographs which look to this reviewer to be laden with fluid inclusions are otherwise interpreted by the author. Thus, Fig. 126, which looks like healed secondary planes of inclusions cutting across quartz grain boundaries, is described as a "Linear distribution of fine pigments (representing an initial gel-structure)..."; what appear to be planes of vermiform secondary melt inclusions in augite from a basalt (Fig. 210) are interpreted as a myrmekitic-like intergrowth of undertermined infiltration process (p. 32); and solid inclusions of tourmaline outlining growth stages in a quartz crystal (Fig. 632) are interpreted as formed by a later infiltration along "interleptonic spaces" (p. 70). (ER).

AVDONIN, V.V. AND KEL'KH, V.Ye, 1973, Temperature conditions of formation of the Tishinskoe deposit as indicated by results of inclusion homogenization and decrepitation: Abstracts of papers at Fourth Regional

Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30, Sept., 1973: Rostov, Rostov Univ. Press, p. 87-88 (in Russian; translation through the courtesy of A. Kozlowski). Authors at Moscow University.

1. The Tishinskoepolymetallic deposit occurs in Middle Devonian volcanic-sedimentary rocks (in Ore Altai Mts. - Rudnyi Altai).Decrepitation data of pyrites, as well as T_d and T_h in quartz from quartz-carbonate veins are based on about 350 samples.

2. Temp. of beginning of decr. of pyrites ranges from 210-310°C, and the temp. decrease (210-270°C) toward the ore body or ore channel way faults. Maximum temp. were found in late (post-ore) feldspathic metasomatites.

3. Quartz veins may be divided into two groups; early with extensively developed deformation, practically does not decrepitate; late, post-ore gives T_d 320-350°C. The above data are supported by T_h of primary inclusions (at 370-260°C). Inclusions in blocks of quartz lying between large boudinages of quartzites and massive deformed ores homogenize at 365-375°C. (Authors' abstract)

BAKUMENKO, I.T., CHEPUROV, A.I., and CHUPIN, V.P., 1973, Diagnostics and investigations of the properties of melt inclusions: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Spet., 1973: Rostov, Rostov Univ. Press, pp. 21-23 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Inst. of Geology and Geophysics, Siberian Branch, Academy of Sciences USSR, Novosibirsk.

The essential question during investigation of magmatic processes by the methods of physical geochemistry is the correct genetic and phase diagnostics of primary and pseudosecondary glass, crystallized, transformed and combined inclusions of parent melts. There exist the distinct properties distinguishing them from secondary glass inclusions formed during the local crushing of minerals in the case of meteoritic or other impacts, from pseudo-melt inclusions formed in the experiment or under natural conditions as the result of migration and contamination of gas-liquid inclusion matter with silicate phases. Silicate gas-crystal inclusions or salt-rich inclusions of brine with a composition not corresponding to the composition of parent magmas, when minute, may be incorrectly identified as melt inclusions.

All these kinds of inclusions may be identified during morphologic and optical investigations combined with scientific photography, visual observations of inclusions during heating and cooling, gas phase analysis and electron microprobe analysis (EMA) of individual inclusions. For example, it was shown by the EMA method that the compositions of melt inclusions in magmatic minerals of acid, alkaline and ultrabasic rocks actually are the same as the composition of appropriate magmas, i.e. those inclusions are not the products of dispersion of host minerals in other strange phases. On the other hand, strongly impacted samples contain inclusions with the composition of the host minerals (lechatelierite or other glasses without analogous natural magmas).

The important aspect is to achieve comparable data from a series of hermetic inclusions, investigated at equilibrium at the temperature of phase changes. Diagrams of homogenization (heterogenization) temperature (T_H) versus time of experiment (t or better log t) are useful to determine the time for reaching equlibrium and the viscosity of melt. The heating rate most suitable is 10-30°C/min. before the beginning of melting and 1-2°C/min. with periodic breaks in temperature increase at the time of melting. The time period for inclusion homogenization in basic rocks is 1/2 to 1/4 of that for acid rocks and at least 3-5 hours to 6-12 hours in the latter (acid) rocks (1-2 hours for ultrabasic rocks). Large and crystallized inclusions require longer exposure time than the small ones. In previously stablilized melt inclusions in minerals of ultrabasic rocks, alkaline basaltoides, and granitoids, the time for achievement of equilibrium at temperatures close to T_H are 2-5 min., 20-30 min. and 1-2 hours respectively. (Authors' abstract).

BANNIKOVA. L.A. AND SUSHCHEVSKAYA, T.M., 1973, Chemical regime of formation of cinnabar deposits of Krasnodar district: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept. 1973: Rostov, Rostov Univ. Press, p. 154-155 (in Russian; translation through the courtesy of A. Kozlowski). Authors at GEOKHI, Acad. Sci. of USSR, Moscow.

1. (...) At the investigated deposits (Pereval'noe, Sakhalinskoe) two mineralogical zones were distinguished. The interal zone consists of strongly silicified clays partly replaced by quartz, with irregular aggregates and veinlets of sulfides. The external zone is made of calcite veinlets cutting the silicified clays. Silicification was the first stage of deposition. Calcite and sulfides precipitated at the same time but at various places.

2. Using water leachates from quartz, calcite, cinnabar, antimonite and pyrite, the following features of the mineral-forming solutions were determined: low salinity, $Ca>Mg>K>Na\geqslant Li$, $SO_4>HCO_3>F>Cl$ (but in calcite: $Ca>Mg>Na>K$, $HCO_3>Cl>F\geqslant SO_4$). Li was found in inclusions in calcite. Sulphate ion occurs in very small amounts in calcite but in solutions from quartz it is the prevailing anion. Na/K, Mg/K, Cl/F and Cl/B differ strongly (by 1-2 orders) in solutions from quartz and from calcite. (Authors' abstract, abbreviated by A.K.)

BANSHCHIKOVA, I.V., KRAVCHENKO, S.M. AND MANUCHARYANTS, B.O., 1973, Conditions of crystallization of extrusive andesites of Mendeleev Volcano (melt inclusion data): Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 209 (in Russian; translation through the courtesy of A. Kozlowski). Authors at Inst. of Mineralogy and Geochemistry of Rare Elements, Moscow.

Melt inclusions were investigated in phenocrysts of plagioclase, quartz, and olivine from andesites and dacites of the central post-caldera Holocene dome of Mendeleev Volcano at Kunashir Island (the Southern Kurils).

Phenocrysts of plagioclase and quartz commonly bear melt inclusions: glass plus gas, rarely glass plus cyrstals plus gas, distributed in all the phenocrysts in the same mode and strictly regularly. The central part of plagioclase phenocrysts (with melted edges) does not bear primary inclusions, but often contains numerous pseudosecondary melt inclusions corresponding to primary ones from the outer part of the crystal.

The outer part of the plagioclase phenocrysts bears major amounts of primary inclusions, localized along growth zones. The most numerous inclusions in a zone adjacent to the partly melted inner part have T_H 1380°C. In the outer part of pheocrysts, in addition to the above, some groups of primary inclusions are distinctly isolated in growth zones, with T_H regularly decreasing from 1370 to 1290°C, toward the outside of the pheoncrysts. In some cases certain groups of inclusions mark small local zones of slight melting.

Phenocrysts of quartz bear primary and pseudosecondary melt inclusions with T_H 1150-980°C. (Authors' abstract)

BARKER, Colin, and SOMMER, M.A., 1973, Mass spectrometric analysis of the volatiles released by heating or crushing rocks, in Analytical Methods Developed for Application to Lunar Samples Analyses, ASTM STP 539, American Society for Testing and Materials, p. 56-70. Authors at University of Tulsa, Tulsa, Oklahoma 74104.

The volatiles trapped in rocks can be released either by heating or by crushing. Unfortunately crushing generates new, clean surfaces which adsorb chemically active gases and thus change both the amount and composition of the evolved gases. For quantitative analysis the volatiles were released by heating 0.1-g samples in fused silica tubes at temperatures up to 1200°C. The evolved volatiles were separated into two fractions by fractional freezing. Volatiles which were not condensed in a liquid nitrogen-cooled trap (hydrogen, carbon monoxide, methane, nitrogen, helium, etc.) were mixed with a known amount of argon internal standard and leaked into a calibrated E.A.I. QUAD 1110 mass spectrometer for analysis. The condensable volatiles (water, carbon dioxide, higher hydrocarbons) were subsequently evaporated and analyzed in the same way. The analog output from the mass spectrometer was fed to a digital integrator which printed the areas of the peaks on a teletype and simultaneously punched a paper tape. The tape was later transmitted over a telephone line to a time-shared computer for data processing. (Authors' abstract)

BARLIER, J., TOURAY, J.-C., and GUILHAUMOU, N., 1973, Evidence of the genesis of liquid and gaseous hydrocarbons in the inclusions in quartz of the Autapie Nappe, Provence Alps, France: Acad. Sci., (Paris) C.R., Ser. D, v. 277, no. 21, p. 2297-2300 (in French). First author at Lab. de Géochim. des Roches Séd., Univ. Paris Sud, Centre d'Orsay, Bat. 504, 91405, Orsay, France.

A series of inclusions were examined over a wide range of temperature (-180 to +220°C) and tabular data presented on the thermal behavior of aqueous and hydrocarbon (mainly CH_4) inclusions. Good photomicrographs. (ER.)

BARNES, H.L., 1973, Review of Composition of Fluid Inclusions, by E. Roedder: Econ. Geol., v. 68, p. 415 (see Fluid Inclusion Research - Proceedings of COFFI, v. 5, 1972, p. 89).

A generally favorable review by an otherwise negative exponent of fluid inclusions. (E.R.)

BARNES, Ivan, and HEM, J.D., 1973, Chemistry of subsurface waters: Annual Review of Earth and Planetary Sciences, v. 1, 1973, Fred A. Donath, Editor: Palo Alto, California 94306, Annual Reviews Inc., p. 157-181. Authors at U.S. Geological Survey, Menlo Park, California.

A review of water types and localities in terms of special (or nonspecial) compositions or temperatures, with explanations of their origins and 178-item bibliography (E.R.).

BARRON, L.M., 1973, Nonideal thermodynamic properties of H_2O-CO_2 mixtures for 0.4-2kb and 400-700°C: Contr. Mineral. and Petrol., v. 39, p. 184. Author at Geological Survey of New South Wales, Australia.

A brief discussion of data in Ryzhenko and Malinin, 1971. (ER)

BARSUKOV, V.L., and SUSHCHEVSKAYA, T.M., 1973, Evolution of composition of hydrothermal solutions in the formation of tin-ore deposits: Geokhimiya 1973, no. 4, p. 491-503 (in Russian; translation in Geochem. Internat., v. 10, no. 2, 1974, p. 363-375). Authors at Vernadskiy Institute of Geochemistry and Analytical Chemistry, Academy of Sciences of the USSR, Moscow.

Results are presented on decrepitation, homogenization, and analysis of aqueous extracts (particularly for Na/K and HCO_3/Cl) from inclusions in the minerals of ore bodies and mineralized zones around sulfide-cassiterite and quartz-cassiterite deposits. It is found that the hydrothermal solutions that gave quartz-cassiterite deposits contained mainly sodium, whereas those that gave sulfide-cassiterite ones contain mainly potassium.(Authors' abstract)

BARSUKOV, V.L., and SUSHCHEVSKAYA, T.M., 1973, On the composition evolution of hydrothermal solutions in the process of the formation of tin ore deposits: Geokhimiya, 1973, no. 4, p. 491-503 (in Russian; translated in Geochemistry Internat., v. 10, no. 2, 1974, p. 363-375). Authors at V.I. Vernadsky Institute of Geochemistry and Analytical Chemistry, USSR Academy of Sciences, Moscow.

Data on decrepitation (100°-380°C), homogenization (190°-514°C) and analysis of water extracts from inclusions in minerals of ore bodies and mineralized zones of sulfide-cassiterite and quartz-cassiterite deposits are presented. Some of the decrepitation temps. are as much as 130° lower than homogenization temperatures, due to high CO_2 concentrations. It is shown that during the formation of quartz-cassiterite deposits hydrothermal solutions are mainly sodic, and during the formation of sulfide-cassiterite deposits they are mainly potassic. F ranged from 1 to 4 gm/l. (Authors' abstract, extended by ER.)

BARTON, P.B., BETHKE, P.M., and RYE, R.O., 1973, Hypothetical process for formation of O^{18} and deuterium-rich ore-forming waters at Creede, Colorado: Geological Survey Research 1973, U.S. Geol. Sur. Prof. Paper 850, p. 5.

The oxygen and hydrogen isotopic compositions for sericite, chlorite, quartz, carbonates, and fluid inclusions show that the water of the ore-forming system differs dramatically from both normal magmatic water and modern ground water. The data suggest either a drastically different climatic regime in the San Juan area in the late Oligocene, or a hypothetical process (such as the evaporation of lake) that could enrich the meteoric water in both O^{18} and deuterium, or prolonged reaction of magmatic water with volcanic rocks at low temperature to produce an oxygen shift of heretofore unrecognized magnitude. (Authors' abstract)

BARTON, P.B., Jr., and HAAS, J.L., Jr., 1973, Role of nitrogen in hydrothermal ore formation: Geol. Survey Research 1973, U.S. Geol. Sur. Prof. Paper 850, p. 138.

Considerations of thermodynamic data and natural occurrences of nitrogen-bearing compounds show that atmospheric nitrogen could have an oxidizing influence under some conditions of sulfide ore formation. The nitrogen is reduced to ammonia or ammonium ion, giving an oxidizing effect about three times as great as that of dissolved atmospheric oxygen. This effect is favored by low pH and fixation of ammonium in solid phases. It is suggested that these processes would lead to significant isotopic fractionation of nitrogen and that such fractionation could prove useful in the interpretation of conditions of ore formation. (Authors' abstract)

BASKOV, Ye.A., VETSHTEYN, V.Ye., SURIKOV, S.N., TOLSTIKHIN, I.N., MALYUK, G.A., and MISHINA, T.A., 1973, Isotope composition of H, O, C, Ar, and He in hot springs and gases in the Kuril-Kamchatka volcanic region as indicators of formation conditions: Geokhimiya, 1973, no. 2, p. 180-189 (in Russian; translated in Geochemistry Internat., v. 10, no. 1, 1974, p. 130-138). First author at All-Union Geological Research Institute, Leningrad.

Isotopic compositions are given for H, O, C, Ar, and He in thermal springs and gases in the Kuril-Kamchatka volcanic region; the isotopes of H, O, and Ar indicate that most of the hot springs contain water of atmospheric and sedimentation (marine) origins. Volcanoes in the solfataric stage, the most deep seated, are fumaroles (sic) as of sulfate composition, to judge from the $\delta^{18}O$, whereas those of the halogen stage are fumaroles of chloride composition. The source of the methane rich in ^{12}C($\delta^{13}C$ to -3.2) may be organic matter in sediments. Some of the gases (CO_2, He) have a probable deep (mantle) origin. The clearest criterion for a deep origin of hydrothermal solutions is the very high level of ^3He (δ^3He usually 500-700% relative to atmospheric helium). Authors' abstract)

BASS, M.N., MOBERLY, R., RHODES, J.M., SHIH, C., and CHURCH, S.E., 1973, Volcanic rocks cored in the Central Pacific, leg 17, Deep Sea Drilling Project, sect. 14 <u>in</u> Initial Reports of Deep Sea Drilling Project, v. 17, ed. by P.H. Roth and J.R. Herring: Washington, U.S. Govt. Printing Office, p. 429-503. First author at Hawaii Inst. Geophysics, Honolulu, Hawaii.

A thorough study of the petrology and alteration of the various igneous and volcanic rocks cored. Zeolite facies metamorphism has been extensive. Some textures suggested as stemming from immiscible carbonatite magmas (Plate 1, figs. 7 & 8). (E.R.)

BAZAROV, L. Sh., 1973, Evolution of mineral-forming medium during pegmatitic and apogranitic processes: Abstracts of papers from Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 191-192 (in Russian; translation through the courtesy of A. Koslowski). Author at Inst. of Geology and Geophysics, Siberian Branch, Acad. Sci. of USSR, Novosibirsk.

Process of formation of pegmatites and apogranites (depending on local conditions) includes three stages following one another:

a) Magmatic: phase state - melt; solution-melt. T interval 1080 ± 400°C; P 1500 ± 250 atm, water concentration 40 - 2 wt %. Melts consist of rock-forming minerals (quartz, feldspars, spodumene, etc.) and alkaline chlorides (KCl, NaCl), CO_2 not analytically recognizable H_2S, SO_2, HF, HCl, NH_3, besides N_2+ rare gases and other components.

b) Pneumatolytic: phase state-gaseous, T, 780 - 370°C (and lower under condition of low density of solutions) P, 1400 - 150 atm, (and lower) density (calculated on the basis of water, dissolved salts omitted) up to 0.3 g per cm^3 when homogenous. Gases, in addition to H_2O bear CO_2, the group (H_2S + SO_2 + HF + HCl + NH_3), H_2, O_2, and N_2 + rare gases.

c) Hydrothermal: phase state-liguid, T, 520 to 60- 100°C (depending on density), P, 670 - 30 atm, density (calculated as above, in b) up to 0.95 g per cm^3, salt concentrations from 2 - 3 wt % to 50 and more. Composition: Ca, Mg, Si, Fe, Al, Mn, Na, K, Cl, SO_4^{2-}, F, CO_2, O_2, H_2, CO, N_2 + rare-gases and other components. (Author's abstract)

BAZAROV, L.Sh., AND BAULIN, K.M., 1973, Inclusions in minerals of non-granitic pegmatites: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30, Sept. 1973: Rostov, Rostov Univ. Press, p. 239-240 (in Russian; translation through the courtesy of A. Kozlowski). Authors at Inst. of Geol. and Geophysics, Siberian Branch Acad., Sci. of USSR, Novosibirsk.

1. (...)

2. Inclusions in veins of olivinite pegmatoids of Bor-Urlyakh intrusion: The intrusion is composed nearly completely of olivinites, cut by thin veins of alkaline syenites and carbonatites. The essential part of the pegmatoid veins of olivinite with phlogopite and titaniferous magnetite ores occurs in central and NE part of intrusion.

3. (...) T_H of crystallized inclusions in olivine from pegmatoid veins = 980-1100°C, in clinopyroxene such inclusions gave T_H = 900-1000°C,

4. Phase composition of the inclusions (in %): gas (5) + olivine (55) plus pyroxene (30) plus ore mineral (10). (Authors' abstract, with abbreviations by A.K.)

BAZAROV, L. Sh., GORDEYEVA, V.I., SENINA, V.A., and MOTORINA, I.V., 1973, Physicochemical conditions of crystallization of spodumene in rare-metal pegmatite: Akad. Nauk SSSR, Doklady, v. 213, no. 4, p. 922-925 (in Russian; translated in Doklady Acad. Sci. USSR, v. 213, p. 137-139, 1975; abstract in Int. Geol. Rev., v. 16, no. 2, p. 241-242, 1974.) Authors at Institute of Geology and Geophysics, Siberian Division, USSR Academy of Sciences, Novosibirsk.

Mineralo-thermo-barometric investigation of thousands of primary, pseudosecondary, and secondary inclusions in spodumenes, from several pegmatite provinces in USSR, lead to the following generalizations: a) in rare metal pegmatites, spodumene crystallizes from the melt (solution) at 520-220°C and around 1500 atm pressure; b) density of the spodumene-yielding solution is up to 1.8 g/cm^3 of which, in gm/cm^3, 0.3 is water and CO_2, 0.3 dissolved salts, and the remainder - dissolved solid phases of minerals; c) the aqueous phase of the inclusions contains Na, K, Li, Mg, HCO_3, Cl, SO_4; the gas phase contains CO_2, H_2S, SO_2, HCl, HF, NH_3, N_2, rare gases; d) concentration of Li in the solutions, 1.92 to 0.15% by weight, decreases progressively at decreasing temperature of the crystallization; Mg is missing at >350°C; K seems unrelated to the temperature; Na increases from 400 to 300°C and then decreases to its minimum at 200°C. (Authors' abstract)

BAZAROV, L.Sh., and MIKHAYLOV, M.Y ., 1973, New method for determining carbon dioxide and water in inclusions in minerals: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. press, p. 300 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Inst. of Geol. and Geophysics of Siberian Branch of Acad. Sci. of USSR, Novosibirsk.

In IGG SB AS USSR the authors have constructed an apparatus for determination of the amount of water and carbon dioxide in inclusions. Two methods are used for opening inclusions: crushing in vacuum and opening by heating.

Exact determination of the amount of CO_2 and H_2O is achieved by recording the solid-gas phase inversion during temp. decrease in a system of constant volume. When the system reaches the two-phase curve, a sharp decrease in pressure occurs. Calculations were made using the Mendeleev-Clapeyron equation, taking into account the temperature dependence of the phase inversion on the pressure of saturated water vapor and CO_2. The method permits determination of the amount of H_2O and CO_2, practically separately, for each temperature generation of G-L inclusions. The accuracy of the determination of the amount of H_2O ± 2.5%, and the sensitivity is 0.00001g. (Authors' abstract)

BAZAROVA, T.Yu., CANILHO, E.M., SOBOLEV, V.S., and SHUGUROVA, N.A., 1973, Temperatures and conditions of crystallization of alkaline effusives from the Majo Isle (Cap Vert): Lithos, v. 6, p. 403-411. First author at Institute of Geology and Geophysics, USSR Academy of Sciences, Novosibirsk, USSR.

Inclusions of glass, crystals, and gases in minerals from the rocks basanite, etindite and melilite-ankaratrite, Majo Island, Cap Vert, indicate that crystallization took place at temperatures between 1180 and 1110°C and that CO_2 was the most important gas, making up 97.5 vol. % of the gas phase. The partial pressure of CO_2 during crystallization of melilite-ankaratrite was 4.5 kbars. (Authors' abstract)

BELAVIN, E.A., and KARZHAVIN, V.K., 1973, Calculating homogeneous gas reactions in geochemistry. Algorithm for calculating equilibrium constants: Probl. Izuch. Osvoeniya Prir. Resur. Sev., 1973, p. 207-215 (in Russian). Edited by Ivanova, T.N., Akad. Nauk SSSR, Kol'sk, Filial: Apatity, USSR. Chem. Abstracts, v. 80, 136005q, 1974.

Starting with the law of mass action an algorithm was developed for the computer-assisted calcn. of equil. consts. (K) in the closed gas-liq. systems, found as inclusions in rocks and minerals. The theor. K detd. for several temp. and pressure conditions can be compared with K detd. for the actual gas-liq. inclusions. The comparison provides the ranges of temp. and pressure for the inclusion formation. (Authors' abstract)

BERGER, V.I., BELOZEROV, V.N., GOLUBCHINA, M.N., KUZ'MIN, V.G., LEVITSKIY, Yu.F., AND MOSKALYUK, A.A., 1973, Formation conditions of the W. Palyanskoe mercury deposit: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press,

p. 96-97 (in Russian; translation provided through the courtesy of A. Kozlowski) Authors at VSEGEI, Lenigrad.

The deposit occurs in the N part of Okhotsk-Chukotka volcanic range and it is connected with a Lower Cretaceous volcanic structure. Two stages of mineralization were found: A. early hydrothermal - veins of quartz, and B. postvolcanic ore stage, subdivided into two parts: early - cinnabar-sulfide with very fine-grain collomorphic ores, and late, cinnabar-dickite-siderite with coarse-grained aggregates of cinnabar, free of other sulfides.

Stage A is characterized by a low temperature of origin: 150-130°C, and by alkaline sulfate-bicarbonate solutions.

Early ore mineralization (stage B) formed at temperatures 230-160°C, from solutions of sulfate-NH_4^+-Mg-Ca type, that were acid and high in salt concentrations; late ores (stage B) precipitated at 190-129°C from dilute bicarbonate-halide-Mg-Ca-alkaline solutions bearing low amounts of NH_4^+. (Authors' abstract, shortened by A.K.)

BESKROVNYI, N.S., 1973, Specific peculiarities of petroleum in endogenic processes: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973:Rostov, Rostov Univ. Press, p. 158 (in Russian; translation through the courtesy of A. Kozlowski). Author at All-Union Scientific-Research Geological-Prospecting Institute, (locality not given, A.K.)

Two groups of specific peculiarities of petroleum in endogenetic processes were distinguished on the basis of data obtained from investigations of recent hydrotherms of Uzon volcano (Kamchatka), Yellowstone caldera (Wyoming), inclusions in a doleritic dike (Dipvik)* (Norway), inclusions in quartz from vein of a crystalline massif (S. Africa; probably that investigated by Kvenvolden & Roedder, A.K.), inclusions in fluorite from Koh-i-Maran (Pakistan, cf. Beskrovnyi, et.al., 1971, Doklady AN SSSR vol. 201, no 1, pp. 187-190, A.K.) and others.

The first group of features testifies to a "hot" origin of petroleum, with the action of hydrogenization processes, synthesis from simple gases and, perhaps, decomposition of complex organic compounds.

1. Presence in petroleum of compounds that are unstable under atmospheric conditions, probably with aldehyde group C=O and with S with isotopic composition close to meteoritic standard. 2. Petroleums of various composition occurring very sparsely and lacking fractions in the range 200-250°C. 3. Domination of molecules with an even number of carbon atoms between n-alkanes. 4. Strong domination among n-alkanes of molecules with n - C_{18} etc.

The second group of features indicating an anomalous "hot" occurrence of petroleum: hydrocarbons and structural elements, which after some reconstruction can be related to components of living substance.

1. Porphyrins. 2. Tetracyclic naphthene hydrocarbons (C_nH_{2n}). 3. Isoprenoids 4. Optical activity. (Author's abstract)

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* Russian transcription, original name is not available (A.K.).

BESKROVNYI, N.S., and KAMENSKIY, I.L., 1973, Gaseous homologs of methane in some hydrothermal systems of Kamchatka: Akad. Nauk SSSR, Doklady, v. 208, no. 1, p. 211-213 (in Russian; trans. in Doklady Acad. Sci. USSR, Earth Sci. Sects., v. 208, p. 200-202). Authors at All-Union Petroleum Exploration Research Inst., Leningrad.

Gases from 16 samples from hot springs were concentrated and analyzed by gas chromatography using molecular sieves for H_2O, O_2, CH_4,

C_2H_6, C_3H_8, H_2, N_2, (Ar, Kr, Xe), (He, Ne) and heavy hydrocarbons. (ER)

BETHKE, P.M., RYE, R.O., & BARTON, P.B., Jr., 1973, Hydrogen, oxygen and sulfur isotopic compositions of ore fluids in the Creede District, Mineral County, Colorado (abst.): Geol. Soc. Amer. Abstracts with Programs; v. 5, no. 7, p. 549. First author at U.S. Geological Survey, Reston, Va. 22092

Measured isotopic ranges from the Ag-Pb-Zn-Cu Creede District are:

PHASE (samples)	$\delta^{18}O$‰ SMOW	δD‰ SMOW	PHASE (samples)	$\delta^{34}S$‰ CD
Surface water (3)	-15.2 to -14.9	-112 to -109	Sphalerite (49)	-3.3 to +1.7
Fluid incl. (2)	- 5.9 to - 5.4	- 62 to - 54	Galena (2)	-4.1 to -0.9
Sericite (8)	+ 1.8 to + 4.9	-101 to - 88	Pyrite (5)	-3.5 to +0.7
Chlorite (11)	-2.1 to + 0.9	-111 to -102	Barite (4)	+19.8 to +31.3
Vein quartz (13)	+4.4 to + 9.3			

Studies of fluid inclusions and calculations on the mineral assemblages show that the depositional parameters were: T = 190-265°C (median 250°C); depth = 1500±500 feet; salinity=4-12 wt.%; Na/K $_{(atomic)}$ $\sim$10; pH = 5.5-6; $\Sigma S = 10^{-1\pm0.8}$. f_{O_2/S_2} was buffered by reactions between chlorite, hematite, pyrite, and quartz to a band between $\log f_{O_2}/\log f_{S_2} = -33/-10$ to $-38/-13.5$ (250°C), and most, but not all, sulfide deposition appears to have taken place from a Σsulfate>Σsulfide fluid. $\delta^{18}O$ of water from fluid inclusions in sphalerite, and calculated from the solid phases, ranges from -6 to 0‰ and δD is -58±‰. The $\delta^{18}O$ is far too low to be of deep-seated origin, whereas the δD differs drastically from present surface water. The ore fluids apparently were dominantly meteoric waters whose isotopic character was established in the late Oligocene under a different climate and then enriched in ^{18}O by reaction with the volcanic country rocks. The interpretation of the sulfur isotope data remains ambiguous, but the narrow range in $\delta^{34}S$ of sulfides formed over a wide range of chemical conditions suggests isotopic and/or chemical disequilibrium in redox reactions involving sulfur. (Authors' abstract)

BETTETINI, Etienne, 1973, De l'utilisation de la macro et microcinématographie appliquée a l'étude des inclusions dans les cristaux et les gemmes, en particulier aux inclusions fluides: PhD dissertation, Univ. Nice, 79 pp. (in French)

A review of the study of inclusions (20 references), both solid and liquid, in a variety of minerals and gems, and a discussion of the mechanical and optical procedures used by the author in making a motion picture of several facets of their behavior, as on heating. Includes 17 large photoplates and description of 72 slides used in a talk on "The interior of crystals and gems" as well as the script accompanying the 16-mm film (title as shown at top). (ER).

BOBOLOVICH, G.N., 1972, Application of inclusion decrepitation methods for investigation of minerals with excellent cleavage; Institute of Geology of Komi Division, Academy of Sciences of USSR, Yearbook for 1971: Syktyvkar 1972, pp. 183-189. (In Russian; abstract through the courtesy of A. Kozlowski). Author at Inst. of Geology of Komi Division of Acad. Sci. of USSR, Syktyvkar.

In the literature one may find various opinions on application of the decrepitation method to minerals with excellent cleavage (e.g. calcite, dolomite, barite, and fluorite). The author, after reinvestigation of the problem by use of thermoacoustic, visual, thermogravimetric and thermobaric decrepitation methods and the homogenization method, concludes as follows:

1. Thermometric determinations by the decrepitation method in minerals with excellent cleavage can be made to reach reproducible results that are independent of the crystallization temp. Data on minerals with various types of cleavage are not comparable.

2. During interpretation of acoustic decrepigraphs it is necessary to take into account not only presence or absence of inclusions in minerals, but also the relative amount of inclusions. The beginning of decrepitation ought to be determined especially carefully, and usually is used to estimate T_H. The temperatures of maximum decrepitation are believed to be more comparable, and best results are obtained by examination of all decrepigraphs.

3. Values of T_D obtained by all the methods tried are similar, proving that calcite, fluorite and sphalerite of the investigated deposits crystallized at similar intervals of temperature.

4. Anomalous decrepitation is not caused only by mineral cleavage, but also by the presence of (solid? Ed.) inclusions, and the cleavage intensifies the decrepitation effect.

T_D obtained by use of various decrepitation techniques

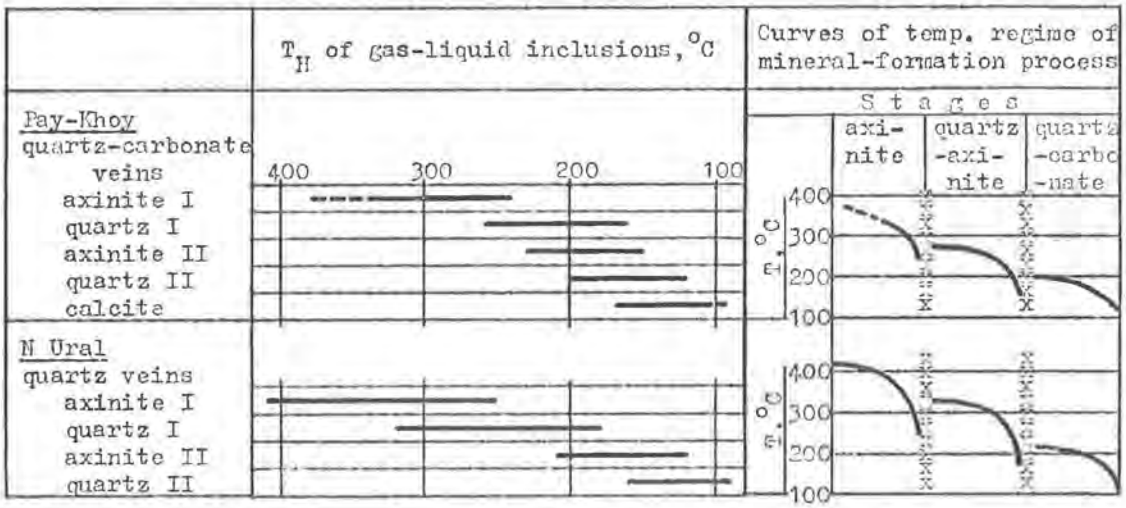
Locality	Acoustic			Visual		Gravimetric			Baric
	fluorite	calcite	sphalerite	fluorite	calcite	fluorite	calcite	sphalerite	fluorite
Amdermin fluorite deposit, quartz-fluorite-sphalerite ore	260-280(2)	-	-	-	-	400(1)	-	-	-
	260-280(1)	-	-	320-340(1)	-	-	-	-	-
	300(2)	-	-	320-370(2)	-	370-450(8)	380-410(4)	-	350-390(2)
	300(1)	-	-	-	-	395(1)	-	-	-
NE part of anticlinorium sphalerite-sulvanite ore	-	280(1)	240-300(2)	-	320-340(1)	-	-	-	-
Severnyi Field, Morev Mt. Cu ore	-	260-280(2)	-	-	350(1)	-	-	-	-
Yushar Region chalcopyrite-sphalerite ore	-	-	260-300(1)	-	-	-	-	380(1)	-
Central Pay-Khoy quartz-calcite veins in diabases	-	300-320(1)	-	-	-	-	390-395(2)	-	-

BOBOLOVICH, G.N.,1973, Temperature regime of axinite-bearing vein formation at Pay-Khoy and N. Ural: Institute of Geology of Komi Division, Academy of Sciences of USSR, Yearbook for 1972: Syktyvkar, 1973, pp. 149-154 (In Russian; abstract through the courtesy of A. Kozlowski). Author at Inst. of Geol., Komi Division, Acad. Sci. USSR, Syktyvkar.

Axinite-bearing quartz-calcite veins at Pay-Khoy are connected genetically with sills of Middle Paleozoic diabases and occur in diabase or in hornfels. External zones of the veins consist of opaque and semitransparent axinite (1), mainly fine grained; zone 2 - coarser grained axinite and semitransparent quartz; zone 3 - the main part, filled by milky quartz; zone 4 - central, platy calcite. Axinite of (1) bears minute two- and one-phase inclusions; primary ones have degree of filling F = 70-80 vol. %, T_H 245-342°C. The earliest axinite (unsuitable for investigations because of very low transparency) was probably formed at higher temperatures. Axinite of (2) bears very numerous inclusions (solid) of tremolite asbestos, and fluid inclusions with F 85 - 90 vol. %, T_H 230-150°C. Milky quartz of (3) gives T_H 200-120°C, and calcite of (4) - 175-105°C.

Early axinite from N. Ural gives T_H of primary inclusions 405-250°C, late axinite - 205-125°C. The temperature and tectonic regime is given in the figure.

Figure. Temperature and tectonic regime of axinite-bearing veins



xxx:xxxxxx - tectonic gaps

BOBOLOVICH, G.N. and PETROVSKY, V.A., 1973, Mechanism of formation of anomalous syngenetic inclusions in crystals: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press p.313-315 (inRuss.; translation provided through the courtesy of N.P. Ermakov). Authors at the Institute of Geology of the Komi Branch of the USSR Academy of Sciences, Syktyvkar, USSR.

A directional stream of gas bubbles was formed by adding some acid to the solution and several Zn granules were placed under one of the two seed-crystals. A large number of hydrogen bubbles formed from the reaction of Zn with HCl.

Thus two types of crystal growth conditions were produced in the crystallizer: a) growth in the directional stream of gas bubbles; b) growth in comparatively quiet conditions, with chaotic motion of small gas bubbles. A series of six experiments were made, varying the degree of supersaturation, with the following results:

1. The first type of growth conditions did not result in bubble capture even at considerable supersaturation except through formation of separate inclusions on faces having the greatest growth speed. On the other hand, a considerable number of anomalous inclusions were trapped in the crystal growing free of the directional flow of gas bubbles.

2. If large gas bubbles (0.5 - 1.0 mm) stuck to a normal growth face, its surface is broken because of the nonhomogeneous stream of nourishing solution. Streaming-over-bubble-figures were marked by convectional stream, which is fixed by series of small transformator inclusions (0.01 - 0.3 mm) (sic). Radial inhomogeneities were observed on the phase boundary gas bubble - crystal face, because of bubble vibration, which formed a halo of small inclusions. This case is much like

the one described by G.G. Lemmlein for overheated inclusions.

3. Capture and non-capture of the bubble and its form were determined by its size and growth speed of the face under consideration.

4. In all cases liquid phase was captured together with the gas phase and their ratio is independent of the size of bubbles. (Authors' abstract).

BOETTCHER, A.L., MYSEN, Bjorn O., and MODRESKI, P.J., 1973, Phase relationships in natural and synthetic peridotite-H_2O and peridotite-H_2O-CO_2 systems at high pressures (extended abst.): in Internat. Conf. on Kimberlites, Extended Abstracts of Papers, L.H. Ahrens, et al., eds.: Univ. of Cape Town, Rondebosch, Cape Town, South Africa, p. 35-38. Authors at Dept. of Geosciences, Pa. State Univ., University Park, Pa. 16802.

BOGOLEPOV, V.G., 1972, Essential directions of investigations in determination of the practical value of hydrothermally altered rocks; criteria of ore productivity of metasomatites, in Papers of All-Union Symposium, Alma-Ata, 1972, Kazakh Scientific-Research Institute of Mineral Raw Materials, and Inst. of Geological Sciences, Academy of Sciences of Kazakh SSR, part 1, Alma-Ata 1972, pp. 9-35 (in Russian; abstract through the courtesy of A. Kozlowski).

On the basis of fluid inclusion study the similarity of ore-forming fluids with subsuperficial waters (from near surface to 5 km) in terms of hydrochemical zonality, was ascertained. Argon composition from fluid inclusions of quartz from pegmatites, greisens and skarns of relatively shallow deposits (same range of depths), indicates its atmospheric origin (similar to Ar isotope composition in subsuperficial waters). Juvenile waters were revealed only in inclusions in pegmatitic minerals of very old and deep formations (Karelia, Volhyn). Mixed Ar isotope compositions are known also, and in higher temperature inclusions the participation of atmospheric Ar is sometimes less than in low temperature inclusion generations (pp. 19-20).

The presence of F in chloride type greisenising solutions complicates the greisen composition and the ore mineralization has a complex character. When F is practically absent, metasomatites become simpler and bear essentially only Mo ore mineralization.

The amounts of Cl and CO_2 in greisens of Kazakhstan are the same in all parts of the greisen bodies, being trapped in gaseous-liquid inclusions (in some bodies calcite was found in their top parts). The amount of F and S in the solutions migrating in the metasomatites increases, reaching a maximum in apical parts of the bodies, forming quartz-topaz greisens with continuous presence of disseminated pyrite (p. 34).

BOGOLEPOV, V.G., DAVIDENKO, I.V. AND POLYVYANNYI, E.Ya., 1973, Application of argon from gaseous-liquid inclusions of quartz from pegmatites to the solution of genetic and practical problems: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 162-163 (in Russian; translation through the courtesy of A. Kozlowski). Authors at Kazakh Inst. of Mineral Raw Materials, Geological Inst. of Kola Division of Acad. of Sci. USSR.

One may ascertain, as shown by a number of pegmatites from various regions of the USSR, that the content of atmospheric and radiogenic argon in low- and high-temperature inclusions in quartz is not accidentally connected with the dimensions of commercial mineralization of pegmatitic bodies. As the unit to be compared, the percent concentration of atmospheric Ar in low- and high-temperature inclusions was accepted. Commercial muscovite pegmatites have a ratio lower than 1, deposits with minor amounts of poor muscovite have a ratio 1 - 2.5, and quartz from non-commercial pegmatities have a ratio higher than 2.5 (see Table).

Characteristics of gaseous component of gas-liquid inclusions of quartzes from pegmatitic deposits

No.	Atmospheric Ar, %		I/II	Commercial value of pegmatitic body			
	I	II		A	B	C	D
			Mica-bearing pegmatites				
1	26.60	3.27	8.15				x
2	0.63	0.16	3.94			x	x
3	36.82	12.0	3.06				x
4	14.49	5.68	2.55			x	x
5	10.70	4.28	2.50			x	
6	2.49	1.78	1.40			x	x
7	73.30	53.33	1.38			x	
8	92.46	79.49	1.17		x	x	
9	44.80	41.66	1.07		x	x	
10	2.66	2.84	0.93	x			
11	9.89	11.69	0.85	x			
12	1.77	3.53	0.50	x			
13	15.33	33.37	0.46	x			
14	13.48	42.88	0.314	x			
15	1.94	10.60	0.11	x			
			"Ceramic" pegmatites				
16	1.02	0.35	2.92			x	
17	3.56	1.96	1.82	x			
18	4.94	3.12	1.59			x	
			Silexites				
19	66.67	31.83	2.10	x			
20	90.0	83.4	1.08	x			

Note: I - percent of atmospheric Ar in low-temp. inclusions, II - as above, in high-temp. inclusions, A - large pegmatitic body, B - medium, C - small, D - non-commercial; 1-6, 11-13 and 15-18 - pegmatites of Kola Peninsula, 7-9, 19 and 20 - pegmatites & silexites of Kazakhstan, 10 & 14 - pegmatites of Mama River Region. (Authors' abstract)

BOGOYAVLENSKAYA, I.V., 1973, Investigations of inclusions of mineral-forming fluids abroad (1968-1972): Abstracts of Papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 26-27 (in Russian; translation provided through the courtesy of A. Kozlowski). Author at Moscow University. (Ed's. note: In the Program this was listed with L.M. Valyashko as co-author).

A review.

BOGOYAVLENSKAYA, I.V., DOLOMANOVA, E.I., LOSEVA, T.I. and BOYARSKAYA, R.V., 1973, Fluid-inclusion evidence on the physico-chemical aspects of the environment of formation of the Ehrenfriedersdorf tin deposit (DDR): Abstracts of papers at Fourth Regional Meeting on Thermobarogeochemistry of Mineral-Forming Processes at Rostov-on-Don, 24-30 Sept., 1973: Rostov,

Rostov Univ. Press, p. 76-77. (In Russian; translation provided by Dr. E.I. Dolomanova of IGEM, Moscow) Authors at Moscow State University and IGEM, USSR Academy of Sciences, Moscow

1. Inclusions of hydrothermal solutions in cassiterite, topaz, and quartz were studied. The gas-to-liquid ratio for vacuoles in the above minerals is different in greisen (after granite) and quartz veins occurring in the outer-contact zone. In the former, the gaseous phase predominates in primary inclusions (up to 60%); in the latter the liquid phase (up to 50-60%). In pseudosecondary inclusions, gas occupies 25 percent or less of a vacuole.

2. X-ray microspectrographic analysis was made of the composition of deposits on the walls of the vacuoles in cassiterite. The principal elements of the solids in the vacuoles in cassiterite from greisen are Nb, Ta, Fe, Mn, Ti, Al, Ca, K, and Si; the minor elements are W and Mo. The common elements in the vacuoles in cassiterite from quartz veins are Si, Ca, Al, Ti, Fe, K, and Cl, with lesser S and Na. The above elements in some cases enter into the composition of certain mineral species: NaCl, KCl, $AlCl_3$, $FeCl_3$, $CaCl_2$, potassium feldspar (?), fluorite or calcite (?), hauyne, columbite-tantalite, ilmenite, and rutile, and in others they form mixtures of powder-like mineral aggregates which are difficult to identify.

3. The homogenization temperature for cassiterite from greisen was 470-490°, according to type II (i.e., in the gas phase; Ed.), and 390-420°, according to type I (i.e., in the liquid phase; Ed.). The homogenization of the liquid-gaseous inclusions in cassiterite from quartz veins took place at 390-430°, and that of the gaseous-liquid inclusions at 360-370°, in both cases according to type I. The secondary inclusions were homogenized at 200-220°, according to type I.

The homogenization temperature for the liquid-gaseous fluid inclusions in topaz from greisen ranged from 430-490°, according to type II, and for gaseous-liquid ones from 290-370°, according to type I. In topaz from quartz veins, the liquid-gaseous inclusions homogenized at 390-430° and gaseous-liquid ones at 280-360°, according to type I.

The homogenization temperatures for inclusions of hydrothermal solutions in quartz are similar to those recorded for topaz. The homogenization usually proceeds according to type I, rarely to type II.

4. Decrepitation temperature of the inclusions was determined with the help of a thermobarometric unit. Most inclusions in cassiterite from greisen blow up at 450°, and those in cassiterite from quartz veins between 350° and 525°. Violent decrepitation of the inclusions took place in topaz at 320-470° and in quartz at 250-400°. In all the minerals very few inclusions blew up at higher or lower temperatures. Decrepitation temperature produces evidence of statistical character; it involves inclusions differing in size, shape, and gas-to-liquid ratio. Heating rate was 3-5° per minute.

5. The evidence obtained suggests that the deposit was formed from pneumatolytic-hydrothermal, high-concentration, multicomponent solutions at temperatures between 500° and 200°, disregarding the P correction. (Authors' abstract).

BOGOYAVLENSKAYA, I.V., and NAUMOV, V.B., (compilers), 1973, Bibliography of Soviet literature for 1972 on inclusions of solutions and melts in minerals: Moscow, Vernadski Inst., Akad. Nauk SSSR, 32 pp. (in Russian; N.P. Ermakov, Editor).

This little volume, issued in only 300 copies, lists 164 references (plus author index). Many references are to sources such as theses that are otherwise impossible to locate. It represents the continuation of the previous issue (Fluid Inclusion Research - Proceedings of COFFI, v. 5, 1972, p. 20-21). (ER)

BORCOS, Mircea, 1973, Observations on the significance of magmatic relics of mineral inclusions in volcanic rocks: Buchar., Univ., An., Geol., v. 22, p. 23-30 (in Romanian with Engl., Fr., Russ. sum.).

BORISOV, O.G., and BORISOVA, V.N., 1973, Gases of eruptive rocks and possibility of their use for geological interpretation: in Geosynclinal magmatic formations and their ore production, V.M. Necheukhin and V.A. Marks, eds.: Sverdlovsk, Inst. Geol. and Geochem., Ural Scientific Center, Acad. Sci. USSR, Transactions, v. 102, p. 168-179 (in Russian; translation provided through the courtesy of A. Kozlowski).

On the basis of statistical methods of investigation, the possibility is examined of the application of gas phase data (separated from rocks under vacuum conditions at temp. 1200°C) as petrochemical indicators of conditions of origin of those rocks. The method of calculation, the precision, and the application of data on gases of rocks, from various geological materials are given. (...) The amount of gas emanations and composition depends on the magma source. (Authors' abstract)

BOYARSKAYA, R.V., 1973, Advantages of electron microscopy in studying fluid inclusions in minerals: Abstracts of papers of Fourth Regional Meeting on Thermobarogeochemistry of Mineral-Forming Processes at Rostov-on-Don, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p320-321 (in Russian; translation provided by Dr. E.I. Dolomanova of I.G.E.M., Moscow). Author at IGEM, USSR Academy of Sciences, Moscow.

The morphology of fluid inclusions in cassiterite and sphalerite is studied by methods of transmission and scanning electron microscopy with microdiffraction and electron probe analysis. Together with E.I. Dolomanova and M.G. Kobrovol'skaya, several entrapped minerals and the composition of the liquid phase of vacuoles are identified.

The shape, size, and distribution pattern of the fluid inclusions in sphalerite and cassiterite from different deposits were established. It was also found that crystallization of the liquid phase takes place when it is ejected onto the adjacent areas of the fracture at the moment of vacuole opening. During its crystallization dendritic segregations were shown to form, as were incompletely crystallized drops, crystals with strans, (sic.) etc.

The parameters of the grid of some entrapped minerals and the minerals from the crystallized liquid were determined by microdiffraction in combination with the method of replicas with extraction. As a result, sylvite has been identified in the vacuoles in sphalerite and cassiterite and hauyne among the minerals from the crystallized liquid in cassiterite from the Ehrenfriedersdorf deposit. (Authors' abstract).

BOZHKO, M.T., POLYKOVSKIY, V.S., and KHATUNTSEV, G.V., 1973, Improved model of decrepitation apparatus "Luch-2" and of apparatus for its calibration: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 308-309 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at MINGEO, Uzbek SSR.

Decrepitometers in which electromechanic counters were applied for registration of microfracturing are characterized by limited speed of counting, <100 impulses per sec. At higher counting speeds and larger numbers of breaks, such decrepitometers yield erroneous results.

To remove this liability, industrial counting apparatus PP-16, having decatrons as indicators, was applied in "Luch-2", an improved model of decrepitometer. This apparatus can count 10^5 impulses per sec.

Decrepitometer "Luch-2" consists of a heating stage with initial amplifier, counting apparatus PP-16, a 3-millivoltmeter M-64, and a system of semi-automatic regulation of speed of heating of the furnace.

Under industrial conditions during simultaneous use of two or more decrepitometers the most important question is the calibration of sensitivity of the decrepitometers. A C-generator with 4 frequencies: 5, 20, 200 and 1000 Hz was constructed for calibration.
(Authors' abstract, with abbreviations by A.K.)

BRAITHWAITE, R.S.W., FLOWERS, W.T., HASZELDINE, R.N., and RUSSELL, M., 1973, The cause of the colour of Blue John and other purple fluorites: Mineralog. Mag., v. 39, p. 401-411. Authors at Dept. of Chemistry, Univ. of Manchester Institute of Science and Technology, England.

'Blue John' and other purple fluorites have been studied by a wide range of techniques. Hydrocarbons are not the cause of the colour of these fluorites. No significant difference in the concentrations of 73 elements between the purple and colourless zones of Blue John has been detected. The spectroscopic and thermal bleaching behavior of the purple zones is consistent with the presence of 'colloidal' calcium as colouring agent, and coloration of fluorites with calcium vapour gives material showing similar properties. The distribution of colour suggests trapping of the calcium in lattice defects along {III} (cleavage) planes through {00I} (growth) zones. The 'colloids' could be produced by aggregation of calcium atoms liberated by irradiation from sources found in the geological environment of Blue John. The banding could arise from variations in the concentration of lattice defects caused by variations in growth rates of the fluorite. (Authors' abstract) (Editor's note - see also Holgate, this volume)

BRICE, J.C., 1973, The growth of crystals from liquids: Amsterdam, North-Holland Pub. Co. 379 pp.

A general discussion of growth processes, kinetics, transport processes, and techniques. (ER).

BROWNE, P.R.L., and LOVERING, J.F., 1973, Composition of sphalerites from the Broadlands geothermal field and their significance to sphalerite geothermometry and geobarometry: Economic Geology, v. 68, p. 381-387.

Sphalerites from the Broadlands, New Zealand, geothermal field have been analyzed by electron microprobe and shown to have variable FeS and MnS contents. Samples analyzed come from drillcores at depths between 302 m and 1,841 m, where measured temperatures range from 140°C to 294°C and water pressures vary from 58.6 bars to 158.8 bars. The variable FeS contents of sphalerites coexisting with pyrite but not pyrrhotite are attributed to sulfur fugacity fluctuations. One core from drillhole Br 16 at 787 m depth (219°C) contains vugs in which pyrite, pyrrhotite and sphalerite (7.1 ± 0.6 mole % FeS) have crystallized together in equilibrium.

The composition of the Broadlands sphalerites indicates that the slope of the sphalerite + pyrite + pyrrhotite phase boundary shifts sharply below 300°C toward the low FeS field, and means that Boorman's (1967) and Scott and Barnes' (1971) constant sphalerite composition value of 20.7 ± 0.6 mole % FeS between 300°C and 550°C cannot be extrapolated to lower temperatures. Similarly, the proposed sphalerite geobarometer (Scott and Barnes, 1971) cannot be applied to deposits in which sphalerite, pyrite and pyrrhotite crystallized together at temperatures below about 300°C. (Authors' abstract)

BULGAKOVA, Ye.N., and KONENKO, V.F., 1973, Determination of pressure in inclusions of melt: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 311-312 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Inst. of Geol. and Geophysics of Siberian Branch of Acad. Sci. of USSR, Novosibirsk.

(...) Pressure of gas in inclusion was measured at room temp. on basis of enlargement of gas bubble after opening of inclusion, as well as T of beginning of melting of solid phases. Gas composition was determined by method of quantitative analysis of individual inclusions. Gas bubble remains unchanged up to a T 100-150°C lower than T_H; changes of P versus T are isochoric. Equation of state of real gases at constant volume permits calculation of the pressure of gas mixture at T near to T_H of inclusion of melt.

Pressures determined by this method for rocks of Norilsk trap intrusives were ca. 10-200 atm, and may be accepted as minimum P of origin (for T about 100-150°C lower than T_H).
(Authors' abstract, with abbreviation by A.K.)

BURYKHINA, Z. Ye. and BURYKHIN, I.V., 1973, Temperatures of formation of mineral associations of polymetallic and low-temperature mercury ore mineralization of Moldo-too and Akchatash chains: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 95-96 (in Russian, translation provided through the courtesy of A. Kozlowski). Authors at Geological Inst. of Kirgiz SSR Academy of Sciences.

Ore areas of Moldo-too and Akchatash chains, Middle Tyan'-Shan', have mecury and polymetallic ores of low T origin, simple mineral associations, and monometallic character.

Temperature interval, indicated by fluid inclusions, is 30-200°C. T_d of galena 40-120°C, T_h of inclusions in sphalerite - 50-150°C; Th of inclusions in calcite, fluorite, and barite - 30-100°C, with most inclusions in the interval 30-70°C.

In mercury ore fields Th of inclusions in cinnabar, tetrahedrites (?), barite, and calcite range from 40 to 120°C.

Polymetallic and mercury deposits formed in practically isothermal conditions with the main part of the crystallization at 50-120°C.
(Authors' abstract)

CALAS, G., and MAURY, R., 1973, The color centers of fluorite; principles of a geologic thermometer (abstr.): Reun. Annu. Sci. Terre., (Programme Resumes), p. 115 (in French).

An attempt to combine data on T_H and laboratory bleaching of color centers to yield time-temperature data on natural fluorite. (E.R.)

CHEPUROV, A.I., 1973, Thermometric study of inclusions of melt in pseudoleucitite minerals of the central Aldan district: Akad. Nauk SSSR, Doklady, v. 213, no. 2, p. 437-440 (in Russian; translated in Doklady Acad. Sci. USSR, v. 213, p. 165-168 (1975); abstract in Int. Geol. Rev., v. 16, no. 2, p. 236, 1974). Author at Institute of Geology and Geophysics, Siberian Division USSR Academy of Sciences, Novosibirsk.

Solid inclusions in olivine, pyroxene, apatite from the "ultrapotassium" alkalies in the Yllymakh and the Tommot massifs (fig. 1) homogenize at 1140-1220°C, on the whole (fig. 2), i.e. at somewhat lower temperatures than their analogs in the "pseudoleucitite" minerals elsewhere. (Author's abstract)

CHETYRBOTSKAYA, I.I., 1971, On one classification feature of wolframite deposits, pp. 164-172, <u>in</u> Mineralogy and geochemistry of tungsten deposits (Materials of 2nd All-Union Symposium on Mineralogy, Geochemistry and Genesis of Tungsten Deposits of USSR): Leningrad, Leningrad Univ. Publishing House, 344 pp. (In Russian; abstract through the courtesy of A. Kozlowski). Author at Central Scientific-Research Geological-Prospecting Institute.

Concentrations and interrelations of Ta, Nb and Sc in wolframite changes regularly, depending upon the genetic type of deposit, and on geological-structural and physico-chemical conditions of origin, as follows:

Genetic type of deposit	Formation groups	Ore formation	T° decr. of wolframite	Deposit	Element Content, %		
					Ta_2O_5	Nb_2O_5	Sc_2O_3
Greisen	Quartz greisen	Wolframite-molybdenite	280 - 300	Akchatau	0.004	0.23	0.036
		Wolframite	270	Antonova Mt.	0.042	0.44	0.019
		Wolframite-cassiterite	260	Dedova Mt	0.23	0.50	N. F.
			240	Zun-Undur	0.162	0.63	0.002
			200	Karaoba	0.012	0.50	0.014
Hydrothermal	Quartz low-sulfide	Wolframite-cassiterite	200	Aldakachan	0.029	0.46	0.0005
	Quartz-sulfide	Wolframite-sulfide	220	Belukha	0.003	0.058	0.0006
			200	Dzhida	0.003	0.044	-
			150 - 200	Bukuka	0.004	0.09	0.0004

CHETYRBOTSKAYA, I.I., 1972, Wolframite as indicator and new source of tantalum raw material: Moscow, Nedra Press (in Russian).

T_D of wolframites decreases with increasing distance of the mineralization from the parent granites, but the intensity of decrepitation increases: the difference of intensity is especially great between wolframites from metasomatites and from veins filling open fractures, the latter being the highest. Similar changes of T_D are typical for cassiterites. T_D of columbite-tantalite from apogranites of E Siberia is 220°C. Other data given are the same as in Chetyrbotskaya, 1971 (see previous item). (Abstract by AK)

CHIKAYAMA, Akira, 1973, Gem identification by the inclusions: Gemmological Assoc. of All Japan, (Color Edition), 246 pp. (in Japanese with some English section captions).

This volume includes 588 color photomicrographs, mostly photomicrographs of solid, liquid, or gas inclusions in gem material. (ER).

CHIKHIRKIN, V.K., PROKOPOV, N.C. AND KLINKOV, S.V., 1973, Mechanism of trapping and coalescence of gaseous-liquid inclusions (experimental data): Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov, Univ. Press, p. 286-287 (in Russian; translation through the courtesy of A. Kozlowski). Authors at Rostov University.

To explain the trapping and coalescence of fluid inclusions experiments were made on the synthesis of crystals from concentrated aqueous solutions in stainless steel autoclaves under conditions of sharp changes of P & T. In experiments of T = 350°C and P = 300-350 atm, skeletal crystals of NaCl were obtained (3 mm long), bearing a large amount of G-L and L-G inclusions. Formation of inclusions filled to various degree is explained by local microheterogenization of the solutions during quick pressure change and great speed of trapping of particles of the parent medium by the growing crystal faces.

Fluid inclusions are localized in growth zones of the crystals, they are characterized by elongated-tubular or hypidiomorphic shape and their dimensions increase greatly from the tops of growth pyramids to the base. This fact proves the correlation of speed of growth of crystal and speed of enlargement of heterogeneous defect areas in the parent solution structures.

Along with closed inclusions, numerous channels were found in crystals of NaCl; the channels are filled by gas that is soluble in silicone, and olive oils, gasoline, and other organic solvents but very slightly soluble in water and aqueous solutions of halide salts.

T_H of G-L inclusions varies from 175 to 200°C (i.e., one half of the initial T of experiment). This T decrease may be explained by the adiabatic character of the process during sharp P drop.

During thermodynamic activation of synthetic and natural halite crystals, the phenomenon of coalescence was observed in inclusions systems, taking place with measurable speed. The individual phases migrated with various speeds under the action of thermodynamic gradients resulting in diffusion of fluid, the regulation of the habit of the inclusions, and fractionation of their filling to separate gaseous and liquid phases. (Authors' abstract).

CLEMENT, C.R., 1973, The emplacement of some diatreme-facies kimberlites (extended abstract): in Internat. Conf. on Kimberlites, Extended Abstracts of Papers, L.H. Ahrens, et al., eds.: Univ. of Cape Town, Rondebosch, Cape Town, South Africa, p. 67-69. Author at Geology Dept., De Beers Consolidated Mines Ltd., Kimberley, South Africa.

Presents textural evidence (p. 68) for emulsion-like mixtures of late-stage, low temperature, immiscible K-rich silicate and carbonatitic liquids. (ER)

COOPE, J.A., 1973, Geochemical prospecting for porphyry copper-type mineralization - a review: Journal of Geochemical Exploration, v. 2, p. 81-102. Author at Newmont Mining Corporation of Canada, Toronto, Ont. (Canada).

Various prospecting techniques are discussed, including fluid inclusions. Unfortunately, the use of fluid inclusions is discussed essentially in connection with analyses of whole-rock water-extractable chloride (see Kesler et al., 1973). Although this procedure has some merit, the most obvious possible application of inclusions to prospecting is ignored. This is the qualitative identification, under the microscope, of inclusions characteristic of porphyry copper deposits, both the high salinity inclusions (from recognition of NaCl daughter crystals) and inclusions from boiling (large vapor phase). It is the presence of such inclusions and not their abundance (and hence total chloride) that is perhaps most significant, and they should be preserved in quartz residues in gossan, soil and stream sediments from a porphyry copper terrain, long after most soluble chloride is leached and gone.(Ed.)

COVENEY, R. M., Jr., 1973, Fluid inclusion studies at the Oriental Gold Mine, (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 5, no. 4, p. 309. Author at Department of Geology-Geography, University of Missouri, Kansas City, Mo. 64110.

Filling temperatures of primary fliud inclusions indicate that the gold-quartz veins of the Oriental mine were emplaced at temperatures exceeding 220°C. The inclusions are enriched in CO_2 which is present as a separate immiscible liquid phase at room temperatures. Estimates of the relative volumes of the various included phases combined with thermometric data permit estimation of the total CO_2 contents (about 24 wt. percent) and the minimum pressures of entrapment (near 800 bars). These results coupled with those from sulfide geothermometers suggest maximum P-T conditions of entrapment in the vicinity of 500°C at 2000 bars.

Dawsonite ($NaAlCO_3(OH)_2$) occurs as a daughter salt in nearly all primary fluid inclusions examined. Calcite, ankerite and oligoclase are less common as daughter salts. Thus the fluids are generally saturated at room temperature in Na^+, Al^{+3}, OH^- and CO_3^{-2} and commonly have high concentrations of Ca^{+2}, Mg^{+2}, and silica.

Serpentinite and amphibolite wall rocks have been hydrothermally altered to mixtures of various carbonate species including ankerite and magnesite, though not dawsonite. Granitic rocks have been altered to a material consisting predominately of oligoclase. The characteristics of the mineralizing fluids as inferred from fluid inclusion studies are viewed as being fully consistent with the bulk mineralogies of the quartz veins and the adjacent altered rocks. (Author's abstract)

CRAMPON, Norbert, 1973, Hydrothermal low grade metamorphism within saline and penesaline facies with reference to the "saliferous complex" in Northern Tunisia: Contr. Mineral. and Petrol., v. 39, p. 117-140 (in French with English abstract). Author at Laboratoire de Pétrologie, U.E.R. Sciences de la Terre, Métallurgie, Chimie Minérale, Université de Nancy I, 54037-Nancy Cedex, France.

The sedimentary rocks of "saliferous formations" in the Tunisian far North have gone through frequent recrystallization or a notable dolomitization to which idiomorphic minerals, mainly quartz and feldspar, are frequently added. Studies carried out on fluid inclusions from these crystals lead thermometric figures clearly exceeding the range of values met with in diagenesis. These new parageneses are best related to low grade metamorphism in hypersaline brines bearing relation with thermal anomalies likely connected to volcanism. (Author's abstract)

CUNNINGHAM, C.G., Jr., 1973, Multiple intrusion and venting of the Italian Mountain intrusive complex, Gunnison County, Colorado (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 5, no. 6, p. 474. Author at Central Mineral Resources, U.S. Geological Survey, Denver Fed. Center, Denver, Colo.

Fluid inclusion studies of hydrothermal quartz veins suggest that moderately saline fluids in the core boiled at 385° ± 15°C. Pressure limitations based on a hydrostatic model suggest a depth of approximately 2500 meters for this last event. (Author's abstract, greatly abbreviated by ER)

DAVIS, J.D., 1973, Geothermometry, geochemistry, and alteration at the San Manuel porphyry copper ore body, San Manuel, Ariz.: Ph.D. Dissertation, Univ. of Ariz., 250 pp.

The San Manuel-Kalamazoo ore deposit in southeastern Arizona, a type example of porphyry copper deposits, has been investigated using a multisided approach involving fluid inclusion study, alteration petrography, and geochemistry in cooperation with the Magma Copper Company and the U.S. Geological Survey. Investigation of a large number of closely spaced samples in two arrays across the ore-alteration zones has produced new information on the nature of the ore-forming system in three-dimensional space and provided information to test the various genetic hypotheses proposed for this ore type.

The fluid inclusion data suggests a single period of hydrothermal activity characterized by the gradual evolution of highly saline fluids at temperatures approaching 600°C and associated with barren quartz veinlets through an ore-depositing stage at 450°C to 275°C characterized by boiling of the hydrothermal fluids, to dilute, non-boiling fluids associated with quartz-calcite veinlets below 275°C. Fluid inclusion barometry suggests the top of the ore-forming system was emplaced at depths of less than one mile.

The lack of salinity and thermal gradients proposed by White and others (1971) or a thermal-salinity discontinuity at the interface of the potassic and phyllic zones (Sheppard and others, 1971) along with the temporal and spatial relationships of alteration minerals to fluid-inclusion-bearing quartz suggests a magmatic source for the hydrothermal fluids. There is little evidence for an outward migration of higher temperature-salinity conditions with time. There is, however, evidence for a post-mineralization retrograde encroachment of low temperature-salinity conditions as reflected by late secondary inclusions imposed upon early barren veinlets and sulfide-bearing veinlets. Fluid inclusion study at San Manuel-Kalamazoo supports the orthomagmatic genetic model for porphyry copper deposit formation, although some post-ore mineralization introduction of meteoric water is indicated. (Author's abstract)

DeGROODT, J.H., Jr., 1973, Determination of temperatures of fluorite formation by fluid inclusion thermometry, central Tennessee, (abst.): Geol. Soc. America Abstracts with Programs, v. 5, no. 5, p. 394. Author at The University of Tennessee, Knoxville, Tennessee, 37916.

Samples were collected in the northeastern part of the Central Basin of Tennessee from seven surface veins and from the Elmwood Mine of the New Jersey Zinc Company. Approximately 700 inclusion filling temperatures were determined on individual vacuoles within 50 specimens. Inclusions examined are considered to be dominately primary as indicated by negative crystal shape, regularity of outline, uniformity of vapor bubble size, and disposition in zones parallel to primary crystal growth features such as color banding and crystal faces.

For the surface veins, temperatures recorded from 64° to 151°C. Within this range approximately 75% of the temperatures are between 90° and 119°C. A temperature gradient is indicated for the formational temperatures of the fluorite from the surface veins, the mean and average temperatures decreasing from southeast to northwest across the study area.

At the New Jersey Zinc Company's Elmwood Mine, temperatures recorded range from 99°C to 126°C. Within this range, approximately 70% of the temperatures are between 110°C and 120°C. (Author's abstract)

DEICHA, Georges, 1973a, Scanning electron microscopy of cavities in gangue and rock minerals (abstr.): Soc. Fr. Mineral. Cristallogr., Bull., v. 96, no. 4-5, p. XIX (in French).

DEICHA, Georges, 1973b, Microfractures of granitic quartz and geochemical circulation of fluids of plutonic origin: Les Roches Plutoniques dans leurs Rapports avec les Gites Mineraux; Relations Spatio-Temporelles entre Granites et Gites Mineraux; Methodes d'Etudes, p. 229-230: Paris, Masson & Cie (in French, with English sum.).

DEINES, P., and GOLD, D.P., 1973a, The carbon isotopic composition of carbonatites, kimberlites, and diamonds (extended abst.): in Internat. Conf. on Kimberlites, Extended Abstracts of Papers, L.H. Ahrens, et al., eds.: Univ. of Cape Town, Rondebosch, Cape Town, South Africa, p. 85-88. Authors at Dept. of Geosciences, Pa. State Univ., University Park, Pa. 16802.

DEINES, P., and GOLD, D.P., 1973b, The isotopic composition of carbonatite and kimberlite carbonates and their bearing on the isotopic composition of deep-seated carbon: Geochimica et Cosmochimica Acta, v. 37, p. 1709-1733. Authors at Department of Geosciences, The Pennsylvania State University, University Park, Pennsylvania 16802.

New carbon and oxygen isotopic compositions of carbonates from 14 carbonatite and 11 kimberlite occurrences are reported. A review of the available data on the carbon isotopic composition ranges of carbonatite and kimberlite carbonates shows that they are similar and overlap that of diamonds. The mean carbon isotopic composition of carbonates from 22 selected carbonatite complexes (-5.1 o/oo, s = ±1.4 o/oo vs PDB) is indistinguishable from that of 13 kimberlite pipes (-4.7 o/oo, s = ±1.2 o/oo) as well as that of 60 individual diamond analyses (-5.8 o/oo, s = 1.8 o/oo). The oxygen isotopic compositions of kimberlite carbonates, however, are enriched in O^{18} by several permil with respect to those of carbonates from the subvolcanic type of carbonatite.

The data suggest that not all carbonatite, kimberlite and diamond occurrences have the same average carbon isotopic composition and that significant differences exist between them. Carbon isotopic composition measurements available for the East African Rift system suggest geographic and/or tectonic groupings e.g. carbonate lavas, tuffs and intrusive carbonatites associated with the Eastern Rift yield a range of δC^{13} values from -5.8 to -7.4 o/oo, similar to that of the carbonate rocks associated with the Western Rift volcanism (-5.8 to -7.9 o/oo). In contrast the interrift area encompassing Lakes Victoria, Malawi (Nyasa) and Chilwa, apparently are characterized by carbonatitic carbonates of higher C^{13} content (-2.4 to -4.4 o/oo).

If carbonatite and kimberlite carbonates as well as diamonds represent deep seated carbon, the mean isotopic composition of this carbon is estimated as -5.2 o/oo and the range is -2 to -8 o/oo. The selection of any particular value within this range to be used as a criterion of deep-seated origin is at the moment not warranted. Indeed, the choice of any specific composition for such carbon may be meaningless, as the source of kimberlite, carbonatite and diamond carbon may not be isotopically uniform. (Authors' abstract)

DERJAGUIN, B.V., 1973, [Soviet study shows polywater doesn't exist]: Chem. Eng. News, v. 51, 1973, p. 13-14.

DESMARAIS, D.J., HAYES, J.M., and MEINSCHEIN, W.G., 1973, Techniques for the analysis of gases sequentially released from lunar samples, in Analytical Methods Developed for Application to Lunar Samples Analyses, ASTM STP 539, American Society for Testing and Materials, p. 71-79. Authors at Indiana University, Bloomington, Indiana 47401.

This paper describes two methods for the analysis of light gases that are sequentially evolved from 2 to 10 mg of lunar sample. A hydrofluoric acid hydrolysis of lunar material is achieved by repeated exposure of the sample to hydrogen fluoride. In the second technique, gases are evolved from lunar samples by the stepwise heating of these samples to 1400°C. The gases evolved by either hydrolysis or pyrolysis are analyzed in a gas chromatographic system using a helium ionization detector. The sensitivities of this detector for the gases, as analyzed, range from 2×10^{-11} g/s for hydrogen to 2×10^{-13} g/s for carbon dioxide. (Authors' abstract)

DOBROVOL'SKAYA, M.G., BOYARSKAYA, R.V., and VASIL'EVA, G.L., 1973, On the fluid inclusions in highly ferrugenous sphalerite from the Savinskoe no. 5 deposit, East Transbaikal: Abstracts of papers at Fourth Regional Meeting on Thermobarogeochemistry of Mineral-Forming Processes at Rostov-on-Don, 24-30 Sept., 1973: Rostov, Rostov Univ. Press* (In Russian; translation provided by Dr. E.I. Dolomanova of I.G.E.M., Moscow). Authors at IGEM, USSR Academy of Sciences, Moscow. * p. 176-177

Vacuoles up to 1.5 mm in diameter have been found in a fragment of a large sphalerite studied in detail. On mechanical opening, salt particles crystallized on the smooth cleavage surface of the crystal. This rare natural phenomenon was studied by various methods: under the microscope in reflected light, by spectral analysis, and under the electron microscope, to obtain new data on the composition of fluid inclusions and their patterns of distribution in the studied sphalerite.

As a result of the microscopic study of the sphalerite, rare inclusions of accessory minerals were found: pyrrhotite, cubanite, and mackinawite. The above inclusions are occasionally two-phase or three-phase. In rare cases the polished surface of the sphalerite exhibits vacuoles partly filled with pyrrhotite.

The microspectral laser analysis conducted at IGEM and at Korovel Laboratory (GOI, Leningrad) has shown that the surficial film adjacent to a fluid inclusion contains much calcium, silicon, manganese, magnesium, iron, carbon, and aluminium, and some titanium, and very little zinc, magnesium (sic.), sulphur, and chlorine. It also suggests that carbonate solutions participated in sphalerite crystallization. The presence of calcium, magnesium, silicon, and aluminium in the sphalerite is apparently due to the fluid inclusions, rather than to mechanical admixture of mineral inclusions containing the above elements.

The replicas of the fractured surfaces of the sphalerite, ion-etched areas, and the crystalline particles on the surface of the sphalerite were studied under the electron microscope to obtain data on the distribution of the particles crystallized following vacuole decrepitation. The morphology of the crystals precipitated from solution has been determined. The inclusions are generally grouped, their aggregates having variable shape: droplike, crystalline, dendritic, starlike, etc. Each aggregate contains, as a rule, individual crystals of clearly cubic or rectangular shape, 0.2 to 2 μm in size. Microdiffraction studies of the crystallized liquid phase shows the presence of sylvite in the inclusions. (Authors' abstract).

DOE, B.R., 1973, Lead isotopes, ore genesis, and ore prospect evaluation: a review (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 5, no. 7, p. 599-600. Author at U.S. Geological Survey, Denver, Colorado 80225.

Lead isotope data are now available not only for ores but also for cryptic leads in most principal rock types. The data are finding great application to problems of ore genesis and show great promise for us in ore prospect evaluation. In ore genesis, the major applications are in defining the source material for ore lead and in determining an estimate of the age of mineralization. As examples, (1) lead in the Phanerozoic galena ores of southeast Missouri is found to have been derived mainly from a Cambrian sandstone aquifer unit with perhaps subordinate amounts from Paleozoic carbonate host rocks and Precambrian basement rocks (in agreement with a lateral secretion hypothesis), and (2) the age of the bulk of the Coeur d'Alene ores in Idaho now is established as Precambrian, whereas some geologists previously thought the deposits were Cenozoic. In mineral prospect evaluation, most major base metal ore deposits of the world have lead isotopic compositions that evolved under conditions approximating *single-stage* conditions wherein there are no changes in the value of U/Pb and Th/Pb in the source since the earth formed other than those resulting from the radioactive decay of uranium and thorium. Many minor deposits appear to have leads not evolved under these conditions. A tool therefore exists for ore prospect evaluation anywhere in the world. The "igneous-type" leads in high-temperature copper ores of Utah and the "country rock-type" leads in low-temperature, lead-zinc-silver ores at Creede, Colorado, suggest that the lead isotopic composition might parallel the zoning of the ore metals in a district and be of use in exploration. (Author's abstract)

DOLGOV, Yu. A., 1973a, Investigations of inclusions in cosmogenic material: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, P. 9-11 (in Russian; translation provided through the courtesy of A. Kozlowski). Author at Inst. of Geophysics and Geology, Academy of Science USSR, Siberian Branch, Novosibirsk.

1. Varieties of tektites were investigated with special attention to the composition of gases in inclusions. On melting tektites the gases evolved can be essentially divided into 3 groups:

a) pure carbon dioxide with a small admixture of S-bearing gases,

b) 50 to 70% CO_2, 20 to 40% H_2, up to 6% N_2, and up to 5% S-bearing gases,

c) air plus 20 to 40% CO_2.

2. The first group of gases is similar to those from terrestial volcanic glasses, e.g., from the Transcaucasus and Transcarpathians area. The second group is believed to be mixed gases formed during the explosion of comets in the Earth's atmosphere (moldavites, Libyan glass). The third group can form during the melting of glasses in the Earth atmosphere (Darwin glass, artificial glasses).

3. Melted globules from the layered sediments from 1908 at the area of the Tungusskiy phenomenon contain gases of the second group. This indicates the phenomenon to be a comet explosion in the Earth's atmosphere.

4. Cosmic dust from deep parts of the Pacific Ocean, similar to various tektites, was melted in the atmospheres of Moon, Mars, Venus and unknown atmospheres of other planets (sic.).

5. Investigations of the glass globules from the lunar soil shows the prevalance of hydrogen in the gas mixture in the inclusions.

6. Pressures in inclusions of the all cosmogenic samples are significantly lower than 1 atm. Some tektite inclusions had pressures as low as 0.0002 atm.

7. In meteorites there occur inclusions consisting of coexisting glass, crystal and gas phases, like those described by Roedder in lunar rocks. (Author's abstract).

DOLGOV, Yu. A., 1973b, Condensed gases at the ocean bottom: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 24-26 (in Russian; translation provided through the courtesy of A. Kozlowski). Author at Inst. Geol. and Geophys., Acad. Sci. USSR, Siberian Branch, Novosibirsk.

1. Investigation of inclusions in authigenic minerals such as barite, and phillipsite, as well as the droplets of deep water in the shells of forams, radiolarians and in microconcretions of palagonite proves that the deep waters are the mineral-forming solutions for those same minerals. Deep waters from inclusions of authigenic minerals contain a large amount of dissolved gases (CO_2, N_2, O_2). Inclusions in transparent minerals were one-phase, liquid, and the amount of dissolved gas after opening was tens times larger than the volume of the inclusion.

2. The solubility of gases in the depths of the oceans depends on the total pressure, but not on the partial one (as some scientists thought). Partial pressure of CO_2 has a significant influence on

solubility only at low pressure, in agreement with the numerous determinations in the surface layer of the ocean. Sampling and investigation of waters from ocean depths with consideration of their pressures have not been done previously. High pressures influence the solubility of gases by Henry's coefficient in the thermodynamic expression of Henry's law.

3. Under pressures of 1000 atm in ocean deeps, submarine volcanic extrusions loss their explosive nature, and exhalations occur as secretions of liquified, (condensed) gases. Under high pressure the gases dissolve in sea water to reach saturation. The continuous secretion of liquified gases from submarine volcanoes makes it possible to form a separate (liquified gas) phase with a phase boundary. These liquified gases may exist for indefinitely long periods of time. Isolated liquified gases at 1000 atm are heavier than sea water and they concentrate in "valleys" in the sea bottom.

4. Similar to subaeral volcanoes, the most common gases of exhalations determine their minimum depth ranges for possible preservation of phase boundaries on the sea bottom. At 3000-3500 m, the densities of CO_2 and of water are equal. At lesser depths small amounts of liquid CO_2 are possible, but the density of CO_2 is lower than the density of water and the CO_2 will rise up with increasing speed. Above 600 m depth exhalations of CO_2 from submarine volcanoes are possible only in the gas phase. This depth (600m) is the probably boundary of origin of gas-hydrates.

Investigations of inclusions in authigenic minerals open the way to recognition of hitherto unknown processes in the ocean depths. (Author's abstract.)

DOLGOV, Yu.A., 1973c, Inclusions in minerals of metamorphic rocks: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 222-223 (in Russian; translation through the courtesy of A. Kozlowski). Author at Inst. Geol. and Geophysics, Siberian Branch, Acad. Sci. of USSR, Novosibirsk.

Investigations of inclusions in quartz and kyanite from metamorphic rocks of the Mama River mica deposit proved as follows:

1. Normal two-phase inclusions were revealed as not gas-liquid but as bearing two dense liquids without gas bubble. Homogenization of such inclusions gave T of full homogenization of CO_2 with aqueous-salt solution in the range 260-329°C. Phase ratio varied widely, but had little influence on T_H. On CO_2 - H_2O diagram for the same T, two values of concentration of CO_2 occur.

2. Inclusions bearing 100% of CO_2 were found. The density of CO_2 was determined by cryometric homogenization and heterogenization of CO_2.

3. On the intersection of the isochor and the isotherm, known from physico-chemical experiments as the parameters for the formation of kyanite, P was obtained (at T of growth). These P values agree well with theoretical. This means that density is the characteristic parameter.

4. In metamorphic rocks from the Chuysk area inclusions in kyanite, andalusite and quartz were studied. Measurements, as described above, gave the highest P-values for kyanite, and the lowest for andalusite. Besides inclusions with CO_2 and mixed ones, vacuoles with liquid N_2 were found (sic).

5. The distribtion of minerals proves that the pressure changes

from higher values in the center of fan-like folds (kyanite) to the lower ones in the periphery (andalusite) with an abrupt, stepwise transition to green schist facies of metamorphism. This testifies to the presence of horizontal pressures and the vertical zonal occurrence of metamorphic series. (Author's abstract)

DOLGOV, Yu. A., VISHNEVSKIY, S.A. AND SHUGUROVA, N.A., 1973, Preliminary investigation of gaseous-liquid inclusons in glassy and melted rocks of the Popigayskaya Crater: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p.197-198 (In Russian; translation through the courtesy of A. Kozlowski). Authors at Inst. of Geol. and Geophysics, Siberian Branch of Acad. Sci. of USSR.

Gas-liquid inclusions were investigated in separated parts of lechâtelierite, maskelinite, and other glasses, as well as inclusions in essentially glassy rocks of the Popigayskaya Crater.

1. In glasses of vitroclastites gas inclusions of various density are found.

2. In glasses of tagamites various inclusions are found: gaseous, gas-liquid with various ratios G:L (up to the domination of one of phases), and G-L with a solid phase. All kinds of indusions may occur in one schlieren simultaneously.

3. In glasses of partly melted wall-rocks, similarly tagamites, various inclusions also occur.

4. T_H ranges from 150 to 400°C, and the type of homogenization varies.

5. During freezing of inclusions down to - 42 to - 57°C, a solid phase in the gas bubble appears; during heating at T = -19 to -28°C the original phase ratios return. In the solutions no observable changes occur during cooling to -167°C.

6. The composition of the gaseous component of the inclusions (determined by the method of quantitative individual micoranalysis) is characterized by the absence of O_2 and CO, the presence of H_2 (0-20 vol. %, usually 8-12 vol. %), CO_2 (47-75 vol. %) and a group of undifferentiated gases ($H_2S + SO_2 + HCL + NH_3$) (8-23 vol. %). In some inclusions hydrocarbons occur (8-22 % by vol.), and gas phase of the inclusion consisted of 98 vol. % of hydrocarbons + 2 vol. % of H_2.

7. The variety of gas-liquid inclusions and the essential variations of their characteristics in one sample together with inhomogeneity of the glasses prove that the rocks of the Popigayskaya Crater were internally unequilibriated and the processes of their formation were of short duration. (Authors' abstract) (Translator's note--see also Dolgov, 1973a).

DOLIDZE, I.D., 1973a, Stages of mineral-formation of copper-polymetallic deposits of Merissa ore district (Adzharian Autonomous SSR): Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 179-181 (in Russian; translation through the courtesy of A. Kozlowski). Author at Geological Inst. of Acad. Sci. of Georgian SSR, Tbilisi.

The Merissa group of Adzharian Cu-polymetallic deposits occurring in a volcanic complex of Middle Eocene age are characterized by continuous substantial composition of ores. (. . .) On the basis of chemical analyses of triple water leachates, and homogenization studies in quartz, barite, carbonate,+ sphalerite, one may ascertain that formation of minerals at all deposits took place during three stages (barren, sulfide, and sulfide-barite).

In the early (barren) stage during formation of fine-grained quartz with sericite, chlorite and pyrite, the mineral-forming solution had a relatively high temp. (above 260°C) and contained mainly chlorides and bicarbonates of alkali and alkaline-earth metals.

In the sulfide stage T decreased to 260-155°C and solutions became chloride-sulfate-bicarbonate with alkaline-earths prevailing over alkalies.

Mineral-forming solutions of the sulfide-barite stage are characterized by further drop of temperature to 230-60°C and equilibrium between alkali and alkaline-earth ion, or domination of the latter. Sulfate-ion strongly prevails over bicarbonate and chloride ions, yielding barite (only at this stage).

During temp. decreases of mineral-forming solutions (there is a) regular drop of concentration of Cl and alkalies and increase of concentration of SO_4^{2-} and alkaline-earth ions.

First and third stage are characterized by a simple solution composition; solutions of the second stage are most complex. Formation of ores took place mainly at the second stage. (. . .) (Author's abstract, abbreviated by A.K.)

DOLIDZE, I.D., 1973b, Thermobaric conditions for the formation of the Lukhuni deposit: Soobshch. Adad. Nauk Gruz. SSR, 1973, 70(3), p. 649-652 (in Russian). Author at Geol. Inst., Tbilisi, USSR. Chem. Abst., v. 79, no. 13, 148058b, 1973.

The Lukhuni As deposit is associated with preore quartz-carbonate veins. Results of homogenization of gas-liquid inclusions in quartz and calcite of the veins indicate that ore mineralization proceeded in a wide (265-125°) temp. interval and at 350-850 atm. The crystn. temp. of quartz, of the ore mineralization stage, increased in proportion to an increase in depth. Realgar-orpiment mineralization occurred during the metasomatic replacement of limestones by hydrothermal solns.

DOLOMANOVA, E.I., GASOYAN, M.S., RUDNITSKAYA, Ye.S., TYUTHNEVA, G.K., and USPENSKAYA, A.B., 1972 Determination of the composition of mixtures and temperature of origin of vein and other quartzes by use of infrared spectra: Acad. Sci. of USSR, Fersman Mineralogical Museum, Trudy, v. 21, p. 35-49 (in Russian; translation provided through the courtesy of A. Kozlowski).

The authors propose an infrared method of distinguishing of paramorphs of low- after high-quartz, believing that the IR method is better than other methods, e.g. fluid inclusion studies.

DOLOMANOVA, E.I., LOSEVA, T.I., and TSEPIN, A.I., 1973, X-ray microspectral evidence on the chemical composition of the solids from fluid inclusions in cassiterite, tourmaline, and quartz from the tin deposits of Transbaikal: Abstracts of papers at Fourth Regional Meeting on Thermobarogeochemistry of Mineral-Forming Processes at Rostov-on-Don, 24-30 Sept., 1973: Rostov, Rostov Univ. Press* (In Russian; translation provided by Dr. E.I. Dolomanova of I.G.E.M., Moscow). Authors at IGEM, USSR Academy of Sciences, Moscow. * p. 181-182

1. X-ray microspectral analysis has been used to study the elementary composition of the solids from the vacuoles found in cassiterite, tourmaline, and quartz from the tin deposits of Transbaikal and Central Africa. (Presumably solids found on the surface of the host after opening an inclusion - see Dobrovol'skaya et al., and Tsepin and Dolomanova, this volume. Ed.).

2. The vacuoles in cassiterite exhibited chlorides of K, Na, Fe, Ca, and Al, ZnS, $ZnAl_2O_4$ (?), Na_2S, $FeTiO_3$, and $(Fe,Mn)(Nb,Ta,Ti)_2O_6$ with an admixture of W. Many vacuoles contain solids consisting of K, Al, Si, and Ca, Al, Si (they probably belong to feldspar), and Al (corundum), Ti (rutile), Ca, Ti ($CaTiO_3$?), Si (quartz), and Mn.

3. K, Na, and Ca chlorides were found in the vacuoles in tourmaline. In many vacuoles they form a mixture with the sulphides of the same metals plus Ag_2S, ZnS, PbS, and Bi_2S_3, and with SnO_2, Al_2O_3, and TiO_2. More complex solids were recorded as follows: Ca and Ti as $CaTiO_3$?; Fe, Mn, and Ti as $(Fe,Mn)TiO_3$; Ca, Ti, and Si as $CaTiSiO_5$?; and K, Na, and Mg phosphates.

4. In the solids from less studied vacuoles in quartz, the following were found: Zn, Fe, Cr, Ni, Mn, Cu, Pb, Co, Ti, Ca, Na, Al, F, N, S, and Cl. Among compounds that are apparently present are $FeTiO_3$, $Fe(Al,Cr)_2O_4$, $Al(NO_3)$, NaCl, TiO_2, CrS, phosphates, nitrates, and sulphides. Owing to the coating with carbon, it was not determined. (Authors' abstract).

DONALDSON, C., REID, A.M., RIDLEY, W.I., BROWN, R.W., and DAWSON, J.B., 1973, The Igwisi Hills extrusive "kimberlites" (extended abst.): in Internat. Conf. on Kimberlites, Extended Abstracts of Papers, L.H. Ahrens, et al., eds.: Univ. of Cape Town, Rondebosch, Cape Town, South Africa, p. 93. First author at Lunar Science Institute, Houston, Texas 77058.

DOROGOVIN, B.A., and MENCHINSKAYA, T.I., 1973, Liquid inclusions in turquoise and their homogenization temperature: Zap. Vses. Mineral. Obshchest., 1973, v. 102, no. 6, p. 712-713 (in Russian), Chem. Abstracts, v. 80, 72716n, 1974.

Turquoise in the Biryuzkan and Kalmakyr deposits is localized in secondary quartzites and granodiorite-porphyries. The 2-phase gas-liq. inclusions occur in the center of turquoise grains. The homogenization temp. of the gas-liq. inclusions is 90-195°. Data indicate that turquoise was formed from hydrothermal solns. at moderate depths. (Authors' abstract).

DYMKIN, A.M., SHEPEL', A.B., and FEDOSEYEVA, M.M., 1973, Crystallization temperature of pegmatite in magnetite deposits of the Tashelgin ore no. 4, p. 957-959 (in Russian; translation in Doklady Acad. Sci. USSR v. 211, 1974, p. 175-176; abstract in Int. Geol. Rev., v. 15, no. 10, p. 1236,1973). Authors at Institute of Geology and Geophysics, Siberian Division, USSR Academy of Sciences, Novosibirsk.

Homogenization temperatures of gas-liquid inclusions in microcline fall definitely in one of the following groups (°C): 800-690; 600-450; 400-200. Curiously, there are none in the 690-600 range, i.e. the temperatures are either "high" or "low" and the "medium" microcline T is missing. In quartz, the homogenization temperatures are: 750-600;

500-350; 300-150. The gap (100°C) here is between the "high" and the "medium" T. The fact that the "high" T range is found in both microcline and quartz is evidence of a magmatic origin of the pegmatites. (Authors' abstract).

DYMOND, J., and HOGAN, L., 1973, Noble gas abundance patterns in deep-sea basalts - primordial gases from the mantle: Earth Plan. Sci. Letters, v. 20, no. 1, p. 131-139.

DZHUMAILO, V.I., VASILENKO, V.N., AND RYLOV, V.G., 1973, Forms of redeposition and conditions of formation of gold in Cu-sulfide ores of the Urup group of deposits, (N. Caucasus): Abstracts of papers from the Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 115-116 (in Russian; translation through the courtesy of A. Kozlowski). Authors at Rostov Univ.

Three stages of ore formation were revealed: quartz-pyrite, bornite-sphalerite-chalcopyrite, and quartz-calcite. The first stage was the exhalation-sedimentary process, at low temp. and pressure in the presence of increased amounts of Zu, An and noble metals. The second one ranged from 400 to 190°C and the noble metals crystallized at 190-250°C. Chemical-analytical and physicochemical investigations of water leachates revealed that hydrothermal Au-transporting solutions were alkaline , with low redox potentials (pH 10, Eh 0.6 V). Such parameters permit the existence in solution of sulfides of various metals, including the noble ones. Gold probably was transported as sulfide (AuS). Sulfide ores and wall rocks of the deposit were metamorphosed under greenstone facies conditions (T 300-500°C) and the productive mineral association was also formed under such conditions. (Authors' abstract)

EGGLER, D.H., 1973a, CO_2 as a volatile component of the mantle (extended abstract): in Internat. Conf. on Kimberlites, Extended Abstracts of Papers, L.H. Ahrens, et al., eds.: Univ. of Cape Town, Rondebosch, Cape Town, South Africa, p. 95-98. Author at Geophysical Laboratory, 2801 Upton St., N.W., Washington, D.C. 20008.

Petrologic studies of kimberlite and related rocks have indicated that a CO_2-H_2O vapor phase was involved in their origin. This phase equilibria study indicates at least three reasons why such vapor associated with kimberlite and alkaline rocks should be CO_2-rich: (1) The model system Fo-En-H_2O-CO_2 indicates that in the presence of CO_2 or CO_2-H_2O mixtures peridotite comprising the upper mantle melts at higher temperature. Although the presence of CO_2 has little effect on the silica-saturated or undersaturated nature of liquid produced by partial melting at any particular temperature, liquids produced at higher temperatures are less silica-saturated because of the "enstatite effect". Higher melting temperatures also produce a smaller degree of melting, at any point along the geotherm, yielding more alkalic melts. The effect of CO_2 is therefore the production of less silica-saturated, more alkalic melts. There may be primordial areas of the mantle rich in CO_2, or CO_2-rich vapor may rise to certain localities. Mantle regions with vapor richer in H_2O would melt more completely to yield silicic magmas. (2) Silicate melts dissolve rather large amounts of H_2O at high pressures.

The presence of a free vapor is unlikely. Melts dissolve much less CO_2, so that the miscibility gap between melt and CO_2-rich vapor is wider, and the presence of a free vapor is more likely. (3) Vapor rich in CO_2 does not dissolve excess silica, unlike H_2O-rich vapor and may well dissolve excess alkalies. Such vapors would produce many alteration effects observed in kimberlite. (Author's conclusions)

EGGLER, D.H., 1973b, Phase relations in the system $CaMgSi_2O_6-CO_2-H_2O$ at 20 kilobars (abst.): Amer. Geophys. Union, Trans. (EOS), v. 54, no. 4, p. 479.

EGGLER, D.H., 1973c, CO_2 in the mantle: $Mg_2SiO_4-SiO_2-CO_2$ at 20 Kbars (abstr): Geol. Soc. Amer. Abstracts with Programs, v. 4, no. 7, p. 608. Author at Geophysical Laboratory, 2801 Upton St., N.W., Washington, D.C. 20008.

Compositions of liquid (L) produced by partial melting of the model peridotite assemblage forsterite (Fo)-silica-CO_2-H_2O have been determined. Hydrous melting relations are dominated by the melting of enstatite (En) to En+L (H_2O-undersaturated) at temperatures above 1400°C at 20 kbar and to Fo+En+L at temperatures below 1400°C. When CO_2 is added (up to 3.7 percent dissolves in melt), temperature of the change in enstatite melting behavior is nearly the same, both in the vapor-absent region and in the presence of H_2O-CO_2 fluid. The results indicate negligible effect of CO_2 on melt structure.

CO_2 has a large effect on composition of initial melts, however. In the presence of CO_2-rich vapor, "peridotite" (Fo-En) melts at much higher temperature than with H_2O. Because of the melting behavior of enstatite, initial melts produced at the same depth in the mantle may range from silica-oversaturated (temperature low, vapor H_2O-rich) to silica-undersaturated (temperature high, vapor CO_2-rich). For Fo-En, the change from silica-undersaturated to silica-oversaturated liquid occurs at 1400°C at 20 kbar when $CO_2/(CO_2+H_2O)$(mole) equals 0.42. The results indicate a natural affinity between silica-undersaturated melts and CO_2-rich fluids. (Author's abstract)

EHMAN, M. F. AND HANNA, J. E., 1973, Gas chromatographic analysis of gases in crystal inclusions: Journal of Crystal Growth, v. 18, pp. 309-311. Authors at North American Rockwell Electronics Group, Anaheim, California 92803.

A technique is presented for analyzing gases trapped in inclusions in crystals. The qualitative and quantitative analysis of gases trapped in BeO crystals grown by the flux-method is presented. A screw-driven pin is used to puncture the inclusions in a vacuum chamber, and a triangular array of stopcocks permits entry of the sample gas into the gas stream to the gas chromatograph. (Authors' abstract, extended by ER)

ELDERS, W.A., & BIRD, Dennis, 1973, Active low-temperature alteration of arenaceous sands in a near-surface geothermal environment in the Imperial Valley of California (abst): Geol. Soc. Amer. Abstracts with Programs, v. 5, no. 7, p. 610. Authors at Institute of Geophysics and Planetary Physics, University of California, Riverside, California 92502.

Extensive alteration of sandstones by geothermal brines at shallow depths occurs near the Algodones Dunes at the southeastern margin of the Salton Trough where a positive gravity anomaly is accompanied by very high temperature gradients near the surface (112°C at 114 meters). A 612-meter deep test hole encountered a temperature maximum of 105°C at 290 m, with a negative thermal gradient below this depth.

The rocks recovered are terrigenous detritus of the Colorado River Delta, primarily medium to fine arenaceous sands and silty sands, with pebble, granule, and clay size fractions together comprising about 15% of the section, Four distinct sedimentary facies are present, deltaic sand, channel-fill, beach-dune and lacustrine facies. Below 240 m the sediments are typically detaic whereas at shallower depths they have been modified by beach and eolian processes.

Post-depositional alteration from unaltered, porous, red sandstone to dense, vitreous appearing gray quartzite is evident in three intervals: 110 to 115 m, 148 to 154 m, and 240 to 300 m. In the incipient stages, this alteration is characterized by syntaxial growth of minute, pyramidal quartz crystals and the reduction of hematite to pyrite. In more advanced stages this is accompanied by expitaxial growth of quartz and by euhedral overgrowths of albite on detrital microcline. The porosity and permeability of these sandstones is reduced almost to zero and the density and seismic velocities are greatly increased. It appears that when hot geothermal brines migrating laterally through the aquifers encounter colder rock, the consequent percipitation of silica renders the rock impermeable. Thus, in porous sandstones, this geothermal system is essentially self-sealing. (Authors' abstract)

ELINSON, M.M., and ALIDODOV, B.A., 1973, Composition of gases of inclusions in minerals and some physico-chemical conditions of mineral formation in the Chorukh-Dairon ore field: Izvest. Akad. Nauk S.S.S.R., Ser. Geol., 1973, no. 7, p. 103-111. (In Russian). See Translations Section.

EPPLER, W.F., 1973, An unusual three-phase inclusion in kunzite: Deutsche Gemmol. Ges., Z., v. 22, no. 3, p. 93,(in German).

A kunzite from California contains a large three-phase inclusion: liquid, vapor, and an unidentified solid phase. (E.R.)

ERHAN, V., and ONICEANU, M., 1973, The geothermometry of quartz in the crystalline rocks of the Ineu-Bretila anticline zone, East Carpathians: Iasi, Univ., An. Stiint., Sect. 2, B (Ser. Noua), v. 19, part 2, p. 23-27 (in Romanian with German sum.).

ERMAKOV, N.P., 1973a, Homogenization and decrepitation temperatures of inclusions in knowledge of dynamics of processes of deep mineral formation: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 5-7 (in Russian; translation provided through the courtesy of N.P. Ermakov). Author at Moscow University.

Temperature is one of the important intensive thermodynamic parameters regulating the course of crystallization of minerals in deep and surface earth conditions and in synthetic systems of mineral-forming solution and melts. This parameter fixes the degree of heating of substances of different states of aggregation on a conditionally accepted scale. The choice of the latter is subjective. The notion of temperature is (based on) its measurement. The measurement of energetic levels of endogenous processes of mineral formation is revealed with the help of retrospective thermodynamic tests of geochemical systems of inclusions.

The determination of relative homogenization and decrepitation temperatures is the main problem. These temperatures (Th and Td) have the independent sense for the deep processes and do not depend on the accepted temperature's scale for the Earth's surface (sic). The exposure of only relative temperature in a system T-P-X-F is insufficient for the general direction of the development of thermobarogeochemistry. (There have been many attempts to determine) the homogenization and decrepitation temperatures in terms of the Centigrade thermometer.

It is not necessary to correct homogenization temperatures for revealing the temperature intervals and dynamics of formation of ore bodies and deposits. There is full coincidence of Th with T synthesis for inclusions in synthetic quartz, formed under pressures of 100 atmospheres.

For pressures up to 300 atm, T_h is low only by 10-20°C. In synthetic calcites, formed at 227 and 270°C, and under pressure below 100 atm at a salt concentration of 9%, the homogenization temperatures of gas-liquid inclusions were 224-227° and 266-273°C.

The difference between the synthesis temperature (T_s) and homogenization temperature (Th) was insignificant at salt concentration of 12%; T_s-280°; T_h-275-280°C; T_s-224°; T_h-224-230°C.

In view of the permeability of rocks, in our opinion, a pressure of 500 atm is very high for hydrothermal system in fractures, in which veins are formed. On account of high density of magmatic matter filling the vacuoles, the pressures effects on the T_h of melt inclusions (is very small). Hence the temperatures of the Moon's tholeiite basalt lavas are determined sufficiently exactly (1050-1220°C).

For the determination of the decrepitation temperature quartz is most often used, because of detailed study of its strength. The temperature of the start of mass decrepitation (T_d) and the interval for the first peak must (be determined).

This temperature (T_d°C) corresponds to the T_h°C in accordance with the last of our experiments, and those of Dr. Dorogovin, carried out on synthetic quartz.

The results are represented in the following table:

	Synthesis conditions		Temperature °C		T_s	T_d	T_d
	P	T	T_h	T_d	$-T_h$	$-T_s$	$-T_h$
1.	100	306	308	370	-1*	+64*	+65*
2.	300	318	300	360	+18	+42	+60
3.	500	334	300	360	+34	+26	+60
4.	700	338	288	350	+50	+12	+62

*sic.

From these data(we deduce that)the results of decrepitation are given by the homogenization temperature plus 60-65°C, because of mechanical solidity of quartz. From this table it can be seen that T_h coordinates with T_s.

The time is not ripe for the breit (sic) use of decrepitation for the determination of mineral formation temperatures because of the unknown strength of different minerals. Relative values of T_d may be useful for genetic interpretation, especially in combination with the results of homogenization, of inclusions in the same mineral, formed in different generations and physico-chemical conditions.

Thus, the most important quantity in mineralogical thermometry of deep and ancient processes is the homogenization temperature of geochemical systems of melt and gas-liquid inclusions, permitting clarification of the character of changes of other interrelated general parameters of past mineral formation. (Author's abstract.)(Editor's note — This abstract is not identical to that printed in the Russian original).

ERMAKOV, N.P., 1973b, Use of gas-liquid inclusions in geologic prospecting: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 20-21 (in Russian; translation provided through the courtesy of N.P. Ermakov). Author at Moscow University.

At the present time the application of decrepitation of gas-liquid inclusions in rocks, minerals and ores must develop in two directions: 1) The search of simple and overlapped pneumatolytic-hydrothermal bodies with the help of decrepitophonic and shlichodecrepitatic (sic.) methods and 2) perspective estimation of parcel productivity of quartz veins and zones of hydrothermal solution-saturation (quartzolites, albitites, etc.). It is necessary to give additional attention to the useful study of cation composition of inclusions and exposure of CO_2 composition, distillated aside from the mineralizing canals (sic.).

Its composition is always less in the inclusions of the hydrothermal solution-saturation aureoles in rocks, formed around the ore bodies. Aqueous and aqueous-carbonic paleohydrotherms, preserved in secondary inclusions in host-rock minerals, are so abundant that we can use the dehydrotationic (sic.) method of detailed study with the help of the microthermal or torsion balance. The value of weight loss by such heating is definitely related to distance to the ore body.

Decrepito-logging of drill core based on the theory of formation of hydrothermal solution-saturation aureoles must be in the arsenal of detailed geological methods, combined with geophysical and geochemical methods of prospecting for ore bodies. The paper presents concrete examples of use of gas-liquid inclusions in practice of geologic prospecting. (Author's abstract).

ERMAKOV, N.P., KHETCHIKOV, L.N., NAUMOV, V.B., and BAZAROV, L.Sh., 1973, Method of homogenization and its application in mineralogical thermometry: Program of the Fourth Regional Meeting on Thermobarogeochemistry of Mineral-Forming Processes, at Rostov-on-Don, 24-30 Sept., 1973: Rostov-on-Don, USSR (in Russian). (Part of an inclusion training session ; no abstract in Abstracts volume).

ERMAKOV, N.P., and KUYKIN, S.S., 1973, An attempt at comparing the decreptophonic and geochemical methods on the example of the vein polymetallic deposits of the Sadonian group: Bulgarian Acad. Sci., Bull. Geol. Inst., Metallic and Nonmetallic deposit series, v. 22, p. 155-167 (in Russian, with English abstract).

The studies carried out show the applicability of the decreptophonic method of prospecting for endogenic mineral deposits and of the portable decreptograph, developed for this purpose at Moscow State University.

Intensive haloes of hydrothermal solution-saturation of the enclosing rocks, as a rule well-comparable with the primary geochemical haloes, are established to stretch for up to several dozens of meters in proximity to quartz-sulphide veins and up to hundreds of meters in the case of closely disposed veins. The number of the decrepitations increases on approaching the mineral veins, except an occasional decrease in zones of leaching or post-ore tectonic movements.

The different displacements of the maximums of the decreptophonic and geochemical anomalies observed in certain places, as well as the separate manifestations of either of the anomalies, above all reflect the unequal representation of the products from the different stages of a common mineralization process or the superposition of diverse mineralization processes or the superposition of diverse mineralogical geochemical types of mineralizations of different ages.

The haloes of hydrothermal solution-saturation, reflecting the manifestations of the pneumatolytic-hydrothermal mineralization in general are an indirect indication for ore deposit prospecting, whereas the geochemical haloes are a direct indicator for the presence of a given type of mineralization in the region prospected.

The comparison of the number of impulses of the high temperature (500-700°C) and the low-temperature (up to 500°C) intervals of heating helps in determining the characteristic temperature and aggregate type of the mineralizing solutions. In the case of prospecting for medium and low-temperature hydrothermal deposits, a decreptometric study of the samples at temperatures of up to 500°C is more efficient than one up to 700°C (useful for prospecting for pneumatolytic-hydrothermal deposits). (Authors' abstract, edited by ER)

ERMAKOV, N.P., and LAPSHIN, V.A., 1973, Application of decrepitation method for detailed prospecting for rock-crystal-bearing veins in quartzites: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 259-260 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Moscow Univ.

1. Studies were made at one of the deposits in the Upper Aldan rock-crystal-bearing region, in quartzites of an Archean sedimentary-metamorphic complex.

2. Decrepitation of quartzites in an experimental section near a known rock-crystal-bearing vein occurs in the interval 120-600°C. On a statistical basis two characteristic decrepigraph peaks were found: 120-300 and 300-400°C.

3. On the basis of relative intensity of decrepitation of quartzites at these temps., one may determine the occurrence and distance from vein. On approaching the vein an increase of intensity of the peak at 120-300°C is observed, with a stable background intensity at $T = 300\text{-}480°C$. When the distance from the vein is 25-30 m, a sudden decrease of intensity of decrepitation at 120-300°C is observed and a similar increase of the maximum at 300-480°C; in the immediate proximity of the vein this latter may reach values 20 times higher than background.

4. Thermometry of samples taken at various distances from the vein zone is as follows: the maximum at 120-300°C is connected with two-phase GL inclusions (volume of gas 5-10% of vacuole) and with inclusions bearing gas, liquid CO_2, and aqueous solution; the maximum at 300-480°C is caused by decrepitation of GL inclusions bearing gas in following ranges (vol. %): 15-20; 25-30 and 40.

5. These data were used as the main criteria for detailed prospecting for vein zones.

At the eluvium/deluvium level of the deposits an area 300x350 m was sampled in a 20x20m net; the area has a number of geophysical anomalies from fracture tectonics. On the basis of decrepitometric studies of 600 samples a large anomaly, of 300 m length was found, with high decrepitation activity in the interval 300-480°C, proving the vein mineralization of the fractures. (Authors' abstract)

ERMAKOV, N.P. and PIZNYUR, A.V., 1973, Theoretical modelling of thermobarogeochemical conditions of postmagmatic mineral-forming solutions: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes 24-30 Sept., 1973: Rostov, Rostov Univ. Press p. 29-30 (In Russian; translation provided through the courtesy of N.P. Ermakov). Authors at Moscow University.

Natural deep mineral forming ionic-molecular solutions usually consist of water containing gases and salts; the main compounds are CO_2 and NaCl. In such geochemical fluid media there are some quantity of easily soluble combination of useful components, which formed ore-bodies and mineral deposits in definite P-T-X- conditions (sic). This was established with experiments on synthetic systems and was confirmed with observations of geochemical systems of gas-liquid inclusions. The latter points directly at predominance of one or the other of the three mentioned chemical compounds in solutions, forming corresponding mineral associations.

Thus H_2O, CO_2 and NaCl are the "base" of mineral-forming solutions, their properties in synthetic combinations and separately have been comparatively well studied and presented as PT-diagrams.

The level of heating and pressure determine the density of these fluids. Consideration of their interrelations has shown that the mixing of H_2O and CO_2, CO_2 and 30% solution of NaCl (sic) may be unlimited at specific temperatures and pressures. Their solutions are homogeneous in conditions of equal specific volume. On the compiled diagram this is expressed as two "tops", between which there is limited mixing of these components. There are concrete temperature and pressure data on the diagram, by which it is possible to define conditions of mineral-forming solutions in a given section of the "tops", in a static system.

This thesis is confirmed by experiments with synthetic systems (Takenouchi and Kennedy, 1965) and numerous experiments with natural microautoclaves - inclusions of mineral-forming solutions.

We can not submit for consideration the proposed model in this abstract, but it will provide important background for the thermobarogeochemistry of magmatic, metamorphic and postmagmatic mineral-forming processes, with the help of modeling of dynamic systems. The solution of the problem will be aided by data received with the help of synthetic mineral-forming systems, natural mineral-formation on the basis of diagrams, and many varieties of tests of gas-liquid and melt inclusions in minerals. The data presented can reconcile many contradictory views and directions about endogenous postmagmatic ore-forming processes. (Authors' abstract.)

ERMAKOV, N.P., et al., 1973, Homogenization of inclusions and electrical properties of dielectric minerals: Akad. Nauk SSSR, Doklady, v. 208, no. 6, p. 1439-1442 (in Russian; translated in Doklady Acad. Sci. USSR, Earth Sci. Sect., v. 208, p. 165-168; abstract translated in Int. Geol. Rev., v. 15, no. 5, p. 614, 1973).

Flattening in the resistivity-temperature curves at increasing T, as found in synthetic and natural quartz, beryl, and calcite, is found to represent homogenization of inclusions in the minerals, thus changing the dielectric permeability. The authors suggest that this technique for determining T_H has promise. Diamonds from the Mir kimberlite pipe show a similar flat suggesting low-temperature inclusions (426-500°C).

Lingulate secondary liquid-gas inclusions homogenizing at $\sim$430°C were found in these diamonds (Editor's note - this is apparently the first known occurrence of liquid inclusions in diamond.) (ER)

ESSENE, Eric, WALL, Victor, and SHETTEL, Donald, 1973, Equilibria in $CaO-MgO-SiO_2-H_2O$ (abst): Amer. Geophys. Union, Trans. (EOS), v. 54, no. 4, p. 480.

FAIZIEV, A.R., 1973, Morphology of fluorite crystals from the Ak-Dzhilginsk deposit in the eastern Pamirs: Vses. Mineral. Obshchest., Zap., v. 102, no. 6, p. 685 (in Russian).

Very similar to Fayziyev, 1972 (see Fluid Inclusion Research - Proceedings of COFFI, v. 5, 1972, p. 36), but with somewhat different T_H values. (ER)

FAYZIYEV, A.R. AND MOROZOV, S.A., 1973, Thermodynamic conditions of fluorite origin from deposits and ore mineralizations of Tadzhikistan: Abstracts of papers from the Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 125-126 (in Russian; translation through the courtesy of A. Kozlowski). Authors at University of Tadzhikistan, Geology Institute of Academy of Sciences of Tadzh. SSR.

Fluorite in deposits of S. Hissar and Karategin has crystallized in a wide range of temp. (350-50°C) and pressure (450-80 atm). Commercial generations of fluorite have formed at 250-130°C and 350-200 atm. At analogous deposits of Pamir the T and P conditions are 180-70°C and 250-90 atm. At the deposits of the Zervashan Chain optical fluorite crystallized at 185-70°C and 330-120 atm.

Fluorite formation at telethermal Hg-Sb deposits of N slope of the Hissar Chain took place at 110-45°C and 200-60 atm. At some pegmatitic deposits of Central Tadzhikistan fluorite crystallized at temp. 250-80°C and pressures 350-150 atm. For gold deposits T=380-220°C and P=560-275 atm are characteristic and for rare-metal deposits - T=340-290°C and P=500-410 atm.

At tin deposits of Pamir, fluorite cyrstallization occurred at T=305-85°C and P=500-160 atm, and at contact-metasomatic mineralizations, T=230-130°C and P=350-200 atm. (Authors' abstract)

FENN, P.M., & LUTH, W.C., 1973, Hazards in the interpretation of primary fluid inclusions in magmatic minerals (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 5, no. 7, p. 617. Authors at Dept. of Geology, Stanford Univ., Stanford, California, 94305.

Primary fluid inclusions have been produced during the growth of synthetic alkali feldspars from melts in the system $NaAlSi_3O_8-KAlSi_3O_8-H_2O$. Fluid filled bubbles and tubules are commonly observed in crystals grown from H_2O-undersaturated melts. An interface enrichment mechanism is proposed as the source of these inclusions and as such the presence and/or composition of these inclusions is not indicative of the state of the bulk system. These results suggest the need for a reanalysis of the significance and interpretation of primary fluid inclusions in magmatic minerals. (Authors' abstract)

FESQ, H.W., BIBBY, D.M., ERASMUS, C.S., KABLE, E.J.D., and SELLSCHOP, J.P.F., 1973, A comparative trace element study of diamonds from Premier, Finsch and Jagersfontein Mines, South Africa (extended abstract): in Internat. Conf. on Kimberlites, Extended Abstracts of Papers, L.H. Ahrens, et al., eds.: Univ. of Cape Town, Rondebosch, Cape Town, South Africa, p. 111-114. Authors at NIM-WITS A.A.R.G., N.P.R.U., Univ. of the Witwatersrand, Johannesburg.

Gives some evidence (p. 113) for the presence of trapped liquid (silicate) inclusions in diamond, possibly with CO_2 and H_2O. (ER)

FIELD, C.W., 1973, Sulfur isotope abundances in hydrothermal sulfate-sulfide assemblages of the American Cordillera (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 5, no. 7, p. 619. Author at Department of Geology, Oregon State University, Corvallis, Oregon 97331.

Hypogene sulfides from hydrothermal deposits of the American Cordillera are isotopically similar to meteoritic sulfur (0 δ34 ^{o}/oo) regardless of deposit-type, geologic age, and tectonic location. The majority of values occupy a narrow range (-3 to +3 ^{o}/oo) and sulfide mineral pairs and triplets exhibit small temperature dependent fractionation effects with progressive S^{34} depletion in the order molybdenite, pyrite sphalerite, chalcopyrite, bornite, and chalcocite-galena. Sulfides from several contact metasomatic (Craigmont, Peacock, Christmas, and others) and porphyry-type (Galore Creek, Yerington, Ajo, Esperanza-Sierrita, El Salvador, and others) deposits are anomalously depleted in S^{34} (-1 to -14 ^{o}/oo). They are of local to widespread distribution; associated with hypogene iron oxides (magnetite or hematite), hypogene sulfates (anhydrite or gypsum), or both; and presumably confirm the Eh-pH control of sulfur isotope fractionation proposed by Sakai (1968) and Ohmoto (1970; 1972). In contrast, associated hypogene sulfates are expectably enriched in S^{34} (+7 to +15 ^{o}/oo) and isotopic temperature estimates (300 to 600°C) from sulfate-sulfide pairs broadly agree with published fluid inclusion filling temperatures. Models based upon the sulfate-sulfide data, mixing, and isotopic equilibration suggest that total sulfur in these hydrothermal systems was compositionally (0 ± 3^{o}/oo) similar to meteoritic sulfur and may have been derived from a deep-seated source. The data do not indicate appreciable contributions of heavy sulfur (+20 ^{o}/oo) from ocean water-metalliferous sediments or evaporite sources as might be incorporated in convergent plate or craton-shelf tectonic regimes.(Author's abstract)

FOMICHEV, V.I., and KUZNETSOVA, Ye.I., 1972, Metasomatites of Sayakskiy region and criteria of their ore productivity, in Papers of All-Union Symposium, Alma-Ata, 1972, Kazakh Scientific-Research Institute of Mineral Raw Materials, and Inst. of Geological Sciences, Academy of Sciences of Kazakh SSR, part 1, Alma-Ata 1972, pp. 185-192. (In Russian; abstract through the courtesy of A. Kozlowski). Authors at Inst. of Geological Sciences, Acad. of Sci., Kazakh SSR, Alma-Ata.

The ores have a reverse temperature gradation in relation to granitoid massives; on the other hand the metasomatites have the normal, simple temperature zonation. The earliest and highest-temperature (over 250°C) association: gold 1 - gersdorffite - arsenopyrite - cobaltite agrees with the external zone of relatively late and low-temperature metasomatites of quartz-calcite-chlorite composition. The association gold 2 - bismuth - chalcopyrite 1 - pyrrhotite (250°C) occurs in moderate-temperature epidote-actinolite zone. The association gold 3 - wittichenite (Cu_3BiS_3) - molybdenite - bornite - chalcopyrite 2 (225°C) was ascertained in the internal high-temperature zone of skarns. The authors ascertained that the above distribution of ore and parent rock, temperatures is in good agreement with phenomena accompanied by the thermohygroscopic diffusion effect (Lykov, 1950).

FOURNIER, R. O., and TRUESDELL, A. H., 1973, An empirical Na-K-Ca geothermometer for natural waters: Geochemica et Cosmochimica Acta, v. 37, pp. 1255-1275. Authors at U. S. Geological Survey, Menlo Park, California 94025.

An empirical method of estimating the last temperature of water-rock interaction has been devised. It is based upon molar Na, K, and Ca concentrations in natural waters from temperature environments ranging from 4 to 340°C. The data for most geothermal waters cluster near a straight line when plotted as the function $\log (Na/K) + \beta \log [\sqrt{(Ca)}/Na]$ vs reciprocal of absolute temperature, where β is either 1/3 or 4/3 depending upon whether the water equilibrated above or below 100°C. For most waters tested, the method gives better results than the Na/K methods suggested by other workers. The ratio Na/K should not be used to estimate temperature if $\sqrt{(M_{Ca})}/M_{Na}$ is greater than 1. The Na/K values of such waters generally yield calculated temperatures much higher than the actual temperature at which water interacted with the rock.

A comparison of the composition of boiling hot-spring water with that obtained from a nearby well (170°C) in Yellowstone Park shows that continued water-rock reactions may occur during ascent of water even though that ascent is so rapid that little or no heat is lost to the country rock, i.e., the water cools adiabatically. As a result of such continued reaction, waters which dissolve additional Ca as they ascend from the aquifer to the surface will yield estimated aquifer temperatures that are too low. On the other hand, waters initially having enough Ca to deposit calcium carbonate during ascent may yield estimated aquifer temperatures that are too high if aqueous Na and K are prevented from further reaction with country rock owing to armoring by calcite or silica minerals.

The Na-K-Ca geothermometer is of particular interest to those prospecting for geothermal energy. The method also may of use in interpreting compositions of fluid inclusions. (Authors' abstract)

FRAZIER, W.J., 1973, Origin of celestite-bearing vugs in the Pennington Formation of central Tennessee (abst.): Geol. Soc. America Abstracts with Programs, v. 5, no. 5, p. 397. Author at Dept. of Geology, Madison College, Harrisonburg, Virginia 22801.

Celestite-bearing vugs occur in the lowermost dolomite beds of the Pennington Formation (Upper Mississippian) along the northern Highland Rim of central Tennessee. Vugs are elliptical, up to 15cm in length, and may coalesce. Many have brecciated sides and floors. Celestite occurs in two forms: 1) small (0.4-3.6mm), euhedral crystals with anhydrite inclusion-rich centers and 2) larger (1-5mm), subhedral to anhedral, inclusion-free crystals. Intimately associated with the celestite are large euhedral dolomite crystals with curved edges and undulose extinction. Other minerals found in some vugs include: quartzine (usually as small spherulites), calcite, sphalerite and fluorite.

Based on an analogy with recent gypsum nodules and on petrographic data, I interpret the Pennington vugs as having been formed as gypsum nodules beneath the surface of an evaporitic, sabkha-like environment, later undergoing dehydration to form anhydrite. Eogenetic silicification and partial celestite replacement resulted in quartzine spherulites and inclusion-rich celestite. At a later time anhydrite dissolved (due to increased porewater acidity or decreased temperature) allowing celestite to attain a euhedral form. The source of Sr was seawater and concentration was affected by evaporation. Celestite formed by replacement of anhydrite or by direct precipitation from porewaters. (Author's abstract)

GALABURDA, Yu.A., 1973, Hydrothermal mineral formation in the Krivoi Rog Basin: Akad. Nauk Ukr. RSR, Dopov., Ser. B, no. 5, p. 392-395 (in Russian with English sum.).

Some physicochemical parameters of the environment of hydrothermal mineral formation are determined on the basis of investigations of inclusions in quartz from veins in the Krivoy Rog metamorphic rocks. Temperatures of solutions were different for different regions and changed from 220 to 385°C. Only a lower limit of 800-900 atm pressure was determined. Solutions were often enriched with liquid CO_2. (Author's abstract)

GALIY, S.A., KUZNETSOV, Yu.A. AND KULIK, Zh.V., 1973, Conditions of sphalerite formation at Ukrainian deposits: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 85-87 (in Russian; translation through the courtesy of A. Kozlowski). Authors at IGFM AN UkrSSR, Kiev.

1. Sphalerites of 15 deposits were investigated, mainly from Zakarpat'e and Donbass. (...).

2. Over 500 measurments of T_h and T_d were made (...). The data were gathered with those obtained by Kullerud's method.

3. Sphalerite from Zakarpat'e formed at similar temp.: (°C)

a. Beregovskoe	255-220	200-145
b. Byegan'skoe	245-235	210-150
c. Vyshkovskoe	230-170	

4. Polymetallic deposits in the Nagol'nyi district have sphalerite crystallized in two stages of hydrothermal process: 306-270 and 230-150°C. During the first generation precipitation pressure was higher than 700 atm, and during the second - 600-700 and less.

5. The temperature interval of sphalerite formation at Sushchano-Perzhanskaya tectonic zone of Ukrainian Shield was 305-290°C, and 280-250°C, from Krivoy Rog basin - 226-220°C; NW range of Donbass - 250-195°C; N range of Donbass - 152-145°C.

6. Decrepitometric data agree very well with T_h values.

7. Water leachates of fluid inclusions were analyzed (data not given in abstract). Analysis of the gas composition of individual inclusions gave the following results: CO_2 12.5-22.5%, O_2 15.7-19.2%, CO 11.7-27%, H_2S 0-1.8%, N_2 plus rare gases 39.4-53.2%. Kullerud's thermometer is not suitable for temp. determinations for natural sphalerites. (Authors' abstract)

GANEEV, I.G., ERMAKOV, N.P., and MEL'NIKOV, F.P.. 1973, Gas-liquid inclusions in synthetic quartz grown from NaCl solutions: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming

Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp 281-283 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at All-Union Inst. of Mineral Raw Materials,+ Moscow University

Investigation of the composition of inclusions in natural quartz proves that hydrothermal solutions, from which SiO_2, as well as majority of other minerals, have crystallized, have a chloride-bicarbonate-sodium composition with varying amounts of other ions. Assuming the parent character of solution in inclusions, large-scale migration of SiO_2 in similar cases ought to occur easily. But known experimental data on the solubility and crystallization of quartz do not support the possibility of transport of significant amounts of SiO_2 under such conditions.

On the basis of vertical zoning of ore bodies and the existence of a geothermal gradient during their formation, a model was proposed, explaining the mechanism of mobilization, transportation and redeposition of substances by water solutions of NaCl. The basis of the model is the hydrolysis of NaCl under a geothermal gradient with the formation of alkaline solutions in the lower parts of the veins, and essentially acid solutions in the upper parts, as a result of migration of HCl:

$$NaCl + H_2O = NaOH + HCl$$

Experimentally this is supported by growing quartz crystals in solutions of NaCl.

Mechanism of the process: in the lower part of the autoclave quartz and alkalies interact:

$$NaOH + SiO_2 + 2H_2O = Na[Si(OH)_5];$$

the saturated solution migrates by convection toward the upper zone, where silicate complexes hydrolize, forming crystalline quartz:

$$Na[Si(OH)_5] + HCl = SiO_2 + NaCl + 3H_2O;$$

The resultant crystals bear numerous GL inclusions of elongated shape with sharp outline and well developed relief; their dimensions range from 0.52 to 1.5 mm, mostly 0.4-0.5 mm. Individual inclusions bear a solid phase consisting of thin opaque needles, probably rutile. T of inclusions: 395-410°C with intense decrepitation on overheating. On cooling, the inclusions freeze suddenly to a dark mass at -58°C. On subsequent warming, the ice recrystallized and the last crystal disappears at -5.5°C. If the inclusion is cooled again before the last ice crystal melts, dendritic crystals of cryohydrate form rapidly.

Investigations of GL inclusions in synthetic quartz grown from solutions of NaCl as well as KCl, $CaCl_2$ etc. open new possibilities for the study of inclusions in natural minerals. (Authors' abstract.)

GARBUZOV, P.S., 1972, Peculiarities of ore mineralization occurrence in skarns of the Tyetyukhe ore district, in Papers of All-Union Symposium, Alma-Ata, 1972, Kazakh Scientific-Research Institute of Mineral Raw Materials, and Inst. of Geological Sciences, Academy of Sciences of Kazakh SSR, part 1, Alma-Ata 1972, pp. 144-150. (In Russian; abstract through the courtesy of A. Kozlowski). Author at DVPI, Vladivostok.

Vertical zonality of chemical composition of ores agrees with temperature zonality of mineral origin. Thus at the Osnovnoe ore body, from 0 level to +300m level, crystallization temperature decreased 9-10° per 100m; in the interval +300m - +435m there is a significant increase of temp. (50-55°C) and at levels higher than +435m toward the surface the temp. again decreases. On the basis of decrepitation data one may conclude that skarns and ores crystallized at temp. ranges 450-100°C, and the richest ores of Pb and Zn formed at 190-200 and 190-240°C respectively.

GEGUZIN, Ya.E., and DZYUBA, A.S., 1973a The investigation of liquid inclusions in a rock-salt crystal in the entire temperature interval of their existence: Kristallografiya, v. 18, no. 4, p. 813-818 (in Russian).

The behavior of inclusions of saturated aqueous solution in natural single crystals of NaCl was examined from the temperature of crystallization to temperatures exceeding the critical state of the material of the inclusions, when it passed into the gaseous phase. Frames from motion picture sequences are presented, showing the behavior at temperatures up to 410°C, and after subsequent cooling. (ER)

GEGUZIN, Ya.E, and DZYUBA, A.S., 1973b Elastic diffusion interaction of liquid inclusions in an NaCl single crystal: Kristallografiya, v. 18, no. 5, p. 1053-1056 (in Russian).

GEIJER, Per, 1971, Sulfidic "ball ores" and pebble dikes: Sveriges Geol. Unders., Ser. C, no. 662, Ar 65, Nr 8 p. 1-29 (in English).

"Ball ores" occur in several of the areas of sulfide mineralization in the Precambrian of central and southern Sweden. They consist of a sulfide matrix in which are embedded very numerous inclusions of rocks and/or minerals. These inclusions are rounded, often spherical. The common form of a ball ore body is dike-shaped. The characters of the ball ores have, somewhat vaguely, been ascribed to secondary influences. Comparison is now made with the "pebble dikes," mostly barren, which are known from several districts of hydrothermal sulfide mineralization in the western United States and in Australia. From this comparison it appears that the ball ores were formed by fluids injected under very high pressure, the rounding of the inclusions being due to attrition during this process and to corrosion. For the way in which the sulfides of the ball ores were introduced, several possible explanations are discussed. Most likely they were either injected in the solid state as a pulp, or were carried chemically in the injected fluid. A third theoretically possible explanation, implying that they were introduced metasomatically in an originally barren pebble dike, appears improbable. (Author's abstract)

GERLACH, Terrence M. and NORDLIE, Bert E., 1973, Magmatic gases compatible with magnetite-pyrrhotite assemblages in basaltic lavas (abst): Amer. Geophys. Union Trans. (EOS), v. 54, no. 11, p. 1219.

GIMADEEV, Sh.Sh., ANDRUSENKO, N.I. & SCHEPOT'YEV, Yu.M., 1973, Temperature of formation of quartz veins of gold-silver deposits in the N. Kamchatka region: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 55 (in Russian; translation through the courtesy of A. Kozlowski). Authors at Central Scientific-Research Geologic-Prospecting Institute, Ministry of Geology USSR, Territorial Geological Office of Kamchatka, Petropavlovsk.

The ore field is developed in the intersection of the Taygonossko-Murgal'skiy and Penzhinsko-Kondyrevskiy deep faults in the ranges of Okhotsk-Chukotskiy volcanic zone. Investigation of consolidated melt, partly crystallized, and essentially gaseous inclusions in rock-forming quartz of granodiorites revealed that crystallization of acid magmatic melt finished at temp. about 850°C. Gaseous solutions and their hydrothermal condensates caused the essential hydrothermal alteration of rocks resulting in secondary quartzites at a temp. of 420-340°C; subsequent alteration into a sericite-hydromica aggregate took place at the moderate temp. interval 290-160°C.

Formation of Au-Ag adularia-calcite-quartz veins was from hydrothermal, initially near-critical solutions in the temp. range 390-95°C under conditions of unevenly changing regime with temp. drops reaching 110°C. During amethyst crystallization boiling occurred, for a short interval, and the solutions were of a gaseous type. Productive associations precipitated in the temp. interval 310-150°C. Pressures, based on tubular inclusions in amethyst, at individual moments in the development of the series ranged from 190 to 240 atm. (Authors' abstract).

GLAÇON, J., PARK, F. & TOURAY, J.- C., 1973, La rétromorphose du talc dans les dolomies métallifères de Boukdema (Algérie); discussion du rôle des fluides: Mineral, Deposita (Berl.) v. 8, pp. 183-191. (In French with English abstract). First author at Université Paris VI, France.

The samples studied were collected in the Boukdema stratabound deposit (Algeria), where the association dolomite-quartz-talc-sphalerite occurs. Cryoscopic investigations of fluid inclusions in quartz indicate a wide salinity range in mineral forming fluids (4 to 28 weight $^0/_0$ NaCl eq). "Boiling" of hydrothermal fluids possibly explains this unusual characteristic. In this hypothesis thermometric data need no "pressure corrections" and one may conclude that quartz growth (and simultaneously talc dissolution) occurred in the 250°-200°C range. On the basis of this last indication, the relative role of T, f_{CO_2}, a_{Mg}/a_{Ca}, on talc stability is discussed in the mineralogical environment of Boukdema. (Authors' abstract)

GLYUK, D.S., and ANFILOGOV, V.N., 1973, Phase equilibria in the system granite-water-potassium fluoride at a water-vapor pressure of 1000 kg/cm^2: Akad. Nauk SSSR, Doklady, v. 210, no. 4, p. 938-940 (in Russian; translated in Doklady Acad. Sci. USSR, v. 210, p. 237-238). Authors at Inst. of Geochemistry, Siberian Division, USSR Academy of Sciences, Irkutsk.

Data are presented (graphically as a TX diagram) for many points in the range 0.2-1.0 wt. %, and also higher % KF, at 100-900°C. (ER)

GODOVIKOV, A.A., 1973, Introduction to mineralogy: Novosibirsk, Nauka Pub. House, 232 pp + 36 photos (in Russian).

Includes a 5-page summary of fluid inclusions, taken largely from Ermakov's papers on classification, (ER).

GOLIKOV-ZAVOLZHENSKIY, I.V., 1973, Phase state and chemical composition of fluid inclusions in quartz of aeschynite-bearing greisens (Central Kazakhstan): Abstracts of papers from the Fourth Regional Conference on Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 152-153 (in Russian; translation provided through the courtesy of A. Kozlowski) Author at Rostov Univ.

Aeschynite-bearing greisens developed by alteration of alaskite granites. In quartz of greisens two types of inclusions were found: 1. primary and pseudosecondary gaseous and essentially gasesous, homogenizing in gas phase and 2. essentially liquid two-, three-, and polyphase inclusions.

Polyphase and CO_2 bearing inclusions were found in quartz of all greisens, and polyphase CO_2-bearing were found in quartz-feldspathic greisen and in quartz veins. Relic inclusions occur only in apogranites and quartz-feldspathic greisen; here the highest concentration of inclusions was 10.6kg per m^3 (i.e.,∿0.3 wt.%; Ed.).

Three stages of greisen formation were distinguished:

1. Formation of apogranites and quartz-feldspathic greisens from gaseous solutions of bicarbonate-Na composition.
2. Formation of muscovite-quartz greisens from an unstable sometimes boiling liquid solution of sulfate-Mg composition.
3. Solutions (liquid) of Cl-Ca composition, highly concentrated and high-temperature. (Author's abstract)

GOLOVCHENKO, N.G., 1973, On mineral formation temperatures and chemical composition of solutions forming the Nikitovskoe mercury deposit: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 101 (in Russian, translation through the courtesy of A. Kozlowski). Author at L'vov Univ.

Two stages of mineralization are recognized: arsenopyrite-quartz (a) and quartz-antimonite-cinnabar (b). During stage (a) the following minerals were formed: quartz, calcite, arsenopyrite, chalcopyrite, galena (?), and probably pyrite. Primary and pseudosecondary inclusions in quartz have 70-80 vol % filling (F) and homogenize at 290-170°C in the liquid phase. Inclusions in calcite are rarer and homogenize at 190-150°C. Stage (b) includes the following minerals: cinnabar, antimonite, marcasite, sideroplesite, dickite, and quartz. Inclusions in quartz (F = 85-90%) homogenize at 160-90°C, in the liquid phase; the latest, post-cinnabar quartz generation gave T_h 110-90°C. P measured by use of inclusions bearing liquid CO_2 were 150-120 atm. Inclusions in cinnabar homogenize in the liquid phase at 145-105°C. (Author's abstract).

GONCHAROV, V.I., and SHUGUROVA, N.A., 1973, Volatile composition of near-surface hydrothermal solutions in the Au-Ag deposits of the NE of the USSR: Geokhimiya, 1973, no. 10, p. 1583-1585 (in Russian, abstract translated in Geochem. Internat., v. 10, no. 5, 1973, p. 1170; full translation available from Am. Geol. Inst.).

Gases in fluid inclusions of the Au-Ag deposits of the NE of the USSR were analyzed by microchemical methods. CO_2 and variable amounts of air were found, indicating near surface deposition. -A. Truesdell.

GOROVOY,A.F., MAISKIY, Yu.G., REZNIKOV, A.I., TKACH, B.I., SHTANCHENKO, M.S., AND SHELUKHIN,V.I., 1973, Fluid inclusions in minerals of hydrothermal occurrences from Central Donbass: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 94 (in Russian; translation provided through the courtesy of A. Kozloski). Authors at KIMI Kommunarsk, Rostov Univ., VKGRE, Voroshilovgrad.

Inclusions were examined in quartz, carbonates, fluorite, gypsum, galena, sphalerite, pyrite, cinnabar and layer silicates of polymetallic, gold, mercury and rock-crystal mineralizations of Carboniferous outcrops of Donbass.

Homogenization of inclusions occurs in gas or liquid phase, and occasionally with critical phenomena in CO_2-bearing inclusions. T_h in quartz and carbonates: 300-310, 220-260, 150-170, 80-120°C. Decrepigraphs usually have some maxima: quartz 60-100, 120-160, 220-260, 280-320°C; carbonates 70-120, 180-220, 240-280, 340-380; fluorite 60-100, 180-220°C; galena 260-320°C; sphalerite 80-120, 180-240, 280-320°C; pyrite 60-120, 220-300°C; cinnabar 60-120, 160-200°C; layer silicates 60-120°C. Several generations of inclusions in the minerals occur, providing significant changes of pressure and temperature. (Authors' abstract).

GORYAINOV, I.N., and ANDREYEVA, T.B., 1972, Chlorides of iron, nickel, copper and aluminum in copper-nickel ore of the Talnakh deposit: Akad. Nauk SSSR, Doklady, v. 204, no. 6, p. 1456-1459 (in Russian; trans. in Doklady Acad. Sci. USSR, Earth Sci. Sect., v. 204, p. 224-226). Authors at Research Institute of Arctic Geology, Leningrad.

Chemical composition of the chloride and sulfide phases of the ores (table 1), Fe-Ni-Cu interrelations in these phases (fig. 1), partial and multiple correlations of the metals, ubiquitous presence of chloride in a wide variety of the minerals, and presence of apatite in the ores are definite evidence here of the importance of chloride in transfers of the metals during formation of the ores. Presence of chlorides, apparently as a solid phase, in primary multiphase inclusions in the ore and the gangue minerals lends further support to that conclusion. (Authors' abstract, trans. in Intern. Geol. Review, v. 14, 1972, p. 1382).

GREENWOOD, H.J., 1973, Thermodynamic properties of gaseous mixtures of H_2O and CO_2 between 450° and 800°C and 0 to 500 bars: American Journal of Science, v. 273, p. 561-571.

GROSHENKO, A.R., 1973, A method of heating chamber calibration: Abstracts of papers at Fourth Regional Meeting on Thermobarogeochemistry of Mineral-Forming Processes at Rostov-on-Don, 24-30 Sept., 1973: Rostov, Rostov Univ. Press p. 301-302 (In Russian; translation provided by Dr. E.I. Dolomanova of I.G.E.M., Moscow). Author at IGEM, USSR Academy of Sciences, Moscow.

1. Owing to the great diversity of instruments applied in thermometry by different laboratories and the absence of a single calibration technique, the results obtained by different research centers are often difficult to correlate.

2. A method of calibration is suggested to measure more accurately the temperature in heating chambers. This method takes account of three-dimensional isothermal fields present both inside instruments and in specimens under study. The coordinates of the inclusion under investigation in the isothermal field can be determined, so the temperature of the inclusion is measured quite accurately, with a maximum error of a few percent.

3. It is suggested to prepare reference specimens in a calibration platinum heating chamber specially designed at IGEM, USSR Academy of Sciences. The standards may consist of plates of various minerals with inclusions having stable and clearly defined homogenization points, after determination of their homogenization temperatures in the calibration chamber. Such standards permit any operational heating chamber to be calibrated. (Authors' abstract).

GROSHEV, A.K. AND TURCHINSKIY, V.P., 1973, Tectonic and temperature regime of origin of a beryllium-bearing stock: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 65-66 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Inst. of Geology of Kirgiz SSR, Geological Board of Kirgiz SSR.

The stock occurs in a mass of green amphibole schists, gneisses, and consists of beryllium-bearing orthoclase-albite veinlets, and rarely of metasomatites of biotite of quartz-sericite.

The mineralization occurred in two stages; each began with beryllium mineralization and closed with a barren quartz-fluorite-calcite association.

The main Be mineral-phenacite-occurs in two generations in agreement with the above. The generations differ in morphology, some physical features and in trace elements. Phenacite I occurs with beryl, phenacite II, - with bavenite, milarite and bertrandite.

Crystallization temp. of phenacite I ranges from 390 to 380°C, phenacite II - 420-400°C, beryl - 370-260°C, bavenite and milarite - 370-350°C. The temperature range of mineral formation of stage I is 390-220°, stage II - 425-60°C. The highest temps. were noted at the beginning of stage II. The sudden increase of temp. of stage II solutions by 200°C was significant in their renovation. (Authors' abstract)

GULYAEV, A.P., MIROSHNICHENKO, L.A. AND CHUMACHENKO, P.M., 1971, On the possible form of tungsten transport in important stages in the origin of a rare metal deposit in Kazakhstan, p. 109-115, in Mineralogy and geochemistry of tungsten deposits (Materials of 2nd All-Union Symposium on Mineralogy, Geochemistry and Genesis of Tungsten Deposits of USSR): Leningrad, Leningrad Univ. Publishing House, 344 pp. (In Russian; abstract through the courtesy of A. Kozlowski). Authors at Inst. of Geological Sciences, Academy of Sciences Kazakh SSR.

The deposit is of skarn-greisen type (or so called apocarbonate-greisen type). It occurs in Cambrian metasedimentary rocks (schists, limestones, & dolomites) cut by large dike-like body of fine-grained granites of high silica-acidity and alkalinity, being probably the apical part of hidden intrusive. The ore bodies are greisens, veins and impregnation zones. The ore minerals are wolframite and cassiterite, in limestones, accompanied by near-vein mica-fluorite greisens with chrysoberyl. The veins contain topaz, and feldspar, fluorite, tourmaline, sericite, scheelite, pyrite, stannite, etc.

The skarns formed at high temp., 400-380°C, as indicated by deprepitation analysis of vesuvianite. The most important process of deposit formation there was the greisenization process. Decrepitation analysis proves that near-vein greisens formed at lower temps. (T_d of quartz 350-320°C) than near-fracture greisens (T_d of quartz 380-360°C).

In the solutions, tungsten was transported independent of Sn^{+4} Be^{+2}, Al^{+3}, and it was transported with K^+, Li^+, F^- & OH^-, probably as $K_2(WO_2.F_4)$, $K_2(WO_3.F_2)$, $K_3(WO_2.F_5)$, $K_2(W(OH)_n.F_{8-n})$, and $K_2(W(O,OH)_n.F_{8-n})$.

GUNIAVA, V.D., 1973, Temperature conditions of formation of greisens and secondary quartzites from Adzharia: Abstracts of papers at Fourth

Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 249 (in Russian; translation through the courtesy of A. Kozlowski). Author at Caucasian Inst. of Mineral Raw Materials, Tbilisi.

Greisens and secondary quartzites are developed in the SW part of Adzharo-Trialetskaya structural-metallogenic zone. Products of acid dissolution of rocks occur at external and internal side of the contact of subvolcanic syenite-dioritic intrusives, cutting a middle Upper-Eocene volcanogenic complex of trachy-andesite composition.

Investigations of T conditions of individual facies of metasomatites by homogenization and decrepitation methods have given following results;

1) T_D in °C of typomorphic minerals of vein greisens: tourmaline 460-420, pyrite 420-360, quartz 440-380; T_H of secondary and pseudosecondary inclusions in quartz 320-290°C.

2) T_D of quartz and pyrite from equant greisen bodies 390-360 and 380-360°C, respectively.

3) T_D of quartz from secondary, halogene type quartzites 320-280°C.

4) T_D of quartz from secondary, sulfuric acid type quartzites 280-230°C.

(...) (Author's abstract, abbreviation by A.K.)

GUNTER, B.D., 1973, Aqueous phase-gaseous phase material balance studies of argon and nitrogen in hydrothermal features at Yellowstone National Park: Geochimica et Cosmochimica Acta, v. 37, pp. 495-513. Author at Southwestern State College, Weatherford, Oklahoma.

Quantitative analyses of aqueous phases and gaseous phases, gas flow rates, aqueous flow rates have been performed at twenty-five hydrothermal springs at Yellowstone National Park. Material balance calculations indicate that the inventory of argon and nitrogen in these features can be explained very well in terms of a ground water distillation model. The average rate for the release of nitrogen by both phases is 9.06 micromoles of nitrogen per mole of water discharged, and the average rate of release of argon by both phases is 0.248 micromoles of argon per mole of solution. A Rayleigh type distillation is considered in these calculations, and the distribution of argon and nitrogen between the aqueous and gasesous phases approaches equilibrium in most of the features. It is noted that these data are valid for these samples only at the time of emergence. There is no evidence for the addition of juvenile argon or nitrogen to the atmosphere by these springs at the present. (Author's abstract)

GUNTER, William D., FRANTZ, John D., & EUGSTER, Hans P., 1973, Mineral solution equilibria in the system $K_2O-MgO-Al_2O_3-SiO_2-H_2O-HCl$ (abst): Amer. Geophys. Union, Trans. (EOS), v. 54, no. 4, p. 487.

HALL, W.E., FRIEDMAN, Irving, and NASH, J.T., 1973, Fluid inclusion and light stable isotope study of the Climax molybdenum deposits, Colorado (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 5, no. 7, p. 649-650. First author at U. S. Geological Survey, Menlo Park, CA 94025.

Three molybdenite ore bodies and a late barren stage at the Climax mine are each related to a different intrusive phase of the Climax stock. Alteration zones spatially related to molybdenite ore bodies include an underlying silica zone, an approximately coincident K-silicate zone, and overlying greisen, sericitic, and argillic zones. All quartz and muscovite, and most sericite, are in equilibrium with water with a calculated $\delta^{18}O$ at 350°C of +3.0 to +5.6‰. $\delta^{18}O$ values of K-feldspar range from +7.2 to -4.5‰. This wide range indicates recrystallization of feldspar with isotopically light water. Calculated δD of water in equilibrium with sericite at 275°C is -92 to -144. This is the same range as δD of fluid inclusions in ore. Kaolinite in the argillic zone has $\delta^{18}O$ values of -0.9 to -2.2 and δD values of -16.2‰. Calculated water in equilibrium with kaolinite at 250°C has $\delta^{18}O$ values of -5 to -6.2 and δD of about -130‰. All temperatures were selected on the basis of homogenization temperatures of fluid inclusions in quartz. A plot of salinity versus δD of fluid inclusions trends from 18% equivalent NaCl and $\delta D = 92$‰ for early ore to <1% equivalent NaCl and $\delta D = 145$‰ for late mineralization.

The isotopic and fluid inclusion data best fit a model whereby the Climax ore bodies were formed from a hydrothermal system in which there was progressive mixing of heavy and light water. The light water in the late stages resembles present day meteoric water. The heavy (early) water may be magmatic or a heavy meteoric water. The latter possibility requires a change in meteoric water composition during the formation of the deposit. (Authors' abstract)

HANOR, J.S., 1973, The role of in situ densities in the migration of subsurface brines (abst.): Geol. Soc. America Abstracts with Programs, v. 5, no. 7, p. 651-652. Author at Dept. of Geology, Lousiana State Univ., Baton Rouge, Louisiana 70803.

Fluid inclusion studies have suggested that sedimentary brines were important constituents of the ore-forming fluids that produced Mississippi Valley Type ore deposits. A fundamental problem, however, is finding a mechanism by which such brines could have been driven up from the depths of a sedimentary basin into the tectonically elevated sites of ore deposition.

Using P-V-T-X data for NaCl solutions, in situ densities were calculated for subsurface waters in the Gulf Coast, Illinois, Alberta, and Michigan basins. It has been found that the increase in salinity with depth for most waters in each basin is just sufficient to counteract the tendency of increasing temperature to reduce brine densities. Water compositions have thus evolved in such a way as to produce a gravitationally stable column of fluid within each basin. Density gradients decrease with depth, however, and approach zero in the deeper parts of the basins. It is possible, therefore, that even minor changes in the heat flow regime of a basin or more local sources of heating at depth, such as intrusive igneous activity, would be sufficient to produce a gravitationally buoyant mass of heated, saline water. This gravitational instability could be effective in causing the upward migration of deep waters. The excess heating necessary to produce gravitational instability is consistent with the fact that apparent temperatures of ore deposition in Mississippi Valley Type deposits often exceed basin temperatures which could have been generated in normal geothermal gradients. (Author's abstract)

HARE, P.E., 1973, Quaternary diagenesis of amino acids (abst): Geol. Soc. Amer. Abstracts with Programs, v. 5, no. 7, p. 652. Author at Geophysical Laboratory, 2801 Upton St., N.W., Washington, D.C. 20008.

Reactions of amino acids observed in samples of Quaternary age include deamination and decarboxylation to form the corresponding fatty acids, amines, and hydrocarbons as well as ammonia and carbon dioxide.

Also observed are racemization (and epimerization) reactions to form increasing amounts of the D-amino acid isomers. Amino acids also react with carbohydrates to form products similar to humic acids and kerogen.

A study of the amino acids in several deep sea cores shows that amino acids may react in different ways and at vastly different rates depending on the sediment fraction with which the amino acids are associated. Amino acids in the carbonate tests of Foraminifera from a Quaternary sediment showed extensive racemization while the amino acids in the clay fraction showed extensive deamination but little or no racemization.

A study of the amino acids in Quaternary fossils and in the various sediment fractions of Quaternary sediments gives information on the age of the sample, possible reworking of older fossil materials, temperature history, and the significance of amino acid diagenesis to such problems as the origin and development of more stable organic materials present in the sediment. (Author's abstract)

HARKER, R.S., 1973, Fluorite with cassiterite [in the tin-tungsten deposits of Cornwall and Devon, England]: Mineralogical Record, v. 4, no. 2, p. 94-95.

Fluid inclusion homogenization temperatures (uncorrected) are given for fluorite from the South Crofty mine of 310-335° (14 level,green) and 237-264 (15 level,purple). Fluorite from 10 level gave 357-377°C (inner green) and 317-347°C (outer purple). Inclusions (in fluorite?) from the Cu-Pb-Zn mine at Menheniot, Cornwall, gave 99-150°C. (ER).

HEKINIAN, R., CHAIGNEAU, M., and CHEMINEE, J.L., 1973, Popping rocks and lava tubes from the Mid-Atlantic rift valley at 36°N: Nature, v. 245, p. 371-373.

Dredge samples from 1360 fathoms decrepitated and jumped up to 100 cm, with a loud noise, for up to 3 days after recovery. The material is fresh glassy olivine basalt. Gas analyses made of this and the non-popping glassy margin of a pillow lava show major amounts of HCl, CO_2, CO, SO_2, and H_2 and minor to trace amounts of H_2S, CS_2, N_2 and hydrocarbons. Rapid quenching from >1100°C on extrusion at oceanic pressures of 250-300 bars is presumed to have precluded loss of the gas in the popping samples. (ER)

HENLEY, R.W., 1973a, Solubility of gold in hydrothermal chloride solutions: Chemical Geology, v. 11, pp. 73-87. Author at University of Otago, Dunedin, New Zealand.

The solubility of gold has been determined in chloride solutions in the temperature range 300-500°C corresponding to the inferred range for the formation of "hypothermal" gold deposits. The solutions were buffered with respect to HCl by a K-feldspar--muscovite--quartz assemblage, and to oxygen by the assemblage hematite-magnetite. Solubilities increased rapidly with temperature from about 10 p.p.m. at 300°C, to 500 and 1000 p.p.m. at 500°C at 1000 and 2000 bar, respectively.

These results are discussed in terms of possible solution species in this high-temperature region where molecular behaviour predominates in the solution equilibria. It is suggested that gold and other metals may be transported to the site of ore-deposition in undersaturated high-temperature solutions. Ore deposition may take place at lower temperatures where ionic gold chloride or sulfide species dominate the chemistry of the ore solutions. (Author's abstract)

HENLEY, R.W., 1973b, Some fluid dynamics and ore genesis: Inst. Min. Metallurgy, Trans., v. 82, sect. B, p. B1-B8. Author at Geology Dept. University of Otago, Dunedin, New Zealand.

Hydrothermal ore deposits are the fossil remnants of former fluid flow systems in the earth's crust, and their present-day analogues are the geothermal systems which occur in New Zealand, Japan, Mexico, etc. The physical characteristics of such systems are discussed, and it is shown that free convection of fluid is the heat- and mass-transfer process which operates in these areas. The components of geothermal systems are compared with a scheme for hydrothermal ore genesis, and some convective models are discussed which may apply to the range of conditions which have governed the formation of orebodies. An order of magnitude calculation shows that ore genesis at Morro Velho, Brazil, involved very high Rayleigh number convection. Some corollaries of the convective schemes concern the origin of pipe-shaped orebodies and the spatial distribution of lode deposits. (Author's abstract)

HEYL, A.V., LANDIS, G.P., & ZARTMAN, R.E., 1973, Isotopic evidence for the origin of Mississippi Valley-type mineral deposits: a review (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 5, no. 7, p. 668-669. Authors at U.S. Geological Survey, Denver, Colorado 80225.

Isotopic and geochemical data available from Mississippi Valley-type ore deposits place significant constraints on models of ore genesis. Lead from galena of all large deposits in the Mississippi Valley is appreciably enriched in radiogenic isotopes compared to the more ordinary lead of most other localities. Such data have generally been interpreted as signifying a shallow crustal source for the lead, from underlying Precambrian basement rocks and/or from Paleozoic sandstone and carbonate rocks. In detail, each district has a distinctive regional isotopic pattern that reflects direction of solution flow, hidden heat sources, and areas of localization of major deposits. Mafic dikes in Illinois and western Kentucky are spatially associated with ore deposits; their strontium isotopic composition is suggestive of a mantle derivation. Published fluid-inclusion filling temperatures and δS^{34} of sulfide mineral pairs, and δO^{18} and δC^{13} of limestone and dolomite indicate very small isotopic alteration halos adjacent to ore bodies. Ore fluids typically exhibit temperatures from 160° to 70°C and salinities in excess of 20 wt. % soluble salts. Temperature, δD, δO^{18}, and chemistry of fluid inclusion waters indicate that main ore fluids in many deposits probably were deep-circulating formation brines. δS^{34} data suggest derivation of sulfur from connate sea-water sulfate (or evaporites) and reflect low-temperature isotopic disequilibrium fractionation between reduced and oxidized sulfur species; the occurrence of sulfur isotopic disequilibrium prohibits recognition of exact sulfide precipitation mechanisms. These isotopic, fluid-inclusion, and chemical data indicate that (1) the main ore fluids were heated oil-field brines having largely a crustal source for lead and sulfur, and (2) regional disturbances, probably of lower crust-mantle origin, initiated large hydrologic systems that produced Mississippi Valley-type mineralization. (Authors' abstract)

HOAGLAND, A.D., 1973, Appalachian zinc-lead and the deposits of Middle Tennessee (abst.): Geol. Soc. America Abstracts with Programs, v. 5, no. 5, p. 404. Author at The New Jersey Zinc Company, Murfreesboro, Tennessee 37130.

Appalachian zinc-lead deposits are structurally deformed counterparts of the Mississippi Valley type. The significant mineralization is epigenetic and pre-orogenic. Primary permeability resulted from paleophysiographic and sedimentary phenomena such as karstification, reefs, etc. The ore fluids were warm Na-Ca-Mg-Cl brines carrying base metal ions. It is probable that the brines were derived from thick geosynclinal or basinal argillaceous sediments. These fluids invaded the permeable zones of accessible carbonate strata enhancing permeabilities by dissolution and alteration of limestone.

It is hypothesized that the ore minerals were deposited as a result of mixing with a second fluid system charged with H_2S. Ore deposition required that at least three conditions persisted over long periods of time: (1) continued replenishment of both fluid systems to provide adequate supplies of metal and sulphur, (2) continued dissolution and alteration of limestone to maintain permeability in the zone of deposition, and (3) a relatively constant hydrostatic balance between the two fluid systems to confine the zone of mixing within a relatively narrow vertical range and insure an adequate concentration of sulphide deposition.

A model for the Middle Tennessee deposits is suggested in which brines from the thick Middle Ordovician shales of the Appalachian geosyncline are introduced into the extensive karst system of the Lower Ordovician Knox and driven to depositional sites on the shelf areas of East and Middle Tennessee where adequate supplies of H_2S are assumed to have been present during the post Lower Ordovocian Paleozoic. (Author's abstract)

HOARE, J.M., and CONDON, W.H., 1973, Lherzolite xenoliths in tholeiite, Nanwaksjiak Crater, Nunivak Island, Alaska (abst.): Geol. Soc. America Abstracts with Programs, v. 5, no. 1, p. 55. Authors at U.S. Geological Survey, Menlo Park, California 94025.

Deformed and recrystallized lherzolite xenoliths of probable mantle origin occur in blocks of olivine tholeiite thrown out of Nanwaksjiak Crater on Nunivak Island, Alaska. The crater was excavated by a very violent eruption of gas-rich highly alkalic ash. The shape, size, and limited distribution of the blocks of lherzolite-bearing tholeiite indicate that they probably derive from a small body of rock that was intruded at shallow depth beneath the crater. It is assumed that the intrusion was facilitated by the gas-rich eruption which formed the crater, for lherzolite xenoliths are unknown in the less alkalic basalts elsewhere on Nunivak Island and are unreported elsewhere in the world. The occurrence of ultramafic xenoliths in basalts is governed by several factors, the most critical of which is probably the ability of the basalt magma to transport such dense material. It is suggested that ultramafic xenoliths are common in highly alkalic basalts because these basalts are relatively gas-rich and consequently rise rapidly and erupt violently. Ultramafic xenoliths are generally lacking in less alkalic basalts because they are relatively gas-poor, rise slowly, and erupt passively. The unusual occurrence of lherzolite in tholeiite at Nanwaksjiak Crater appears to support this hypothesis. (Authors' abstract)

HODGES, F.N., 1973, Solubility of water in silicate melts at high pressure (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 5, no. 7, p. 671. Author at Geophysical Laboratory, 2801 Upton Street, N.W., Washington, D.C. 20008.

The high-pressure solubility of water in simple (monomineralic) silicate melts is, to a large extent, a function of pressure (^PH_2O) and the number of oxygen atoms available in the silicate structure. The solubility of H_2O in forsterite (Mg_2SiO_4) melt at 20 Kb. is 20.2 ± 1.0 wt. % (1425 ± 10°C). This value (66 mole %) is equivalent to approximately 0.5 mole of water (H_2O) per formula oxygen. Values for solubility of H_2O in albite ($NaAlSi_3O_8$), enstatite ($Mg_2Si_2O_6$) and diopside ($CaMgSi_2O_6$) melts at 20 kb. (Eggler, 1973) are, within the limits of experimental error, identical to the value for forsterite when calculated on a per formula oxygen basis (0.5 mole H_2O/formula oxygen). Solubility values at 10 kb. for H_2O in enstatite (Kushiro and Yoder, 1969) and anorthite (Yoder, 1966) are, on a per formula oxygen basis, identical within the limits of experimental error; yielding a value of approximately 0.24 mole H_2O per formula oxygen. Preliminary data at 30 kb. indicate that the rate of increase of solubility decreases with increasing pressure. Although the data presented is for simple melts, its consistency for a wide range of rock forming silicate minerals indicates that it can be used to calculate the solubility of H_2O in complex natural magmas under conditions of the upper mantle. (Author's abstract)

HOLGATE, Norman, 1973, Dichroic pigment-layers in Blue John fluorite: Mineralog. Mag., v. 39, p. 363-365. Author at Dept. Geol., Univ. Glasglow, Scotland G12 8QQ.

The various coloring mechanisms that have been proposed are reviewed; H objects to the suggestion of colloidal calcium since this is an isometric structure and the coloring is dichroic. H suggests hydrocarbons as the most likely. (E.R.) (Editor's note: see also Braithwaite et al, this volume; the mechanism of formation is important in understanding the various inclusions in these materials.)

HOLLISTER, L.S., 1973a, The Khtada Lake (British Columbia) metamorphic complex: the role of CO_2 - rich fluid inclusions (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 5, no. 7, p. 672. Author at Department of Geological and Geophysical Sciences, Princeton University, Princeton, N.J., 08540.

Granulite facies rocks occur with plutonic rocks of the Coast Range Batholithic Complex, 80 km east of Prince Rupert. Metamorphic mineral assemblages suggest temperatures exceeding 700°C at a depth greater than 15 km. The "primary" fluid inclusions (solitary or clusters without geometric pattern) in quartz in the granulite facies rocks, associated amphibolite facies rocks, and associated biotite-hornblende-quartz dioritic rocks ($\sim$250 measurements in 15 inclusion-bearing specimens) are predominantly nearly pure CO_2 (m.p. $\approx$ -57°C, apparent density 0.7 to 0.9 gm/cm^3, solid hydrate melts between +7 +10°C). The homogenization temperatures (to liquid) of the CO_2 can vary within a single quartz grain by as much as 19°C. CO_2-H_2O mixtures, with more than 20 volume per cent of H_2O, occur in only two specimens. H_2O-rich secondary inclusions (m.p. -0.5 to -3°C) typically occur in planes, often associated with planes of low density, secondary inclusions (0.1 to 0.75 gm/cm^3). Rare "primary" hydrous inclusions (m.p. -3 to -14°C) occur with some of the more abundant "primary" CO_2 inclusion clusters. Indirect evidence for the presence of hydrocarbon compounds in some inclusions is suggested by final melting temperatures of -60 to -65°C, preceded by a melting interval of a few degrees (homogenization temperatures (liquid) of these inclusions are between +2°C and -14°C).

Possible interpretations of these data for the Khtada Lake area are (1) the fluid phase, during metamorphism, separated into immiscible CO_2-rich and H_2O-rich phases; (2) the fluid phases re-equilibrated at several stages during uplift along a geothermal gradient between 50 and 65°C/km; (3) the immiscibility was probably facilitated by the presence of hydrocarbon compounds and dissolved solids in the fluid phase. Immiscible fluid phases,due to differences in solubilities of components in the two phases, may be a contributing factor to the development of some common textural features in metamorphic rocks, such as gneissocity and veining. (Author's abstract)

HOLLISTER, L.S., 1973b, Immiscible fluid phases during metamorphism, Khtada Lake area, British Columbia (abst.): Amer. Geop. Union, Trans. (EOS), v. 54, no. 11, p. 1225. See previous abstract.

HORN, R.A. & WICKMAN, F. E., 1973, The Na/K ratio of fluid in pegmatitic quartz and its genetic implications. A study by neutron activation analysis: Lithos, v. 6, pp. 373-387. Authors at Pennsylvania State University, University Park, Pa. 16802

Samples of quartz and its fluid inclusions (f.i.) from Black Hills pegmatites and from graphic granites were analyzed for Na, K, Rb and Cs by neutron activation analysis. The Na/K ratios of the whole quartz and its f.i. seem unrelated. The spatial locations for six samples from the Helen Beryl pegmatite were known. The Na/K ratios of their f.i. are mainly a function of their vertical positions in the pegmatite. The ratios of the central-ore quartz f.i. seemingly indicate a much higher temperature than those closer to the upper wall. This is consistent with the theory of pegmatite genesis by Jahns & Burnham. The f.i. of quartz from two graphic granites give very different Na/K ratios, seemingly related to differences in their formation history. (Authors' abstract)

HUANG, Liang-Wuu, and WYLLIE, Peter J., 1973, Melting relations of muscovite-granite, with application to anatexis in the crust and subduction zones (abst): Amer. Geophys. Union, Trans. (EOS), v. 54, no. 4, p. 481.

HUGHES, T.H., and LYNCH, R.E., Jr., 1973, Barite in Alabama: Geol. Survey Alabama Circular 85.

Includes some studies of fluid inclusions and the origin of the deposits (p. 20-23), including a brief mention of the design of a circulating fluid heating stage. Fluorite associated with barite from the Weaver property, Bibb County, had T_H for primary incs. = 73-91°C; secondary 28-40°C. The deposits are epigenetic, strata-bound, and low-temperature, and formed between stages of the Appalachian orogeny. (E.R.)

IKORNIKOVA, N. Yu., and EGOROV, V.B.,1968, Experimentally determined PTFC diagrams of aqueous solutions of Li, Na, K, and Cs chlorides, in Hydrothermal Synthesis of crystals, A.N. Lobacher, ed: Moscow, "Nauka" Press, (in Russian; translated by Consultants Bureau; 1971, p. 34-51).

Detailed data are given on the systems listed, including data on the system NaCl-H_2O at 60, 70, 80, and 90% filling; P 160-2680 Kg/cm^2; T 190-770°C; and concentrations of 1-6 molal. These data presented differ significantly from those of Lemmlein and Klevtsov, (1961), that are normally used for calculating pressure corrections for homogenization temperatures, because more complete corrections were made for thermal expansion in the later work. The differences result in differences in pressure corrections at up to ∿20°C. (ER).

IKORSKIY, S.V., 1973, Extraction of bitumens from inclusions in minerals by heating: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 305-306 (in Russian; translation provided through the courtesy of A. Kozlowski). Author at Geol. Inst. of Kola Division of Acad. Sci. of USSR, Apatity.

1. Extraction of bitumen is performed in an apparatus consisting of ampoule (pyroxene, quartz) (sic.) with a tube of small diameter having at the end a small glass bulb bearing a desiccant and an empty glass bulb (100-500 ml). Before heating the apparatus is evacuated. A horizontal tube electric furnace is used for heating.

2. On breaking of the inclusions the vapors of the bitumens move toward the vacuum bulb of the apparatus and precipitate on the cold walls of the tube at its connection with the furnace. Temperature is controlled by observation of the precipitates having luminescence in UV light (sic). When the heating is finished, this part of the tube is cut out for investigations on the bitumen.

3. This method provides a solution to the following problems: a) to ascertain the presence of bituminous substance in minerals when its amount in the mineral is low: 0.00n% from a sample of 15-20g; b) by comparison of the temperatures of escape of bituminous vapors with thermometric data one may determine the type of inclusions bearing bituminous substances; to study temperature of alteration of bitumens in the inclusions.

As illustrations, some data are given from investigations of bituminous inclusions in minerals of alkaline rocks.(Author's abstract)

IKORSKY, S.V., and POLYAKOV, A.I., 1973, Results of an investigation of gases in magmatic rocks of East African rift zones: Geokhimiya, 1973, no. 6, p. 816-823 (in Russian; translated in Geochem. Internat., v. 10, no. 3, 1974, p. 620-626). First author at Geological Institute of the Kola Branch of the USSR Academy of Sciences, Apatity.

The content of gases in Neogene-Quaternary magmatic rocks from East African rift zones varies from 0.03 to 2.31 cm^3/kg of the rock. Extraction of gases was carried out by crushing the rock in evacuated ball mills. Determinations (43 samples) were chiefly made for effusive rocks of the Eartern rift zone. Saturated and unsaturated hydrocarbons, hydrogen, CO and CO_2 have been established in gas samples. A slight enrichment in hydrocarbon gases of volcanic rocks having been formed by crystallization of primary mantle melts is noted in comparison with effusive rocks arising during crystallization of residual melts. (Authors' abstract).

INGERSON, Earl, 1973, Review of "Composition of Fluid Inclusions", U.S. Geol. Survey Prof. Paper 440JJ: Amer. Mineral., v. 59, 1974, p. 1340.

IRVING, A. J. & WYLLIE, P. J., 1973a, Melting relationships in CaO-CO_2 and MgO-CO_2 to 36 kilobars with comments on CO_2 in the mantle: Earth and Planetary Science Letters, v. 20, pp. 220-225. Authors at University of Chicago, Illinois, 60637.

The melting curves of $CaCO_3$ and $MgCO_3$ have been extended to pressures of 30 kb by experiments in piston-cyclinder apparatus. At 30 kb, the melting temperatures of calcite and magnesite are 1610° and 1585°C, respectively. New data for the magnesite dissociation reaction permit the location of an invariant point for the assemblage magnesite + periclase + liquid + vapor near 26 kb-1550°. New data are also presented for the calcite-aragonite transition at 800°C, 950°C and 1100°C. At pressures above 36-50 kb, calcite and magnesite melt at temperatures lower than the solidus of dry mantle peridotite. Natural and experimental evidence suggests that carbon dioxide in the Earth's mantle could be present in a variety of forms: (a) a free vapor phase, (b) vapor dissovled in silicate magma, (c) crystalline carbonate, (d) carbonate liquid (e) carbon-bearing silicate analogs, or (f) carbonato-silicates (such as scapolite, spurrite, tilleyite, and related compounds). (Authors' abstract)

IRVING, A.J., and WYLLIE, Peter J., 1973b, Melting relationships in $CaO-MgO-CO_2$ compared with the solidus for mantle peridotite (abst.): Amer. Geophys. Union, Trans. (EOS), v. 54, no. 4, p. 479.

IVANOVA, G.F. AND STUDENIKOVA, Z.V., 1971, Physico-chemical characteristics of conditions of origin of greisen wolframite deposits (E. Transbaikalia), p. 122-130, in Mineralogy and geochemistry of tungsten deposits (Materials of 2nd All-Union Symposium on Mineralogy, Geochemistry and Genesis of Tungsten Deposits of USSR): Leningrad, Leningrad Univ. Publishing House, 344 pp (In Russian; abstract through the courtesy of A. Kozlowski). Authors at Institute of Geochemistry and Analytical Chemistry, Acad. of Sciences USSR, Moscow.

Deposits were investigated in the districts of Khangilay-Shily, Durulguy, Zun-Undur, Soktuy, Aldakachan, and Antonova Mt. The most common of vein ore bodies, with quartz and wolframite, were studied by thermobarometric methods. All inclusions in minerals homogenize in the liquid phase, proving the hydrothermal origin of ores. Decrepitation temp. of wolframites from a number of deposits range from 240 to 330°C, and those of quartz - 200-330°C. $T_{hom.}$ of inclusions in quartz were 240-302°C. Taking into account corrections for pressure, the real crystallization temp. did not exceed 400°C. Pressure at one of deposits (Spokoyne) was about 1650 atm. The main components of inclusions (water leachate method) are as follows: Na (5.1), K(4.4), Ca (3.1), Cl (5.9), F (2.5) gm/l, and varying amounts of CO_2. Ionic strength of solutions varies from 0.29 to 0.76, mean 0.60, and the general concentration was 3-4 wt %. Values of pH for 300°C range from 6.35 to 7.08. The most probably form of tungsten under hydrothermal conditions is H_2WO_4, and partly HWO_4^-; polytungstate ions, such as $HW_6O_{21}^{5-}$, are less probable ones. The authors discuss the possibility of oxyfluoride- and thio-complexes of tungsten at temp. about 300°C. Calculated activity $a_{Fe}{+2}$ was not lower than 2.8×10^{-11} gram-ion/liter = 1.5×10^{-6} mg/liter and $a_{WO4}{2-}$ not $<6 \times 10^{-8}$ gram-ion/liter, when $a_{Ca}{2+}$ was equal 10^{-6} gram-ion/l, permitting precipitation of wolframite rather than scheelite.

(Authors abstract)

IVASIV, S.M., 1973, Physico-chemical conditions of formation and temperature zoning of the Itakinskoe gold-ore deposit: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 274 (in Russian; translation provided through the courtesy of A. Kozlowski). Author at L'vov Univ.

Geological-mineralogical (Mel'nikova, 1970) and mineralthermometric (Ivasiv, 1970) studies prove that the Itakinskoe deposit belongs to the polystage pneumatolytic-hydrothermal type, formed under high-, moderate-, and low-temp. conditions. Development of ore may be divided into 2 stages: a) pneumatolytic-hydrothermal; and b) hydrothermal. To stage a) the quartz-molybdenite (420-360°C) and quartz-tourmaline (430-340°C) substages belong; to stage b) quartz-arsenopyrite (310-230°C), quartz-polymetallic (300-220°C), quartz-antimonite (220-150°C) and quartz-carbonate (180-110°C). Results of mineralthermometric mapping (by means of homogenization of inclusions in quartz from associations with gold, and polymetallic sulfides) prove that temp. of origin of ores increase with depth (average values 15-20°C/100m) and from W toward E (5-10°C/100m). At the boundary of blocks, in a fault zone, a sudden T increase (30-40°C in 15-20 m) was ascertained, as a result of post-ore disruption of the temperature regime.

These peculiarities suggest two types of zoning: from pulsation (i.e., stages) and zoning during precipitation.(Author's abstract)

JACKSON, Herman, 1973, Metamorphic pore fluid composition at Marble Canyon, Texas (abst.): Geol. Soc. Amer. Abstracts with Programs, no. 3, p. 263-264. Author at Department of Geology, Northeast Louisiana University, Monroe, Louisiana 71201.

Contact metamorphism of dolomite at Marble Canyon, Texas, in the eastern margin of the Diablo Plateau, has produced a bleached aureole of brucite marble. Dolomite was decomposed by the reaction: dolomite = calcite + periclase + CO_2. The periclase subsequently hydrated to both the familar "onionskin" brucite as well as parallel aggregates of platy brucite. Individual platelets in the parallel aggregates of brucite are parallel to the intrusive contact and are presumed to have formed before cessation of magmatic movement and contact metamorphism.

Calculated equilibrium curves for reactions in the system MgO-CO_2-H_2O indicate that hydration of the periclase occurred in a fluid of mole fraction $H_2O \geqslant 0.95$. Because periclase hydration occurred before the end of the metamorphic episode, it is concluded that the metamorphic pore fluid was similar. This conclusion is somewhat surprising in view of the rather large amount of CO_2 liberated in decomposition of dolomite and leads inescapably to the conclusion that the fluid composition in the rock being metamorphosed was externally controlled. I believe the fluid composition was controlled by aqueous fluid expelled from the crystallizing granitic magma.

Calculations show that the aqueous fluid (steam) expelled from a granitic magma may be sufficient in volume to completely flush the pore space of a contact aureole such as that at Marble Canyon as many as one-hundred times.(Authors' abstract)

JACKSON, Kern C., 1973a, Ocelli in lamprophyre dikes, Benton Quadrangle, Arkansas (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 5, no. 3, p. 264-265. Author at Department of Geology, University of Arkansas, Fayetteville, Arkansas 72701

Ferguson and Currie(1971) describe carbonate-silicate ocelli from monchiquite and camptonite dikes from Callander Bay, Ontario. These are interpreted by them to represent immiscible liquids. Similar ocelli are found in lamprophyre dikes from Benton Quadrangle, Arkansas. The ocelli contain dominant calcite and analcite with minor nepheline, sphene, and aegerine. The host rocks include ten different rock types (Johannsen classification) and various combinations of augite, aegerine-augite, aegerine, titanaugite, green and brown amphibole, biotite, olivine, melilite, analcite, calcite, nepheline, feldspars, sodalite, ores, apatite, sphene, and perovskite as primary minerals. Primary calcite and analcite are common to all. This seems too wide a range of compositions for immiscibility. Sphene dendrites extend across ocelli and indicate gravitative settling in a low viscosity fluid. It is suggested that ocelli crystallized from a condensed gas phase (oxalates, carbonyls, hydrides and halides suggested). A miarolitic syenite at Sweet Home, Arkansas contains a suite of carbonate, anacite, zeolites, and fledspars in the cavities. Also in the quadrangle is the Benton Breccia, a gas fluidized explosion pipe. Thus there is abundant other evidence of high gas activity in the comagmatic region. (Authors' abstract)

JACKSON, K. C., 1973b, Miarolitic cavity minerals in syenite, Sweet Home, Arkansas (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 5, no. 3, p. 264. Author at Dept. of Geology, Univ. of Arkansas, Fayetteville, Arkansas 72701

Miarolitic cavity lining crystals were studied from the Big Rock Stone and Materials Company Quarry, Sweet Home, Pulaski County, Arkansas. Vugs occur in porphyritic microsyenite and in pegmatitic pulaskite. In microsyenite, vug walls are euhedral extensions of wall rock albite, biotite, and sphene with coating of albite, pyrite, and analcite. Apophyllite, thompsonite, natrolite, pectolite and calcite follow analcite as euhedra. Minor minerals are diopside, apatite, gypsum, fluorite and anatase (?). Aegerine of the wall rock was converted to riebeckite. Pegmatitic pulaskite vug walls are euhedral extensions of albite, biotite, aegerine, and analcite. These are succeeded by second generation albite, analcite, and aegerine plus later natrolite and apophyllite. Minor early vug minerals are fluorite, astrophyllite, eudialite (?) and apatite. Minor late minerals pectolite and calcite. Capillary aegerine is the last mineral in all vugs of the pegmatite. Beautiful mega- and microcrystals are available of albite, analcite, natrolite, thompsonite, apophyllite, astrophyllite, apatite, aegerine, and sphene and radiating fibrous pectolite. (Author's abstract)

JACOBS, D.C., & PARRY, W.T., 1973, Geochemistry of biotites from porphyry copper deposits (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 5, no. 7, p. 681-682. Authors at Department of Geological and Geophysical Sciences, University of Utah, Salt Lake City, Utah 84112.

Hydrothermal, primary, and altered biotites from igneous rocks associated with the porphyry copper deposits at Santa Rita, New Mexico, Bingham, Utah, and Ely, Nevada have been analyzed by microprobe methods. Biotites from a number of nonmineralized plutons have also been analyzed.

Biotites from mineralized plutons in porphyry copper districts contain more magnesium and less titanium than biotites from plutons not associated with porphyry deposits. Hydrothermal biotite from porphyry copper deposits is highly magnesian. Mole fraction PDoxyannite varies from 0.01 to 0.3 for all biotites analyzed with biotites from porphyry copper deposits generally between 0.01 and 0.05. Temperature estimates based on the techniques of Beane fall in the range 100° to 760° with porphyry copper biotites in the range from 400° to 500°C.

Fluorine content of all biotites analyzed falls in the range 0.5 to 4.0% with porphyry copper biotites containing less than 2%F. Coexisting apatite contains up to 5%F. Temperature estimates based on fluorine distribution between biotite and apatite vary from 100° to over 1100°C.

Chlorine content of all biotites analyzed varies from 0.01 to 0.45%. Biotites from porphyry copper deposits generally contain less than 0.2% chlorine. Chlorine is lost in the transformation biotite to chlorite and primary biotite to hydrothermal biotite. The chlorine content of biotites does not differentiate mineralized from nonmineralized plutons. (Authors' abstract)

JENSEN, M.L., 1973, Mineral exploration and stable isotopes (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 5, no. 7, p. 682-683. Author at Department of Geological and Geophysical Sciences, University of Utah, Salt Lake City, Utah 84112.

One of the newer techniques of mineral exploration and genesis involves the increasing understanding of the causes of natural variations in stable isotopic values of light weight elements.

Those isotopic pairs of primary use are D/H^1, C^{13}/C^{12}, O^{18}/O^{16} and S^{32}/S^{32}. Other pairs of light weight stable isotopes have been studied but with little use to mineral exploration, viz., isotopic pairs of Mg, Si, K, and Ca. And other isotopic pairs that do exhibit variations, but only in a lesser number of minerals, are Li, B, and Cl.

δS^{34} values are influenced by variations in pH, pO2, Eh, T and provenance. If some of these or other factors, such as associated mineral assemblages, paragenetic relations, and geothermomentry data are known, the other more evasive factors can be better established with δS^{34} values. For example, there is significant enrichment of S^{32} in sulfides at Mountain Pass and El Salvador, the former as the result of much less H_2S and SO_2.

δS^{34} values exhibit a 0.2% (sic) enrichment of S^{32} per 1,000 ft. over a distance of 6 miles from the Silver City stock, Tintic Mining district.

δO^{18} isotopic fractionation between coexisting oxygen-bearing minerals decrease with increasing temperatures under specific conditions. Hydrothermal dolomitization extending hundreds to thousands of feet from higher temperature, possibly ore-forming sites, may form three dimensional isopleths of equal δO^{18} values, each indicative of decreasing temperatures. Gilman and Park City exhibit such but Butte shows a reversed trend with δO^{18} values increased in the central zone, the result of factors other then temperature. (Author's abstract)

JOLLY, W.T., 1973, Behaviour of Cu, Zn, and Ni during Prehnite-pumpellyite rank metamorphism of the Keweenawan basalts, Northern Michigan (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 5, no.

7, p. 684. Author at Department of Geological Sciences, Brock University St. Catharines, Ontario, Canada L2S 3A1.

Both copper and zinc were mobilized during prehnite-pumpellyite facies rank metamorphism of the Keweenawan basalts. Zinc was leached from all highly altered rocks in permeable zones and removed. Copper was leached only from epidotized rocks in the lower part of the stratigraphic section, where metamorphic reactions were predominantly dehydrating the parents. In the upper part of the section, where pumpellyite, prehnite, laumontite, and chlorite are the principal hydrous secondary phases (and where metamorphic reactions were predominantly hydrational), copper was introduced into permeable zones. The chemical data suggest that fluids evolved by dehydration at depth contained up to 1780 ppm Cu. These fluids apparently percolated upward toward the zone of hydration, where Cu concentrations of up to about 6000 ppm might have been reached if precipitation had not occurred. The model supplies nearly five orders of magnitude more copper than has been produced by mining. It is possible that metamorphic hydration of volcanic piles may be used as an indicator of mineralization. Nickel was not appreciably affected by the metamorphic process except by dilution of void filling in amygdular lavas. (Author's abstract)

JONES, D. R.H., 1973, The temperature-gradient migration of liquid droplets through ice: Journal of Crystal Growth, v. 20, pp. 145-151. Author at University of Cambridge, Cambridge, England.

Experimental studies have been made of the rates at which liquid droplets-containing solutions of, in turn, NaCl, KCl, and HCl--migrate through ice under the influence of a temperature gradient. Droplet velocities were measured for droplet temperatures of 264 ± 0.5 K, macroscopic temperature gradients of 1.4 to 4.3 kK m^{-1}, and droplet sizes of 4 to 80 μm. In most instances it was shown that droplet migration was almost completely controlled by the transport of solute through the liquid. For example, by analyzing the results on the assumption that of the processes by which the droplet interfaces migrated, that which was rate limiting was a screw-dislocation mechanism, it was possible to show that the appropriate kinetic coefficient was $\gtrsim 10$ mm $s^{-1}K^{-2}$. It was not possible to determine the mechanisms of the interfacial reactions from the quantitative data; but morphological evidence was found to indicate that, in some cases at least, the migration of droplets required the presence of crystal defects. The three different solutes did not cause any selective change in the interfacial kinetics. (Author's abstract)

KADIK, A.A., LEBEDEV, E.B., and KHITAROV, N.I., 1971, The water in magmatic melts: Moscow, "Nauka" Publishing House, 267 pp. (in Russian).

KADIK, A.A., and LUKANIN, O.A., 1973, Behaviour of water and carbonic acid in magmatic processes which is determined by solubility: Geokhimiya, 1973, no. 2, p. 163-179 (in Russian; translated in Geochem. Internat., v. 10, no. 1, 1974, p. 115-129). Authors at V.I. Vernadsky Institute of Geochemistry and Analytical Chemistry, USSR Academy of Sciences, Moscow.

The water and carbonic acid saturation surface of magmatic melts of basic and acid composition have been constructed on the basis of experimental and thermodynamic data. At the same partial pressure H_2O solubility is higher by one order than CO_2 solubility which determines a number of inevitable regularities in water and CO_2 behaviour during the formation of magmas and their further evolution while they are moving towards the surface of the Earth. The change of fluid composition in areas of partial melting of the crust and the upper mantle, the change of water and carbonic acid content in magmatic fluids during the movement of magmas towards the surface of the Earth, carbonic acid influence upon conditions of fluid separation from magmas, the influence of carbonic acid assimilation upon the water content in magmas are considered. It is assumed that in the presence of carbonic acid despite the low water concentration in basic magmas their degassing already begins at great depth which obviously correspond to the lower parts of the crust and the upper mantle. (Authors' abstract)

KADIK, A.A., LUKANIN, O.A., LEBEDEV, Ye. B. and KOROVUSHKINA, E. Ye, 1973, Solubility of water and carbon dioxide in felsic and mafic magmas: Akad. Nauk SSSR, Doklady, v. 210, no. 2, p. 449-451 (in Russian; translated in Doklady Acad. Sci. USSR, v. 210, p. 227-229). Authors at V. I. Vernadskiy Institute of Geochemistry and Analytical Chemistry, USSR Academy of Sciences, Moscow.

Solubility of water and CO_2 in granitic melts was investigated at 1000 and 3000 atm. and 1200°C. (ER)

KAJIWARA, Yoshimichi, 1971, Sulfur isotope study of the Kuroko-ores of the Shakanai No. 1 deposits, Akita Prefecture, Japan: Geochemical Journal, (Japan), v. 4, p. 157-181 (in English). Author at Geological and Mineralogical Institute, Tokyo University of Education, Tokyo, Japan.

Sulfur isotope temperatures obtained from coexisting sulfides give temperatures around 250°C, in good agreement with the maximum value of a temperature range indicated by mineral equilibria studies and previously unpublished homogenization temperatures for barite and sphalerite of black ores (100°-240°C). (E.R.)

KALYUZHNYI, V.A., 1973, Physico-chemical principles of homogenization method of fluid inclusions and phase state determination of mineral-forming solutions (the place of pneumatolysis in the process of formation of minerals): Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 33-34 (in Russian, translation provided through the courtesy of A. Kozlowski). Author at Inst. of Geology and Geochemistry of Fuels, L'vov.

1. (Historical). The extreme cases of crystallization were ascertained: a) easily soluble mineral crystallizes from the highly concentrated medium (e.g. $NaCl-H_2O$), b) slightly soluble mineral crystallizes from a solution bearing easily-soluble salts (silicate-$NaCl-H_2O$). The VTX diagram without critical phenomena is suitable for both cases. Especially interesting is the TX-diagram of P-Q type. Phase changes in primarily homogeneous or heterogeneous inclusions are studied by the use of TX-sections. In all cases the temperature of inclusion homogenization is either lower or equal to the temperature of vacuole isolation. The areas where the homogenization method is not suitable are stated. The essential types (about 40) of phase transitions in the homogenization and heterogenization were studied.

2. The necessary condition for the use of the homogenization method for the determination of temperature as well as pressure and

to ascertain the phase state, is the study not only of individual inclusions, but of syngenetic groups of them.

Theoretical examination of PTX- and VTX-diagrams permits identification of the areas of crystallization as follows: 1) pneumatolytic, subcritical, thermocritical, critical, 2) hydrothermal (subcritical, barocritical, critical). The first made TV-sections (at constant composition) illustrate the fields of pneumatolytic, hydrothermal and pneumatolytic-hydrothermal formation of minerals. On the section of two-component systems and in the case of a one-component system in subcritical conditions, the pneumatolytic and hydrothermal areas are divided by an area of boiling solution (B & L & Q, L & Q); under critical P & T conditions, at the boundary of the above named areas there exists as the curve or surface of critical volumes, obtainable by the inclusion heating method. The premises of division as above one may find in the diagrams of Niggli, Ostrovskiy, and Vul'chin. Other diagrams (A.A. Shternberg, I.N. Govorov) are not suitable because the proposed features for dividing areas are difficult to use.

3. Pnuematolysis in natural processes occurs rarely because of the scarce occurrence of suitable conditions of P & T and the low density of fluids. Pneumatolysis is characterized by the parameters of the field of PT-diagram between the T-axis and curve (area) of two-phase equilibrium lying in agreement with the isochor of critical V. (Author's abstract)

KALYUZHNYI, V.A., NAUMOV, V.B., and MALININ, S.D., 1973, Theoretical foundations and methods of barometry by inclusions in minerals: Program of the Fourth Regional Meeting on Thermobarogeochemistry of Mineral-Forming Processes, at Rostov-on-Don, 24-30 Sept., 1973: Rostov-on-Don, USSR (in Russian). (Part of an inclusion training session ; no abstract in Abstracts volume.)

KALYUZHNYI, V.A., SVOREN', I.M., and PLATONOVA, E.L., 1973, Application of mass-spectrometer MX-1303 for gas analysis of fluid inclusions, and problems in the determination of the amount of hydrogen in inclusions: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 306-307 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Inst. of Geol. and Geochem. of Fuels of Acad. Sci. of Ukrainian SSR, L'vov.

Mass-spectrometer MX-1303 was improved with some additional apparatus. Its sensitivity was increased with an ion counter. The pressure in the filling chamber is measured by vacuummeter VIT-2. Crushing of the sample in vacuum in an electric mortar is automated. Each inclusion analysis is controlled by analysis of a standard gas mixture.

A series of analyses were made to evaluate the accuracy of the method and the reproducibility of the results. As an example, honeycomb quartz bears (in percent) CO_2 - 84±1.2; N_2 - 8.4±2.0; CH_4 - 1.7±0.5; H_2 - 5.3±1.8. Analyses of 11 standard gas mixtures gave the following results: absolute error (%) CO_2 - 1.48; N_2 - 2.41; CH_4 - 0.37; H_2 - 2.14; relative error (%) CO_2 - 5.79; N_2 - 4.07; CH_4 - 10.3; H_2 - 19.5.

Inclusions in "reticulated" quartz showed an increased amount of N_2. Gas mixtures obtained during normal crushing of samples of topaz in the electric mortar bear up to 20% of H_2, but opening of large inclusions in this topaz did not produce any hydrogen at all. (Authors' abstract)

KAPCHENKO, L.N., ROGOZINA, Ye.A., and SOKOLOVA, N.Ya., 1973, Gas microinclusions in salts of the Inder salt dome, the Caspian Basin: Geol. Nefti Gaza, no. 5, p. 71-75 (in Russian).

KAPITONOV, M.D. AND KHAKIMOV, A. Kh., 1973, Geological conditions and thermodynamic parameters of formation of pink and yellow topaz in the Kamenka River region (S Ural): Abstracts of papers from the Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 129-130 (in Russian; translation through the courtesy of A. Kozlowski). Author at Moscow University.

Topaz occurs in silicified limestones in parageneses with rock crystals, forming small druses in voids. (Authors' abstract)

Minerals of druse	T_h, °C	Pressure, atm (Kalyuzhnyi's method)
Pink topaz	310-275	870-900
Yellow topaz	300-275	700
Rock crystal	320-270	1050-1100
Platy crystals		
Prismatic rock crystal	300-280	
Minute semitransparent prismatic quartz	190-155	

KARPOV, I.K., KAZ'MIN, L.A., KISELEV, A.I., and KHALIULLINA, O.A., 1973, Calculation of chemical equilibria in hydrothermal multisystems by the use of electronic calculators (theory, algorhithms, programs and numerical examples): Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 322-324 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Inst. of Geochemistry, Inst. of Earth's Crust of Siberian Branch of Acad. Sci. of USSR.

Abstract contains no data of immediate interest to fluid inclusion research, A.K.

KARUP-MOLLER, S., 1973, A gustavite-cosalite-galena-bearing mineral suite from the cryolite deposit at Ivigtut, South Greenland: Medd. Groenland, v. 195, no. 5, p. 1-40.

A small area ($\sim$0.5m) containing a suite of rare bismuth-lead-silver-copper sulphides associated with various gangue minerals was found in the cryolite deposit. The mineral suite occurred close to the contact between the siderite- and fluorspar-zones. It was exposed over an area about half a meter in diameter and is characterized by sulphide-disseminated topaz-fluorspar material contained in a mixture of fluorspar, weberite, fine grained muscovite and very minor amounts of quartz, referred to as "the matrix gangue minerals". (Details on the sulfides are given) ...

Investigations of fluids entrapped in fluorspar indicates a maximum temperature of formation of the sulphides around 300°C. The minimum temperature of formation may lie around 200°C.

The mineral suite is concluded to have crystallized from fluids without introduction of additional material as the crystallization took place. The fluids may possibly have been present as a low temperature sulphide melt. The crystallization sequence of the mineral suite and the possible changes in the composition of the fluids as the crystallization progressed are discussed.

The mineralizing fluids may have developed from mobilization of silver-bismuth-bearing galena which constitutes slightly less than half a percent of the cryolite-siderite ore zone of the cryolite deposit. This mobilization took place when late fluorspar-zone material reacted with galena-disseminated siderite-rich material. (Author's abstract, abbreviated by ER).

KARWOWSKI, Lukasz, 1973, Greisens of the Mladz-Kamien-Pobiedna area of the Izera Upland (Sudetes): Acta Geologica Polonica, v. 23, no. 2, p. 329-340 + 6 plates (in Polish with English abstract and 3-page summary).

The results of field observations and investigations of physicochemical conditions of greisen formation in the Izera Upland are presented. Microscopic studies and investigations of temperatures of homogenization (and decrepitation) of the fluid inclusions in greisen minerals (quartz, fluorite, tourmaline, topaz and apatite) reveal that the greisenization processes proceeded in a temperature range from 300 to 350°C, probably in the presence of a significant amount of such components as B, F and Cl, and besides a large amount of CO_2, the latter occurring as individual liquid in multiphase fluid inclusions, along with various daughter minerals, including NaCl and muscovite. The greisenization process was a part of general metasomatism developed regionally in the Izera Upland, as indicated in part by changes in metamorphic blue quartz. (Author's abstract, extended by E.R.)

KARWOWSKI, Lukasz, and KOZLOWSKI, Andrzej, 1973a, Authigenic smoky quartz from the Famennian Limestones at Lagow in the Holy Cross Mts.: Acta Geologica Polonica, v. 23, no. 1, p. 171-178 (in English with Polish abstract).

Inside smoky and black crystals of quartz from joint fractures in bituminous Famennian limestones at Lagow in the Holy Cross Mts., there occur inclusions containing variable amount of bituminous matter and aqueous solution of salts and gas. The occurrence of light-yellow liquid and viscous, dark brown bitumen gives the quartz its colour. Some bitumen is luminescent in U.V. The average T_H (and T_D) of aqueous inclusions in smoky quartz were 48-72°C, and of black quartz, 106-190°C. Veinlets of brown-black calcite, containing analogous inclusions, crystallized under similar conditions which revealed both minerals being connected with aqueous solutions containing dispersed immiscible droplets of bituminous matter extracted from the host rocks. The bitumen and composite aqueous-bitumen inclusions yield a wide range of homogenization temperatures that presumably do not reflect trapping temperatures. IR absorption spectra, obtained on chloroform extracts, show saturated and aromatic hydrocarbons, and possibly oxidized derivatives. (Authors' abstract, extended by E.R.)

KARWOWSKI, Lukasz, and KOZLOWSKI, Andrzej, 1973b, Use of studies of the gas-liquid inclusions in minerals to reconstruct the conditions of crystallization of those minerals: Przeglad Geologiczny, v. 21, no. 10, p. 512-517 (in Polish with English and Russian abstracts).

The paper summarizes the methodology of reconstructing physicochemical conditions of formation of postmagmatic, metasomatic, and post-sedimentary minerals on the basis of studies on their fluid inclusions. Results of determinations of temperatures of crystallization and of minimum pressures at which the studied minerals crystallized are given. In addition, chemical composition and density of fluids from which crystallization proceded are reconstructed, with examples including multiphase, high density inclusions (up to 1.32 g/cm^3, with NaCl, KCl, $CaCO_3$?, and unidentified daughter crystals) from Alam Kuh (Iran). (Authors' abstract, extended by ER)

KARWOWSKI, Lukasz, OLSZYNSKI, Wieslaw, and KOZLOWSKI, Andrzej, 1973, Wolframite mineralization from the vicinity of Szklarska Poreba Huta: Przeglad Geologiczny, v. 21, no. 12, 633-637 (in Polish with Russian and English abstracts).

In aplogranite from the vicinity of Szklarska Poreba Huta a wolframite mineralization was found. Wolframite occurs in thin quartz veins together with molybdenite, cassiterite, sulphides of iron and copper and bismuth minerals. Besides this, wolframite forms crystals up to 2 cm in size in the minute druses in aplogranite. The named mineral association originated partly in the final pneumatolytic stage (405-375°C) and mainly during the hydrothermal stage (375-200°C), as indicated by fluid inclusions. (Authors' abstract)

KAZAKOV, V.F., and ZHDANOV, B.P., 1973, A new occurrence of metal-bearing solutions in Turkmen SSR: Geokhimiya, 1973, no. 3, p. 454-458 (in Russian; translated in Geochem. Internat., v. 10, no. 2, 1974, p. 339-342). Authors at Turkmenian Geological Expedition.

The chemical features and gas composition of brines from which metallic minerals are presently being deposited are presented. The high content of some elements dissolved in the brines and helium in the gas suggest that waters of deep-seated origin, possibly remotely related to a magma chamber, have risen along a fault system into shallow aquifers.--D. Gottfried.

KELLY, W.C., 1973, Review of Fluid Inclusion Research - Proceedings of COFFI, v. 2, 1969: Econ. Geol., v. 68, p. 894-895.

A very complimentary review which unfortunately was not published until after vol. 3, for 1971, was already in print. (E.R.)

KESLER, S.E., VAN LOON, J.C., and MOORE, C.M., 1973, Evaluation of ore potential of granodioritic rocks using water-extractable chloride and fluoride: Can. Min. & Met. Bull., Feb., p. 56-59. Authors at Department of Geology, University of Toronto, Toronto, Ontario.

The possibility that chlorine and fluorine form complexes with ore metals, thereby having a strong effect on the mobility of these ore metals during late magmatic and hydrothermal processes, suggests that the abundance of chlorine and fluorine in igneous rocks could be used to distinguish intrusions that have generated ore deposits. The simplest and most economical measure of this chlorine and fluorine is the water-leachable chloride and fluoride that is released from fluid inclusions in the rock during crushing of the sample. In order to evaluate the possible use of this technique, measurements of water-leachable chloride and fluoride were made with selective ion electrodes on samples from nine intrusive complexes. There does not appear to be any simple relation between the abundance of chloride and the presence of mineralization. Fluoride values in mineralized intrusions appear to be higher than those in barren intrusions. (Authors' abstract)

KESSON, S.E., 1973, H_2O-CO_2-N_2 fluids in experimental petrology: Melting of albite with $X_{H_2O}^{fluid}$ = 0.25 (abst): Amer. Geophys. Union, Trans. (EOS), v. 54, no. 4, p. 480.

KHETCHIKOV, L.N., 1973, Inclusions of mineral-forming solutions in synthetic crystals and evidence for thermobarometry: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press., p. 13-14 (in Russian; translation provided through the courtesy of A. Kozlowski). Author at All-Union Institute for the Synthesis of Mineral Raw Materials, Aleksandrov.

Inclusions were examined in synthetic crystals grown in aqueous solutions, melt solutions and melts of various composition and at various temperatures (as a rule at pressure 1 atm).

1. Crystals of $NH_4H_2PO_4$ and epsomite were grown from aqueous solutions at 35 to 79°C. The two-phase inclusions were low in gas, and in those grown at 35°C only liquid inclusions were seen. During the first rapid heating homogenization occurred at temperatures very close to those at which the crystals were grown. During slow or repeated heating, due to solution of inclusion walls, the amounts of phases in inclusions change and homogenization temperatures (T_H) were more than two times higher than temp. of growth. Similar homogenization was noted in sugar and NaCl crystals.

One-phase inclusions were found in crystals grown at temp. lower than 40°C. Similar inclusions are known, e.g., from chrysoprase.

2. In barite crystals grown at 190°C large (0.1mm) inclusions were found, bearing gas and liquid, arranged on the growth surfaces of crystals. The amount of gas phase reaches 10 vol. %. T_H = 186-190°C. In addition, small secondary inclusions (0.004mm) were found with T_H up to 160°C.

3. Calcium and magnesium tungstates were grown from a melt solution. They contained tubular two-phase inclusions about 0.3mm long with the melt and 12-18 vol. % gas. T_H is close to T_G. Similar inclusions were noted from tourmalines from Central Kazakhstan pegmatites.

4. Crystals of fluorphlogopite, forsterite, sellaite, spinels, garnets, mullite, zircon, bismuth silicate, etc., were grown from melts at temp. 900-1400°C. All the minerals bear consolidated inclusions with gas inclusions and purely gaseous inclusions. The properties of the inclusions depend on the synthesis conditions. T_H of two and multiphase inclusions are similar to T_G (i.e., of synthesis). (Author's abstract).

KHETCHIKOV, L. N., & SAMOILOVICH, L.A., 1973, Peculiarities of relations between the main thermodynamic parameters of aqueous gas-bearing systems: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 40-42 (in Russian, translation provided through the courtesy of A. Kozlowski). Authors at VNIISIMS, Aleksandrov.

The most abundant and active volatiles in mineral-forming solutions are CO_2, NH_3, and H_2S. Thermodynamic properties (mainly P-V-T-X-relations) of gas-salt-aqueous systems are not simply the sum of the properties of the individual components and hence they were investigated in detail (and some information on methods is given).

The special case studied involved the P-V-T-X parameters in a closed (sealed) system with definite and constant composition analogous to the vacuoles in minerals. In general, the relations between components in such systems may be of two types, involving a deficiency or excess of one component in comparison with the equilibrium state.

The P-V-T-X-relations for systems Na_2SO_4-H_2O-CO_2, NaCl-H_2O-CO_2, NH_3-H_2O, Na_2CO_3-H_2O-CO_2, and H_2S-H_2O at temperatures up to 350°C and pressures up to 300 kg/cm^2 were investigated; salt concentrations did not exceed 12-14% by wt., and gas components - 5-6 wt percent. For all these systems, various sections of P-V-T-X-diagrams were made.

Unlike the systems involving water and a non-volatile component, these systems have the following characteristics:

1. Lower critical temperature and temperature of transition into a homogenous (liquid) state ($T_{hom.}$) with increase of pressure, and with increase in amount of gas component. For example, when 2.5 wt % of CO_2 was added to 12% aqueous NaCl solution, $T_{hom.}$ was lowered 22°C, and $P_{hom.}$ increased 115 kg/cm^2.

2. In the homogenous (liquid) region, the isochors of gas-bearing solutions under otherwise stable conditions move toward lower temperatures. The change depends on concentration, nature of cation and anion, and solubility of volatiles in aqueous and salt-aqueous systems. For example, the movement of the isochors toward lower temperatures with the same amount of CO_2 is 5-10% less in the Na_2CO_3 solutions than in NaCl solutions. With increase of salt concentration, the influence of the volatile component $T_{hom.}$ also increases. The presence of 1.4 wt % of CO_2 in 6% and 12% aqueous solutions of NaCl lowers $T_{hom.}$ 5 and 14°C, respectively, in comparison with the (CO_2-free) salt solutions.

3. The isochor inclination to the T-axis in the P-T plane, determined by $(\frac{\delta P}{\delta T})V$, for gas-bearing solution (due to its high compressibility) is lower, than for the salt-aqueous solutions under the same conditions (V, T, C = const).

4. The peculiarities discussed in times 2 and 3 above result in opposite effects of the volatile component on the general pressure in system, other parameters being equal. However, the prevailing effects on isochor shift were ascertained up to 300 atm for all the investigated systems. There is an increase of pressure in the system with increase in concentration of volatile component, but at higher values of the parameters this relation can reverse. (Authors' abstract)

KHITAROV, D.N., 1973, Physico-chemical peculiarities of beryllium ore formation in carbonate rocks as indicated by data of investigation of gas-liquid inclusions in minerals: Abstracts of papers from the Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 139-140 (in Russian; translation through the courtesy of A. Kozlowski). Author at All-Union Scientific-Research Institute of Mineral Raw Materials.

At the deposit investigated metasomatic fluorite-phenacite-bertrandite ores occur in limestones. Such minerals as phenacite, bertrandite, fluorite, calcite and quartz, were investigated. Fluorite began to precipiate at 380°C, and the major part of the mineral precipitated at 180-150°C. Beginning of crystallization of the other minerals took place at the following temperatures: phenacite 270°C, quartz and white and pink calcite 160°C, bertrandite 165-140°C. Main mass of phenacite-fluorite ores crystallized at 270-160°C (higher than bertrandite-fluorite ores). Pressure for phenacite-fluorite ores was 600-400 atm, and for bertrandite-fluorite - 450-300 atm. Parent solutions were of fluorine-alkaline metal type; concentration decreased from 40 to 4%. pH, calculated from the amount of CO_2 in solution was 7.5-6 for phenacite-fluorite ores and 6.7-5.7 for bertrandite-fluorite ores. (. . .) (Author's abstract, abbreviated by A.K.)

KHITAROV, D.N. and KHITAROV, N.I., 1973, Chemistry of mineral-forming solutions: Program of the Fourth Regional Meeting on Thermobarogeochemistry of Mineral-Forming Processes, at Rostov-on-Don, 24-30 Sept., 1973: Rostov-on-Don, USSR (in Russian). (No abstract present in the Abstracts volume).

KHITAROV, D.N., MOSKALYUK, A.A., DOLOMANOVA, E.I., and SHUGUROVA, N.A., 1973, Determination of chemical and gas composition of fluid phases of inclusions: Program of the Fourth Regional Meeting on Thermobarogeochemistry of Mineral-Forming Processes, at Rostov-on-Don, 24-30 Sept., 1973: Rostov-in-Don, USSR (in Russian). (Part of an inclusion training session; no abstract in Abstract volume.)

KHITAROV, N.I., and KADIK, A.A., 1973, Water and carbon dioxide in magmatic melts and peculiarities of the melting process: Contr. Mineral. and Petrol., v. 41, p. 205-215. Authors at V.I. Vernadsky Institute of Geochemistry and Analytical Chemistry, USSR Academy of Sciences, Moscow, USSR.

The solubility of water in acid, basic and ultrabasic magmas, from experimental data at pressures up to 10 kb, increases with increasing P_{H_2O}. At pressures which apparently correspond to those of the upper mantle, maximum of solubility should be expected. Further increase of pressure decreases the concentration of water in the melt. At pressures up to 5 kb, the solubility of carbon dioxide in magmas of the same composition is considerably less than that of water. The solubility of CO_2 rises with increasing pressure at temperatures above 1000°C. The separation of a fluid phase from magmas during their movement to the earth's surface must be characterized by diminution of part of the CO_2 in the vapor along with decreasing pressure. The solubility of CO_2 at pressures of more than 10-20 kb is expected to be significant and possibly to approach that of the solubility of water. In the field of the low pressures the influence of CO_2 on the temperature of melting of silicates is significantly less than that of water. Increase of CO_2 concentration in the fluid phase with depth determines the rise of temperature minimum on the curve of rock melting. This may be connected with the appearance of processes of local melting. Approximately within the ranges of the Earth crust water separation from magmas of basic and acid composition must be attended by heat absorption and the processes of water dissolution from the environment by heat liberation. (Authors' abstract)

KIEVLENKO, E.Ya. and TURINGE, A.P., 1973, Some genetic features of crystal formations in Somali: Program of the Fourth Regional Meeting on Thermobarogeochemistry of Mineral-Forming Processes, at Rostov-on-Don, 24-30

Sept., 1973: Rostov-on-Don, USSR (in Russian). (Presumably Somalia; no abstract in Abstracts volume.)

KILINC, Attila L, 1973, Beginning of melting in the quartz diorite-H_2O and quartz diorite-H_2O-CO_2 systems (abst): Amer. Geophys. Union, Trans. (EOS), v. 54, no. 4, p. 481

KIYOSU, Yasuhiro, 1973, Sulfur isotopic fractionation among sphalerite, galena and sulfide ions: Geochemical Journal, v.7, pp. 191-199. Author at Nagoya University, Chikusa, Nagoya 464, Japan. (In English)

Sulfur isotope fractionation in ZnS - HS^- and PbS - HS^- systems has been studied experimentally in the temperature range from 50 to 340°C. Sulfur isotopic exchange between sulfide minerals and HS^- ions was found to be unexpectedly fast. In the ZnS - HS^- system several ten hours are enough to attain isotopic equilibrium in the temperature range from 50 to 200°C. Temperature dependence of equilibrium fractionation was estimated as follows:

$$\ln \alpha \text{ sphalerite-HS}^- = 111\ T^{-2} + 0.00136$$

$$\ln \alpha \text{ galena-HS}^- = 782\ T^{-2} + 0.00170$$

From these equations the temperature dependence of sphalerite-galena fractionation is

$$\ln \alpha \text{sphalerite-galena} = 891\ T^{-2} - 0.00057.$$

(Author's abstract)

KNYAZEV, G.B. + MEL'NIKOVA, N.D., 1973, Temperature regime of formation and alteration of pyroxene skarns of magnetite Tabratskoe deposit (E Sayan): Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 106 (in Russian; translation through the courtesy of A. Kozlowski). Authors at Tomsk Univ.

The Tabratskoe deposit occurs in a mylonite zone in gabbros, diorites and porphyrites not far from contact with marbles. The earliest alteration products are the vein skarns and pyroxene-epidote and amphibole-epidote leucocratized rocks with low-iron epidote. Temperature of decrepitation (Td) of these rocks, (about 100 samples) was determined. Pyroxene gives T_d = 580-725°C; crystals giving Td close to 580°C bear inclusions homogenizing at 500-520°C. Pyroxenes usually give also a lower temp. decrepitation effect at 400-550°C. Characteristic temps. for the ore stage: iron-rich Cl-bearing hastingsite-dashkesanite (440-520°C) and magnetite (460-580°C). (Authors' abstract).

KOGARKO, L.N. and ROMANCHEV, B.P., 1973, Crystallization temperature of agpaite magma: Akad. Nauk SSSR Doklady v. 212, no. 4, p. 957-960 (in Russian; translated in Doklady Acad. Sci. USSR, v. 212, p. 169-171, 1974; abstract in Int. Geol. Rev., v. 16, no. 1, p. 115, 1974). Authors at V.I. Vernadskiy Institute of Geochemistry and Analytical Chemistry, USSR Academy of Sciences, Moscow.

Homogenization temperatures of inclusions in nepheline, 930 to

1010°C, for the Lovozero massif as a whole indicate the preferential range of 960-980°C (80% of total determinations). The relative "aridity" of the magmas, as in the P_{H_2O}-T diagram of melting of foyaite (fig. 1) suggests an abyssal origin of the magmas. (Authors' abstract)

KOKORIN, A.M. AND KOKORINA, D.K., 1973a, Thermobarometric conditions of formation of the Iul'tinskoe Sn-W deposit (Central Chuktoka): Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 80-81 (in Russian; translation through the courtesy of A. Kozlowski). Authors at Far-East Geological Inst. of the Far-East Scientific Center of Academy of Sciences USSR, Vladivostok.

(...) Geological setting: the deposit occurs among large granitoid intrusives in metamorphic (metasedimentary) rocks and consists of quartz veins and greisens.

Inclusion analysis in ore-bearing quartz proves that mineral-formation was caused by hydrothermal fluids of various densities and compositions. Fluid evolution was accompanied by sharp fluctuations and occurrence of CO_2-bearing inclusions. In general, the pneumatolytic environment passed into hydrothermal. The amount of CO_2 ranges from 10 to 60% of inclusion weight.

The deposit formed at temp. 400-100°C (in various veins 350-400 down to 100-200°C). Pressure corrections for T_h are equal 20-60°C, i.e., the real formation temps. were at lower horizons (450-250) and subsuperficial (400-150°C).

Pressure conditions are very complicated: at the core the pressure was as high as 1000-250 atm, and at the subsuperficial levels it reached 650-100 atm.(...) (Author's abstract, shortened by A.K.)

KOKORIN, A.M., & KOKORINA, D.K., 1973b, Temperature conditions of formation of the skarn-polymetallic Tyetyukhe deposits (on the basis of gas-liquid inclusion data): Abstracts of papers at Fourth Regional conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 104-105 (in Russian; translation through the courtesy of A. Kozlowski). Authors at Far-East Geological Inst. of Far-East Scientific Center of Acad. of Sciences USSR, Vladivostok.

Ore bodies formed in the T interval 450-50°C. The upper range, estimated on pre-ore quartz, is not satisfactory. Some skarn minerals indicate the upper range to be 500-550°C. The lower T range is determined by the geothermal gradient.

One may discern three stages of mineral formation: skarn stage, 450-350°C, sulfide stage, 350-250°C, and quartz-fluorite-carbonate stage, 250-50°C. Individual minerals crystallized at the following temperatures: hedebergite over 400-300°C, quartz 450-50°C, calcite 350-50°C, datolite 350-100°C, fluorite 200-100°C. Early skarns formed under the action of pneumatolytic solutions that changed to hydrothermal solutions in late skarn stage and lower temp. associations. The change pneumatolytic to hydrothermal conditions was associated with the beginning of precipitation of sulfides. Later solution concentrations varied strongly, sometimes giving inclusions bearing halite and carbonate (daughter minerals).

Pressures changed from 330 to 20 atm. Temp. zonality is expressed mainly as variations of T_h of sphalerite, increasing by about 10°C per each 100 m of depth. (Authors' abstract, shortened by A.K.)

KONKIN, V.D., & RUCHKIN, G.V., 1973, On temperature regime of metamorphic mineralization of pyrrhotitic sulfide deposits of Carelia: Abstracts of papers from Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 111 (in Russian; translation through the courtesy of A. Kozlowski). Authors at Central Scientific-Research Geological-Prospecting Institute of Geology Ministry of USSR, Moscow-TSNIGRI.

20 samples of quartz associated with the pyrrhotitic mineralization of Carelia were examined. The majority of primary inclusions homogenized in liquid phase at temp. 280-300°C, pseudosecondary ones- at 300-320°C. Secondary inclusions homogenized in gas or in liquid phase at temp. 160-180 to 460°C. All the generations of inclusions are connected with crystallization of pyrrhotite.

T_{decr} of pyrrhotites (∿ 100 samples) range from 220 to 400°C: monoclinic pyrrhotite 260-280°C, intergrowths of moncl. and hexagonal pyrrhotite 300-320°C, and hexagonal ones 340-360°C.

During general cooling of the rocks the new portions of fluids probably had higher temperatures. (Authors' abstract, slightly abbreviated by A.K.).

KORMUSHIN, V.A., SHARIPOV, R.K. and LIPOVA, E.M., 1973, Chemical analysis of liquid phase inclusions in quartz: Akad. Nauk Kazakh, S.S.R., Izvest., Ser. Geol., 1973, no. 3., p. 88-90 (In Russian). See Translation Section.

KORNILOV, V.E., and MYAZ', N.I., 1973, Decrepitometric aureoles of Sb-Hg ore bodies: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 264-265 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at L'vov Univ.

At Sb-Hg ore deposits of the jasperoid type (Boordinskoe and Ishmetauskoe ore districts) samples were taken at 5-10 m intervals along sections cutting the screening sandstone-slaty complex, the ore-bearing zone of crushing and silification (jasperoids), and limestones. The fraction 0.5-1.0 mm was analyzed by heating to 400°C and recording impulses for each 20°C. Background decrepitation in the sandstones ranged from 0-32 imp., and did not depend on rock composition. Not far from the platy body of jasperoid in terrigenous rocks a zone was found, 12-22 m wide, with low decrepitation activity, not over background. Further from ore, in these terrigenous rocks, there was a zone of 5 to 25 m, having high activity (48-10 imp.).

Hg ore bodies in systems of steeply inclined veins in uniform carbonate rocks (Symapskoe deposit) were characterized by higher decrepitation of the wall rocks (from 35 to 400 imp. in T interval 100-400°C); the background of the limestones and dolomites was 0-25 imp. Width of the zones of anomalous activity did not exceed 15-20 m. (Authors' abstract, modified by A.K.)

KOROBEYNIKOV, A.F., AND MATSYUSHEVSKIY, A.V., 1973 Application of methods of mineral thermometry for prospecting and evaluation of ore necks in endogenic gold deposits: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 257-258 (in Russian; translation through the courtesy of A. Kozlowski). Authors at Tomsk Polytechnical Inst.

Results of application of the decrepitometric method in connection with other geochemical studies for prospecting and localization of ore bodies were exemplified by gold-bearing skarns, albitites, quartzites, berezites and listvenites from Siberia and Far East. (...) By the decrepitation method, the nonuniform, abrupt increase in the number of impulses of decrepitations of gaseous-liquid inclusions were found in minerals in areas near ore bodies (10-70 times more than background). A correlation was found between concentration of gold and accompanying elements, and the intensity of decrepitation of gas-liquid inclusions in altered rocks in T interval of ore formation (360-70°C). Graphic expressions of element distribution and decrepitation anomalies give similar shapes for the ore bodies, as determined by these two comparable methods. Greatest thermometric anomalies occur immediately over ore bodies, and in unaltered wall rocks they are absent. Diagrams of concentrations of metals, of decrepitation activity, of magnetic susceptibility and of density of rocks prove the similarity or complete analogy of the boundaries of rocks altered in various degrees and ore zones.(...)

In addition, mineral-thermometric methods may be applied for studies of problems of interrelations of dikes, metasomatites and ores. During investigation of relations between secondary quartzites, gold-bearing veins and dikes of diorite-porphyries, and granite-porphyries in the area of the cupola gold ore deposit in the Lower Amur region, it was found that decrepitation activity decreases sharply at the contact of a metasomatic quartz vein with the dike and 0.5-1.2 m beyond again returns to the background value. The aureole of thermal metamorphism around the 2-5 m thick dike reaches 0.5 - 1.2 m and is connected with phenomena of natural decrepitation of G-L inclusions in minerals in the vicinity of the contact with the intruded magma. This phenomenon was ascertained for many other deposits (N.P. Ermakov 1968, etc.).

Thus the method proposed by Ermakov for prospecting for ore bodies may be successfully used for studies of gold-ore deposits of various types. (Authors' abstract, with abbreviations by A.K.).

KOROBEYNIKOV, A.F. AND MATSYUSHEVSKAYA, L.B., 1973, Geochemical types of gold-bearing hydrotherms from data on gas-liquid inclusions in minerals: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 146-147 (in Russian; translation through the courtesy of A. Kozlowski). Authors at Tomsk Polytechnical Institute.

Composition and features of solutions of inclusions in minerals of veins and hydrothermally altered rocks were investigated using the methods of decrepitation and homogenization, and water leachates. Investigated samples were taken from several moderately deep and subsuperficial gold deposits of Siberia, Ural, Kazakhstan and the Far East. The data obtained permit creation of a preliminary geochemical classification of high-, moderate- and low-temperature gold deposits of various mineralogical types. Two general groups of gold-forming hydrotherms were distinguished: Na-Cl-S and K-S. The groups of hydrotherms are connected with groups of magmatic rock formations: moderately deep granitoids and volcano-plutonic baslatic respectively.

Inclusions in minerals of gold-bearing skarns connected with granitoids are characterized by Cl-Na-Mg composition with Na/K ratio from 1:1 to 3:1. Gas-liquid inclusions in minerals of high-and moderate-temperature near-vein altered rocks differ in the domination of bicarbonate ions over chloride ions and of K and Ca over Na and Mg. Inclusions of minerals in productive complexes usually have Na-Cl or Na-HCO_3^--S^{2-} composition, with Cl prevailing over F, and T_H 420-120°C. Inclusions in minerals of gold ores occurring in secondary quartzites of volcano-plutonic formations have K-HCO_3^--S^{2-} composition with Cl dominant over F and T_H 360 - 180°C. (Authors' abstract).

KOROBEYNIKOV, A.F., SAL'NIKOV, V.N., and BESPAL'KO, A.A., 1973, On temperatures of mineral-forming by method of counting of intensity of electromagnetic impulses: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 316-318 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Tomsk Polytechnical Inst.

L.M. Belyaev, V.V. Nabatov and Yu.M. Martyshev have found experimentally that during crushing of crystals of LiF and NaCl, in addition to light phenomenon, electromagnetic radiation impulses are emitted. (...) Some physico-chemical processes taking place in rocks and minerals during heating and cooling, may be accompanied by emission of electromagnetic impulses. Experiments made by the authors proved such emission of electromagnetic radiation from pegmatitic rock, fluorite coloured under action of radiation, and muscovite, in a wide range of T.

Sample of rock (20x20x5 mm) is enclosed by two nickel electrodes of diameter 20mm. One electrode is the antenna, the other is grounded. For higher sensitivity and removal of secondary phenomena, the sample is covered by a thin coat of Pt. For registration of electromagnetic radiation in radiowave range, apparatus was made from a III class wireless set with sensitivity in short-wave interval and in long-wave interval, oscillograph CI-17, and calculating apparatus PST-100. Band of transmission f=5-10kHz. Intermediate frequency f=465kHz. During heating a plate of violet fluorite from quarry of Sorskoe Mo deposit emitted intensive electromagnetic radiation in wave range $\lambda = 9.5$-1333m (600-2133 imp.) at temp. 210-220, 280-310 and 330-350°C which temperatures are characteristic for decrepitation. After cooling from 630°C, the individual impulses were registered at the same temperatures during (a second?) heating. After measurement the plate of fluorite was completely decrepitated. This method can be used for measurements of T_D for evaluation of T of mineral formation. (Authors' abstract)

KORYTOV, F. Ya., 1971, On the origin of fluorite mineralization at wolframite deposits of Transbaikalia, pp. 130-135, <u>in</u> Mineralogy and geochemistry of tungsten deposits (Materials of 2nd All-Union Symposium on Mineralogy, Geochemistry and Genesis of Tungsten Deposits of USSR): Leningrad, Leningrad Univ. Publishing House, 344 pp. (In Russian; abstract through the courtesy of A.Kozlowski.) Author at All-Union Inst. of Raw Materials -VIMS.

Fluorite at investigated wolframite and fluorite deposits, and associated calcite and chalcedony-like quartz, crystallized at relatively uniform temperatures equal 280- 90°C, from fluid inclusion homogenization data.

KORZHINSKII, M.A., 1973, Thermobarometrical investigations of gaseous - liquid inclusions and hydrocarbons in scheelite: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 74 (in Russian; translation through the courtesy of A. Kozlowski) Author at L'vov University

Colorless to dark brown schellite from the Balkanskoe deposit (S. Ural) was investigated. The color repeats the zonal structure of crystals. K. K. Matveev (1947) ascertained the presence of bitumens in scheelite of this deposit. Both in dark-brown and in colorless zones of crystals the secondary two-phase incl. (gas+liquid) as well as composite (CO_2+water) ones occur with temp. of homogenization = 150-155°C, 205-220°C. Such inclusions, but with T_h = 240-245°C, occur only in colorless zones and they are of pseudo-secondary nature. A characteristic feature of the dark-brown zones is the presence of 2- and 3-phase inclusions of worm-like morphology, with a liquid phase which is greenish-yellow bitumen. The composition of gases in dark-brown scheelite was determined by the mass-spectrophotometer as follows: CO_2 = 60.6%, H_2 = 15.9%, N_2= 23.3%, CH_4 = 0.2%. By chemical analysis in the same scheelite C organic - 0.41%. H_2 - 0.12%. Curves of luminescence and absorption of dark-brown and colorless scheelite are also given (...). (Author's abstract, shortened by A.K.)

KOSALS, Ya.A., and DMITRIYEVA, A.N., 1972, Sequences and temperatures in formation of the Buluktay molybdenum-tungsten deposit (Southwestern Transbaykal): Akad. Nauk SSSR, SO, Geol. i Geofiz., 1972, no. 2, p. 11-19 (in Russian; translated in Int. Geol. Rev., v. 15, no. 1, p. 25-30, 1973). Authors at Institute of Geology and Geophysics, Siberian Division of the USSR Academy of Sciences, Novosibirsk.

The high-temperature hydrothermal metamorphism, the relations between the ores, the metasomatically altered wallrocks, and the granites, once overlooked are here worked out comprehensively including identification of three stages (barren, molybdenum, tungsten and rare metals) and 12 phases of mineralogenesis (table). The barren stage (640-520°C), with the associated microclinization and sericitization of quartz monzonites in exocontacts of "granites I", was followed by the two mineralizing stages, each of which was a sequence of microclinization-skarnization-albitization-greisenization ending in growth of the ore-bearing veins. Characteristically, formation temperatures increased by 10-40°C in every one of the microclinizations. The pipe-shaped structure in the deposit may have functioned both as a generator and a distributor of the metals, judging by positions of the ores. (Authors' abstract)

KOSALS, Ya A. and DMITRIYEVA, A.N., 1973, Temperature of formation of leucophane-fluorite metasomatite: Akad. Nauk SSSR, Doklady, v. 211, p. 1433-1435 (in Russian; translated in Doklady Acad. Sci. USSR, v. 211, 1974, p. 180-182; abstract in Int. Geol Rev., v. 15, no. 10, p. 1240, 1973). Authors at Institute of Geology and Geophysics, Siberian Division, USSR Academy of Sciences, Novosibirsk.

The hydrothermal Be-F ores in the exocontact of riebeckite granites (after limestones) were formed at 490-200°C, as indicated by the homogenization and decrepitation temperatures of gas-liquid inclusions in their minerals (table 1), i.e. at somewhat higher temperatures, on the whole, than the phenacite-bertrandite-fluorite ores. These two types of beryllium mineralization differ from each other signigicantly, notwithstanding the petrographic-petrochemical resemblances of their parent granites and of the premineralization stages of the metasomatism. Specifically, the leucophane-fluorite paragenesis is contigent upon high activities of F, Na, Be in high-temperature solutions reacting with the carbonates and the activities evolution series of K-Na-Si-Na, F, Be. The corresponding series in the phenacite-bertrandite-fluorite mineralogenesis is Na-Si-Na-K-K, F-F, Be. (Authors' abstract)

KOSTER VAN GROOS, A.F., and WYLLIE, P.J., 1973, Liquid immiscibility in the join $NaAlSi_3O_8$-$CaAl_2Si_2O_8$-Na_2CO_3-H_2O: Amer. Jour. Sci., v. 273, p. 465-487.

Of significance to fluid inclusion studies in carbonatite environments. (E.R.)

KOVALENKO, V.I., 1973, Distribution of fluorine in a topaz-bearing quartz keratophyre dike (ongonite) and solubility of fluorine in granitic melts, Geokhimya, 1973, no. 1, p. 57-66 (In Russian, translation in Gechem. Internat. v., 10, no. 1, 1973, p. 41-49).

Ongonites are subvolcanic equivalents of albite-lepidolite granites, containing from 0.8 to 3.2% of fluorine. The saturation concentration of fluorine in ongonite melt varies from 2.0 to 3.2%, its solubility in the melt decreasing with increase of silica content. Fluorine separates from the melt in acid form. Formation of fluorine-rich ongonite melt is possible during crystallization of fluorine-saturated alaskite magma in these parts of the magma chamber in which partial pressure of fluorine in the fluid exceeds its equilibrium pressure in alaskite magma. (Author's abstract)

KOVALEVICH, V.M., 1973, Method of measurement of pressure in inclusions by use of special thermobarochamber: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 312-313 (in Russian; translation provided through the courtesy of A. Kozlowski). Author at Inst. of Geol. and Geochem. of Fuels of Acad. Sci. of Ukrainian SSR, L'vov.

(...) For the measurements the inclusions must contain a gas phase. Measurements may be made at any T up to near T_H. P_H is calculated by extrapolation. Working range of stage: T 20-280°C, P 1 - 400 atm. Inclusions are opened by a microborer mounted on the stage; observations are made in transmitted light under microscope. After opening of inclusion the gas bubble is reduced to linear dimensions it had before opening. In the chamber filled by inert liquid the necessary T and P close to P probably occurring in inclusion are achieved before opening of inclusion. After opening, the pressure is changed to the point where the bubble reaches suitable dimension; P is then read from the manometer. As the inert liquid, pure water-free glycerine was used. One may use also other inert liquids with sufficiently high boiling T. Some dissolution of gas in the liquid does not preclude the determination of P, because the primary dimensions of the gas bubble are maintained for some seconds.

The stage was used for measurements of P in inclusions in artificial quartz grown under known conditions, as well as in natural minerals (quartz, halite, sylvite). Errors of measurements do not exceed 10-15%.

A method was found for plates of minerals soluble in water (halite, sylvite). Sometimes inclusions in such minerals ought to be opened by action of glycerine diluted by water, because drilling by the microborer causes deformation of vacuoles of the inclusions.
(Author's abstract, with abbreviation by A.K.)

KOZLOWSKI, Andrzej, 1973, Post-magmatic quartz of the Strzegom and Karkonosze granitoids (Lower Silesia); environment of crystallization and trace elements: Acta Geologica Polonica, v. 23, no. 2, p. 346-363 + 6 plates (in Polish with English abstract and 3-page summary).

Results are presented of thermometric (mainly T_H; some T_D) and chemical investigations (33 analyses for Li, Na, K, Cl, and Br) of fluid inclusions, and studies of trace elements in drusy and vein quartz of pegmatitic and hydrothermal origin from the Strzegom and Karkonosze granitoid massifs. Several generations of fluid inclusions have been distinguished and temperatures of their origin determined (T_H = 450° to 90°C). The variation of mineral-forming fluids and their influence on the presence of trace elements in quartz have been studied. Inclusions showing liquid CO_2, various daughter crystals (including NaCl, KCl (?), and unidentified), necking down, and heterogeneous solutions (boiling ?)) are illustrated. The possibility of determining the crystallization temperature of quartz by the aluminium geothermometer method was examined; 8 samples show T_H within 40°C of the temperature determined by Dennen's method (Fluid Inclusion Research - Proceedings of COFFI, v. 4, p. 18, 1971). (Author's abstract, extended by E.R.)

KOZLOWSKI, Andrzej, and KARWOWSKI, Lukasz, 1973, Bromine and chlorine in gaseous-liquid inclusions in hydrothermal minerals from Lower Silesia: Arch. Mineral. (Pol. Akad. Nauk, Kom. Nauk Geol.), v. 31, no. 1-2, p. 281-295 (in Polish with English summary). Authors at Institute of Geochemistry, Mineralogy and Petrography, Warsaw University. Chem. Abst., v. 80, 27917p, 1973.

The Br and Cl contents were determined in gas-liquid inclusions in pegmatitic quartz and in hydrothermal quartz, albite, fluorite, calcite, and epidote. The highest Br concentrations are 6.1, 4.0, and 2.9 ppm for fluorite, calcite, and quartz, respectively. The Cl/Br ratio is 39-1200 and it decreases with decreasing temperature of the solution as shown by homogenization and thermogravimetric and thermoacoustic decrepitation techniques. Some hydrothermal solution seems likely to have been trapped in the intergranular spaces in the granites.

KRASNOVA, N.I. AND SHADENKOV, Ye.M., 1973, Inclusions in apatites from the Kovdorskoe phlogopite deposit: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 252-253 (In Russian; translation through the courtesy of A. Kozlowski). Authors at Leningrad Univ.

Primary inclusions in apatites of the Kovdorskoe deposit usually have a gas bubble, a small amount of liquid and 3-4 (sometimes more) daughter minerals. Inclusions homogenize in the gas phase; initially at 200-400°C certain solid phases partly dissolve in the liquid; this liquid at 400°C transforms to gas. The last solid phase sometimes is preserved for a long time and disappears at 700-800°C. Primary inclusions from top parts of crystals have lower T_H (dfference up to 100-150°C) in comparison with root parts of the same crystals.

Secondary inclusions homogenize in liquid at low T (250-400°C). The gas composition (data of S.V. Ikorskiy, Lab. of Natural Gases of Kola Division of Acad. Sci. of USSR), shows H_2 prevails (up to 1.17 cm^3/kg) and there are small admixtures of He, CH_4, C_2H_2 (sic.) and C_3H_8. Increased amounts of H_2 were found earlier for other minerals of this deposit (diopside, phlogopite and calcite).

Results of investigation of composition of salts in inclusions in apatites prove the prevailence of $CaCl_2$ over small amounts of other components (Na^+, Mg^{2+}, K^+, SO_4^{2-}, HCO_3^-). (Authors' abstract)

KRENDELEV, F.P., ZOZULENKO, L.B., and ORLOVA, L.M., 1973, Parameters of solutions which metamorphosed metal-bearing conglomerates according to the investigations of gas-liquid inclusions in pebbles and neogenic minerals: Akad. Nauk SSSR Doklady, v. 212, no. 3, p. 713-716 (in Russian). Differs in title, but is essentially the same as given in translation in Fluid Inclusions Research - Proceedings of COFFI, v. 3, 1970, p. 101-107. (ER)

KUCHER, M.I. and MATSAPULIN, V.U., 1973, Methods of analysis for thermobarogeochemistry using a mass spectrometer: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press* (in Russian; translation provided through the courtesy of N.P. Ermakov). Authors at Institute of Physics, Institute of Geology, Dagestanish Department of Academy of Sciences of the USSR. * p. 298-299

Recently the application of mass spectrometers became customary in thermobarogeochemical analysis. Considerable perspective on the application of mass spectrometry for the investigation of inclusions in minerals has been obtained by N.P. Ermakov, Yu.A. Dolgov, E. Roedder and other investigators. We studied mineral inclusions in minerals with high quality vacuum apparatus, coupled with mass spectrometer MB-2302, possessing high (resolution ?). The apparatus consists of two parts: gas evolution part and analysis part.

The gas evolution part of the apparatus permits thermobarometric investigations analgous to those described in the literature. The presence of a cold trap as well as a heated bubbler with copper oxide or calcium chloride permits separation of a mixture into groups of gases and to register the spectra of these gases with the mass spectrometer. Absolute amounts of gases were measured with the mass spectrometer, by method of internal standards, in the analysis part of the apparatus.

Analyses were carried out by various methods: stepped heating of samples and determination of the characteristics at each heating interval, and the method of dynamic annealing, when the temperature rise is continuous and total pressure of gas-vapor mixture is fixed, as well as one of gases, to which the mass spectrometer is tuned. (Author's abstract).

KUL'CHITSKAYA, A.A., 1973, Two-phase liquid inclusions in gypsum: Abstract of papers from the Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 128-129 (in Russian; translation through the courtesy of A. Kozlowski). Author at IGIFM AN Ukrainian SSR, Kiev.

Gypsum crystals from various deposits of the Ukraine were investigated and one- and two-phase inclusions of water solutions were found. One-phase inclusions prevail, proving a temp. of origin not higher than 50°C. For specimens from recent clays and caves, 2-phase inclusions are typical, with 20-90% filling. In one fracture (healed) there occur both one-and two-phase inclusions. Heating to 130°C does not cause visible changes in the phase relations. Opening the inclusions in a neutral medium proved the pressure to be very close to 1 atm. These inclusions formed in superficial or subsuperficial conditions. (Author's abstract)

LAHIRY, Ashoke, 1973a, Fluid Mapping: A new method of mineral exploration based on fluid studies in minerals (abst.): Symposium on Recent Trends in Exploration of Minerals, Oil and Ground Water (Academy of Sciences of U.S.S.R. and Indian National Science Academy), October 15-20, 1973, New Delhi, India; Abstracts Volume. Author at Dept. of Geology, Univ. of Rajasthan.

Studies on fluid inclusions in minerals in recent years have greatly contibuted to the understanding of the physico-chemical environment of formation of ore deposits. The decrepitation method of studying fluid inclusions in minerals has been widely adopted by Soviet geologists to determine the temperture of formation of minerals. There exist variations in the intensities and temperatures of decrepitation in barren and mineralized host rocks and veins. This knowledge has been utilized extensively in the Soviet Union for exploration.

Fluid inclusion research has further revealed a new parameter, the fluid density, which bears a close relationship with the economic concentration of ore minerals in a particular deposit. The idea of construction of isodensity maps with the help of fluid inclusions in an exploration program is proposed and its utility should be given serious consideration. It is based on the recording of densities of fluids in inclusions which would help to delineate the probable zones of mineralization.

Details are given of applications of the decrepitation method and the new concept of fluid mapping for prospecting for ore deposits in the Soviet Union. (Author's abstract, modified by E.R.)

LAHIRY, Ashoke, 1973b, The temperature and chemical nature of mineralizing solution at the fluorspar deposit, Ambar Dongar, Gujarat (abst.): International Symposium on Recent Researches and Applications of Geochemistry (I.A.G.C. and Geochemical Soc. India), Feb. 20-26, 1973, Patna, India; Abstracts Volume. Author at Dept. of Geology, University of Rajasthan.

The fluorspar deposit of Amba Dongar, Gujarat has been, of late, given added significance because of its attributed genetic relationship with the carbonatites occurring there as the country rocks. Fluid inclusion studies in blue and yellow fluorites of Amba Dongar reveal only two-phase and monophase aqueous inclusions. Homogenization and cryometric studies indicate a low temperature of mineralization, from an aqueous solution of low salinity. During cryometric studies superheated ice has also been observed. The fluid inclusions have been analyzed for alkali elements.

In the light of fluid inclusion studies it is suggested that the Amba Dongar fluorites have been deposited from moderately cool mineralizing solutions of low salinity. (Author's abstract)

LANDIS, G.P., 1973, Geologic, fluid inclusion, and stable isotope studies of a tungsten-base metal ore deposit, Pasto Bueno, Northern Peru (abst.): Diss. Abstr. Int., v. 33, no. 7, p. 3143B.

Given in full in Fluid Inclusion Research - Proceedings of COFFI, v. 5, 1972, p. 63-64.

LAPUKHOV, A.S., 1973, On the conditions of formation of some hydrothermal-metasomatic sulfide-polymetallic deposits as indicated by inclusions in minerals: Abstracts of papers from the Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 112-113 (in Russian; translation through the courtesy of A. Kozlowski). Author at Inst. of Geology and Geophysics, Siberian Branch Academy of Sciences, USSR, Novosibirsk - IGiG SO AN SSSR.

Thermometric, cryometric and water leachates analyses were made on samples from the Salairskoe, Kamenushinskoe and Zyranovskoe ore fields. Hydrothermal processes developed at temperatures not higher than 400-450°C (most rarely 500°C), and the most extensive ore formation took place at 350-200°C. Low temp. range of hydrothermal-metasomatic processes (post-ore quartz-carbonate veins) was about 150-100°C. Temp. gradient was equal about 0.1 - 0.5°C per meter. Solutions were weakly alkaline, bearing mainly Ca^{2+}, K^+, Na^+, and HCO_3^-, with subordinate amounts of Cl^-.

Inclusions in calcite, barite and quartz were subjected to freezing. Metastability was encountered commonly. Freezing temperatures (i.e., on decreasing the temperature; Ed.) range from -36.5 to -67.5°C. (First) melting temperatures (of ice) are more stable - about -33°C is the common temp. of beginning of melting. Complete disapperance of cyrstal phases took place at -10.5 to -17.7°C, proving the high concentrations of salts (recalculated to Mg or Ca salts they equal 11.8 - 16.0 wt %). Concentration change versus depth in meters (h) agress with the empirical equation $c = 13 + 5.6 \times 10^{-3} h$ (1 wt % per 100 m). (Author's abstract, abbreviated by A.K.)

LARSON, L. T., MILLER, J. D., NADEAU, J. E., and ROEDDER, Edwin, 1973, Two sources of error in low temperature inclusion homogenization determination, and corrections on published temperatures for the East Tennessee and Laisvall deposits: Economic Geology, v. 68, no. 1, p. 113-116.

The higher part of the range of published homogenization temperatures for fluid inclusions from two mining areas in East Tennessee, the Young mine in the East Tennessee zinc district and several mines in the Sweetwater barite district, and from the lead deposit at Laisvall, Sweden, are in error. The published maximum temperatures are 70 to 150° too high. Two partly compensating and possibly common errors are involved, one from thermocouple calibration technique, and one from permanent nonelastic deformation of the inclusion walls by overheating beyond the homogenization temperature. The latter can yield reproducible but seriously erroneous results; it is most likely to occur in strongly saline, low-temperature inclusions in soft cleavable minerals. Both errors can be avoided by appropriate changes in experimental technique. (E.R.)

LAZARENKO, E.K., PAVLISHIN, V.I., LATISH, V.T., and SOROKIN, Yu.G., 1973, Mineralogy and genesis of the chambered pegmatites of Volyn: L'vov, Acad.

Sci. Ukr. SSR, Inst. Geochem., 358 pp. (in Russian, with 3-page English summary).

A very thorough review of the geology, mineralogy, geochemistry, crystallography and paragenesis of the Volyn chamber pegmatites associated with the rapakivi-like granites of the Precambrian Korostensky pluton in the Ukrainian shield. Includes 12 pages of indices, and nearly 400 references. These are the pegmatites on which perhaps a hundred Soviet papers on multiphase fluid inclusions are based. (E.R.)

LEACH, D.L., 1973a, A study of the barite-lead-zinc deposits of Central Missouri and related mineral deposits in the Ozark region: PhD dissertation, Univ. of Missouri. Author at Lawrence Livermore Lab, P.O. Box 808, Livermore, Calif. 94550.

The more than 250 small, high grade deposits of galena, sphalerite, and barite that occur in the central Missouri barite district are believed to be part of the general Mississippi Valley type mineralization found throughout the Ozark region, covering more than 125,000 square kilometers.

Homogenization temperatures for sphalerite from rock quarries, drill cuttings, and lead-zinc, barite, and coal mines in central Missouri are in the range 80°C to 110°C. Freezing point depression determinations show that the fluids deposited the sphalerite had salinities generally greater than 22 NaCl equivalent weight percent salts. At some time after cessation of the lead-zinc mineralization in central Missouri, barite was deposited at temperatures less than approximately 40°C by solutions containing 4 to 10 weight percent salts. The lack of any mineral deposition in central Missouri in the temperature range 80° to 40°C and salinity range 21 to 10 weight percent salts, suggests the possibility of two distinct (and perhaps completely unrelated) episodes of mineralization.

Homogenization temperatures for sphalerite from the northern Arkansas zinc district are in the range 83°C to 132°C. Freezing point depression determinations for sphalerite from northern Arkansas are nearly identical to those for sphalerite from central Missouri, being generally greater than 22 weight percent salts. A limited number of homogenization and freezing point temperature determinations were made on sphalerite from the Tri-State district and are in agreement with the available data in the literature. The data show that sphalerite from the Tri-State district was deposited by fluids having salinities greater than 22 weight percent salts, in the temperature range, 83°C to 120°C.

It is believed that the lead-zinc deposits in northern Arkansas, Tri-State, and central Missouri are the results of one episode of widespread mineralization in the Ozark region rather than multiple and unrelated episodes. A possible source for the lead-zinc ore-solution may have been the predominately shaley sediments in the Ouachita geosyncline, expelled during diagenesis and low-grade metamorphism in Late Pennsylvanian-Permian time.

Fluid inclusion studies on barite from the Southeast Missouri barite district show that the barite mineralizing fluids were nearly identical to those for central Missouri. The similar mineralogy, fluid inclusion data, and geographic proximity of the two barite districts suggest they may be genetically related.

The complete absence of barite in the Southeast Missouri lead district suggests that it may be genetically distinct from the adjacent Southwest Missouri barite district.

Electron microprobe analysis of barite from central Missouri shows that small scale, repetitive, strontium-rich bands are common in many clear barite crystals. These bands are believed to be annual growth bands, similar to the varvelike bands reported in celestite from Clay Center, Ohio. Estimated growth rates for some barite crystals from central Missouri are in the range 1 cm/500 years to 1 cm/10,000 years. (Author's abstract)

LEACH, D. L., 1973b, Possible relationship of Pb-Zn mineralization in the Ozarks to Ouachita orogeny (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 5, no. 3, p. 269. Author at Lawrence Livermore Lab, P.O. Box 808, Livermore, Calif. 94550.

Epigenetic Pb-Zn mineralization occurs throughout the Ozark region covering an area of approximately 40,000 square miles. Fluid inclusion data for sphalerite from Tri-State, Northern Arkansas, and Central Missouri ore districts, as well as from minor occurrences outside the districts, show that the ore fluids were hot, strongly saline brines, having salinities generally greater than 22 weight per cent salts. The mineralogy, paragenesis, general habitat of the ores, and the fluid inclusion data suggest a common origin for the mineralization. The lowest homogenization temeprature for sphalerite in the region is 80°C, whereas the highest temperatures reached for sphalerite from Northern Arkansas, Tri-State, and Central Missouri were 132°C, 120°C, and 110°C respectively. This distribution of homogenization temperatures suggests that the heat source for the ore fluids was to the south. Any model for the mineralization that is proposed must not only consider the source of the fluids and the heat, but must consider the regional nature of the mineralization. Miser in 1943 attributed the quartz veins and certain metalliferous deposits of the Ouachita Mountains to the closing stages of Ouachita orogeny and suggests that the Tri-State ore deposits may have been contemporaneous. Deriving the ore fluids from the black shales in the Ouachita Geosyncline during low grade metamorphism provides the necessary regional model to explain the data, and it provides a likely source for the metals, shale generally being rich in heavy metals. The evolution and migration of the ore forming solutions, the high geothermal gradients in the Ozark region during mineralization, and the Ouachita orogeny may all be related to some deep-seated activity in Late Pennsylvanian-Permian time. (Author's abstract).

LEACH, D. L., 1973c, Possible two-stage mineralization in the central Missouri barite district, (abst.): Geol. Soc. America Abstracts with Programs, v. 5, no. 4, p. 331. Author at Lawrence Livermore Lab, P.O. Box 808, Livermore, Calif. 94550.

The many small deposits of galena, sphalerite, and barite that are found in central Missouri are believed to be part of the general stratiform mineralization in the Ozark region. However, the overwhelming predominance of barite over galena and sphalerite in the central Missouri barite district as contrasted with the absence of barite in the southeast Missouri lead belt and very minor occurrences in the Tri-State and northern Arkansas ore districts suggests important genetic differences.

Paragenetic study shows that the minor sphalerite and galena in the central Missouri barite district were formed prior to the deposition of any of the barite. Fluid inclusion data show that the sphalerite was deposited by strongly saline brines, generally greater than 22 weight per cent salts, in the temperature range 110°-80°C. At some time after cessation of Pb-Zn mineralization, barite was deposited at temperatures less that 40°C by solutions containing 5 to 10 weight per cent salts.

The period of barite mineralization may represent the cooling, dilution, and introduction of sulfate to an originally Pb-Zn-Ba-rich but sulfur-deficient brine. However, the lack of any mineral deposition in the temperature interval 80°-40°C and salinity range 22 to 10 weight per cent salts plus the absence of major barite mineralization in the Tri-State, northern Arkansas, and Missouri lead districts suggest the possibility of two distinct (and perhaps completely unrelated) episodes of mineralization in central Missouri. (Author's abstract)

LECERF, C., 1973, Extraction and analysis by gas chromatography of fluid inclusions in minerals and rocks: Univ. Nancy Diplome thesis, 36 pp (in French).

Considerable detail on techniques of extraction, gas handling, and chromatography, some analyses of inclusions, and possible application of technique to study of uranium deposits. (E.R.)

LEFAUCHEUX, F., TOURAY, J.-C., and GUILHAUMOU, N., 1972, Thermo-optical analysis of primary fluid inclusions in synthetic hydrothermal calcite: Bull. Soc. fr. Minéral. Cristallogr., v. 95, p. 620-622 (in French). First author at Laboratoire de minéralogie et cristallographie, Université Paris VI.

T_H of inclusions in calcite crystals grown from various concentrations of NH_4Cl and/or LiCl were compared with known conditions of T and P at growth. Pressure corrections (14-39°C) added to T_H yielded T of trapping equal to known T of growth, within experimental errors. (E.R.)

LE MAHIEU, G.C., (compiler), 1972, Tin mineralization of the world arranged geographically, an annotated bibliography derived from Chemical Abstracts and Mineralogical Abstracts, 1st supplement 1968-1969 (3 vols.) (117 pp.): Arnhem, Holland, Billiton Research B.V.

Contains about 380 references; those studies of tin ores including work on fluid inclusions in which inclusion data are mentioned in the published abstract will all be found here, but scattered. See next abstract and also Le Mahieu, 1970, Fluid Inclusion Research - Proceedings of COFFI, v. 3, 1970, p. 42. (ER)

LE MAHIEU, G.C., (compiler), 1973, Tin mineralization of the world arranged geographically, an annotated bibliography derived from Chemical Abstracts and Mineralogical Abstracts, 2nd supplement 1970 (3 vols.) (144 pp.): Arnhem, Holland, Billiton Research B.V.

Contains about 280 references; those studies of tin ores including work on fluid inclusions in which inclusion data are mentioned in the published abstract will all be found here, but scattered. See previous abstract and also Le Mahieu, 1970, Fluid Inclusion Research - Proceedings of COFFI, v. 3, 1970, p. 42. (ER)

LERMAN, A., 1973, Reactions in pore waters: Scenarios for models of diagenesis (abst): Amer. Geophys. Union, Trans. (EOS), v. 54, no. 4, p. 489.(Editor's note - See also 4 additional abstracts in same symposium)

LESSING, Peter & STANDISH, Richard P., 1973, Zoned garnet from Crested Butte, Colorado : American Mineralogist, v. 58, pp. 840-842. First author at West Virginia Geological Survey, Morgantown, West Virginia, 26505.

Anisotropic andradite from Crested Butte, Colorado, shows oscillatory zoning and dodecahedral twinning. Microprobe analyses reveal alternating zones that vary between nearly pure andradite and andradite$_{50}$-grossularite$_{50}$. Rapid changes in chemical composition of hydrothermal solutions or oxidation state of iron may explain the zoning. (Authors' abstract)

LIR, Yu.V., GUREEVA, I.A., and KARYAKIN, I.A., 1973, Temperature conditions of formation of ores from the Deputatskoe deposit: Leningrad Mining Inst. Zapiski, v. 65, no. 2, p. 39-42 (in Russian; abstract courtesy A. Kozlowski).

The deposit occurs in the NE part of Yakutia, and formed in five stages: quartz-tourmaline, cassiterite-silicate-quartz, quartz-sulfide, quartz-carbonate-sulfide, and carbonate. Samples of cassiterite (47) were investigated by the decrepitation method. At the Central Plot cassiterite (from the cassiterite-tourmaline-quartz stage) gave T_D = 370 to 540°C, and at the Western Plot cassiterite (from cassiterite-chlorite-quartz ores) is characterized by the T_D interval 320 to 360°C (7 and 40 samples respectively). Ore bodies close to parent granite massif contain cassiterites which have crystallized at higher T than the distant ones. (A.K)

LISTER, C.R.B., 1973, Hydrothermal convection at sea-floor spreading centers: source of power or geophysical nightmare?: Geol. Soc. Amer. Abstracts with Programs, v. 5, no. 1, p. 74. Author at Geophy. Program and Dept. of Oceanography, Univ. of Washington, Seattle, Wash. 98105.

Measurements of conductive heat-flow in the crustal regions of mid-ocean ridges average between 3 and 6 μcals/cm^2-sec (=HFU). If the new crustal material is emplaced at magmatic temperature, the heat-flow should average about 16 HFU for the zone of age less than 1.5 Myr. The discrepancy can be explained satisfactorily only by postulating that most of the heat is removed from the new material by hydrothermal percolation to substantial depths of 8 km or more. The hypothesis is consistent with details of the heat-flow distribution relative to topography, and with chemical analyses of surficial marine sediments near ridge crests. The continuous hydrothermal output power of about 20 MW per km of crest and cm-yr of half spreading rate is small compared to the energy fluxes in open-ocean circulation, making detection possible only in closed basins containing a ridge. The continuous energy output of say, the Juan de Fuca Ridge, 400 km long and 3 cm/yr, is 24,000 MW thermal, or potentially 10,000 MW electrical. This output power is not inconsiderable, but could require as many as 4000 successful boreholes to be tapped adequately, and would even then make no more than a minor contribution to world energy demand. The high cost of development would be justifiable only if the instantaneous power output available were more than 10 times the long-term mean, so that high demand peaks could be met more readily than by conventional systems. (Author's abstract).

LOFGREN, G.E., & DONALDSON, C.H., 1973, Experimental evidence bearing on the origin of "comb (Willow Lake) layering" (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 5, no. 7, p. 716. First author at Geology Branch, Johnson Space Center, Houston, Tx 77058.

Crystallization experiments in the systems Ab-An-H_2O and Ab-An-Or-H_2O have produced curved and/or branching plagioclase crystals typical of "comb (Willow Lake) layering." After melting, the experimental charges were crystallized either isothermally or at prescribed linear cooling rates. Curved or branching palgioclase developed best at large supercoolings (>100°C/hr). With increased water content in the melt the formation of branching crystals required larger supercoolings or cooling rates. In the ternary feldspar melts branching occurred at lower supercoolings and cooling rates than for the plagioclase melts with similar water contents. Curved crystals are gently arcuate, often twinned and may show stumpy, widely spaced dendritic branches. Branching crystals grade from highly curved forms with complex dendritic branching to coarse open fan spherulites with intricate non-crystallographic branching. Crystals vary from 1-5 mm in length, comparing favorably with natural occurrences. Growth of curved and branching plagioclase crystals at substantial values of supercooling (supersaturation) and at large cooling rates supports the suggestion of Harker (1909), revived by Taubeneck and Poldervaart (1960), that supercooling plays a role in the origin of "comb layering." As increased water content of the melt supresses growth of curved or branching crystals and promotes growth of tabular crystals, the suggestion of Moore and Lockwood (1973) that curved or branching cyrstals grew from an aqueous fluid is not supported. Supercooling (supersaturation) sufficient to produce "comb layering" in a plutonic environment may result from adiabatic expansion of the melt or rapid release of volatile constituents. (Authors' abstract).

LOSEV, N.A., and LYASHENKO, G.K., 1973, On possibilities of application of results of geochemical and decrepitometric methods of investigation during prospecting for hidden bismuth bodies in a region in Uzbekistan: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 263-264 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Tashkent Univ.

Decrepitation studies were made of >100 samples in a section 250 m long. Crystalline Paleozoic limestones are the wall rocks. On approaching ore, decrepitation activity increases (relative to background) and the upper temperature range of decrepitation remains practically constant. T_D (maximum intensity) increases, sometimes to the upper range of decrepitation (from 200-350 to 300-500°C).

At fracture zones, filled by tectonic clay with fragments of sulfides, the upper and lower T boundaries of decrepitation approach each other, sometimes forming one peak, accompanied by sharp decrease of decrepitation intensity. These features can be explained by previous natural decrepitation.

Decrepitometric investigations of sulfides from the ore deposit revealed temperature explosions (sic) from 170-190 to 380-400°C in the formation of the ore bodies, proving the pulsation of the stages of hydrothermal process. (Authors' abstract, abbreviated by A.K.)

LUKASHEV, A.N., 1973, Method of determining of (conditions of) formation of vugs in the Earth's crust: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 301 (in Russian; translation provided through the courtesy of A. Kozlowski). Author at All-Union Scientific Research Institute for the Synthesis of Mineral Raw Materials, Alexandrov.

I. The method of determination of vugs (chambers) in the Earth's crust is based on measurement of natural equilibrium parameters of vugs. These parameters depend on depth of formation and the strength of rocks. Calculations were made using formulas accepted in mining geology.

II. Determination of the depth of vug formation provides data on natural syngenetic vugs: 1. depth of formation of chamber pegmatites, rock-crystal-bearing veins, etc; 2. maximum depth of burial of sedimentary rocks, (thickness of) effusive blankets, etc.; 3. difference between pressure of hydrothermal-pneumatolytic solutions and lithostatic pressure; 4. true temperature of mineral-forming solutions by correction of the homogenization temperatures determined on fluid inclusions in minerals grown on the walls of vugs.

III. On basis of the calculation, it was ascertained that chamber pegmatites of the Kent granite massif (Central Kazakhstan) were formed at depth of more than 3 km, and the pressure of fluids, ascertained on primary fluid inclusions formed at the initial stage, was equal or somewhat higher than lithostatic pressure, but at the final "zanorysh" stage the relations were reversed. (Author's abstract)

LUZANOV, L.S., 1973, Regional differences in temperatures of formation of commercial types of fluorite mineralization: Program of the Fourth Regional Meeting on Thermobarogeochemistry of Mineral-Forming Processes, at Rostov-on-Don, 24-30 Sept., 1973: Rostov-on-Don, USSR (in Russian). (No abstract in Abstracts volume.)

LYAKHOV, Yu.V., 1973, Errors in determination of mineralization pressure, according to gas-liquid inclusions with halite; causes and means of elimination: Vses. Mineral. Obshchest., Zap., v. 102, no. 4, p. 385-393 (in Russian). Chem. Abst., v. 79, no. 11, 128022g, 1973.

Primary and secondary inclusions consisting of a gas phase 15-30, halite 15-30, and aqueous solutions 50-60% occur in early-generation minerals (tourmaline, scheelite, quartz, molybdenite) of ore deposits. Data from homogenization (partial and complete) studies are used to determine the crystallization temperature and consequently the mineralization pressure, by extrapolating the temperature on the isochron. Errors in the determination of pressure arise mainly due to inaccuracy in experimental techniques, limitations of the microthermometer, and miscalculation in the determination of the d. of the liquid phase. Mathematical correction factors are derived for use in the barometric determinations of gas-liquid inclusions.

MAENO, Norikazu, 1973, Studies of the dielectric properties of ice grown from KCl solution: Hokkaido Daigaku, Sapporo, Japan. Teion Kogaku Kenkyujo, Ser. A, no. 25, p. 1-47 (in English).

Polycrystals and monocrystals of ice were grown from KCl solutions and their dielectric properties were investigated as functions of frequency, temperature, concentration, grain size and thickness of each specimen. When the temperature was higher than the eutectic point of the KCl-H_2O system (-10.7°C) the presence of the liquid solution gave considerable effect on the dielectric properties. It was shown that chlorine ions were only incorporated in the crystal lattice of ice when a single crystal of ice was grown from a dilute KCl solution. The upper limit of the chlorine incorporation was approximately 1×10^{-4}M, presumably into lattice defects. (Author's abstract, abbreviated by E.R.)

McCLURE, J.W., Jr., 1973, Base metal content of oil field brines in eastern Kansas (abst.): Geol. Soc. America Abstracts with Programs, v. 5, no. 4, p. 336. Author at Dept. of Geology, Univ. of Missouri, Columbia, Missouri 65201.

Chemical analyses have been made of 27 oil-field brines from eastern Kansas. Representative analyses are:

Rock Unit		Arbuckle	Viola	Mississippi Lime	Bartlesville
pH		7.03	6.88	6.60	7.01
Sp.Gr.		1.028	1.019	1.039	1.072
Fe	(mg/1)	0.65	1.30	9.50	40.0
Mn	"	1.00	0.34	0.58	3.3
Ni	"	1.1	0.77	1.5	2.9
Pb	"	1.7	1.1	1.9	3.4
Zn	"	0.06	0.13	0.09	.14
Cu	"	0.14	<0.1	<0.1	.22
Cr	"	0.09	0.08	0.15	.17
Li	"	7.6	5.0	8.1	4.6
Na	"	14500	8400	17700	35200
K	"	168	114	201	176
NH_3	"	19.0	6.1	28.6	39.3
Mg	"	545	455	967	1150
Ca	"	2420	1380	2940	6000
Cl	"	26100	18840	35720	68040
Br	"	46.6	32.2	73.9	224
SO_4	"	1280	110	325	250
HCO_3	"	250	370	200	136
H_2S as S	"	45	225	135	<1
TDS(calc)	"	45400	30100	58400	110900

The low Br/Cl ratio suggests dissolution of bedded halite (Hutchinson salt?). One mg/l Pb in water containing more than 100 mg/l H_2S is unexpected, and is being investigated. (Author's abstract)

McGETCHIN, T. R. & BESANCON, J. R., 1973, Carbonate inclusions in mantle-derived pyropes: Earth and Planetary Science Letters, v. 18, pp. 408-410. Authors at Massachusetts Institute of Technology.

Calcium and magnesium-rich carbonate inclusions are observed within chrome-rich apparently mantle-derived pyropes from kimberlitic diatremes of northern Arizona. K_2O content of the carbonate is low (less than 0.1%); SrO contents approach 1%. While our observations imply the presence of a carbonate phase in the upper mantle, K_2O is not concentrated within it as has been suggested. (Authors' abstract)

MAHON, W.A.J., 1973, The chemical composition of natural thermal waters, in Symposium on Hydrogeochemistry and Biogeochemistry, Tokyo, Japan, Sept. 7-9, 1970, v. 1, Hydrogeochemistry, 662 pp.: Washington, D.C., The Clarke Co., p. 196-210.

This is only one of 50 papers in this volume, all dealing with various aspects of natural waters, their chemistry and interactions with solids and gases, and hence pertinent to studies of fluid inclusions. (ER)

MAISKIY, YU. G., 1973, On local and regional subisothermal processes of mineral formation: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 38-39 (in Russian; translation provided through the courtesy of A. Kozlowski). Author at Rostov University.

Mass crystallization of minerals takes place at individual deposits in narrow temperature ranges that do not depend on their regional position. At individual deposits with vertical sections over 1 km, significant changes of mineral parageneses and temperatures of origin were not found.

This local and regional subisothermal nature of mineral forming processes depends on the changes of structural and energetical level of fluids (V.N. Trufanov, et. al., 1971), originated by critical phenomena in solutions under thermal and pressure gradients. Factors which determine the direction and dynamics of crystallization processes include structure of solutions, their ability to exist for long times in the metastable state, etc.

Investigations of the remmant mineral forming fluids in inclusions testify to the possibility to recognize primary magmatic fluids and the metamorphic fluids forming polymetallic or gold deposits. The distinction is based on the daughter minerals in inclusions and autometasomatism in hydrothermal minerals. In magmatic condensates the concentration of water-soluble salts increases with decrease in the thermodynamic parameters; in metamorphic solutions, the reverse was found. (Author's abstract)

MAL'KOV, B.A. AND BOBOLOVICH, G.N., 1973, On two generations of calcite in kimerlites: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes: Rostov, Rostov Univ. Press, p. 219 (in Russian; translation through the courtesy of A. Kozlowski) Authors at Komi Division, Acad. Sci. of USSR.

Petrographic investigations of kimberlites from the Yakutian pipes Udachnaya, Vostochnaya, Obnazhonnaya, and Olivinovaya show the presence of two generations of calcite (primary-magmatic and hydrothermal) in kimberlite rock.

In hydrothermal calcite two types of 2-phase inclusions were found: 1) partly faceted inclusions (0.01 - 0.02 mm), F = 20%, T_H 225-253°C (in liquid), they are believed to be primary; 2) on the basis of type of filling these are considered to be anomalous inclusions.

In magmatic calcite, in addition to scarce secondary hydrothermal inclusions, minute melt inclusions were found.

T_H was determined by 1.5 - 2-hour equilibration in a heating stage at 600, 625, 650, 675 and 700°C, followed by rapid cooling (quenching) and observations of changes of phase volumes in inclusions; at 650-675°C bubbles moved and became smaller, at 700°C calcite became turbid due to dehydration and decomposition of serpentine and further oberservations were impossible. Full homogenization ought to occur at 700-750°C. (Authors' abstract)

MALYSHEV, A.G., KOLBIN, B.A., SAMOYLOVICH, M.I., SKOBEL', L.S. & TSINOBER, L.I., 1973, Temperature of formation of quartz crystals from Neroyskoe field, Pripolyarnyi Ural: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 122 (in Russian; translation through the courtesy of A. Kozlowski).

Authors at VNIISIMS, Aleksandrov.

Quartz veins occur in Proterozoic schists in a fault zone; the veins formed after intrusion of Variscan granite massifs and dikes of mafic and acid rocks. During vein formation the wall rocks were as hot as 400-450°C, and late quartz with anomalous smoky pleochroism at temp. lower than 250°C. Both generations are associated with sharply differing paragenetic minerals. (Authors' abstract, abbreviated by A.K.).

MARKOVA, M.Ye. AND BOYKO, S.M., 1973, Characteristics of ore-forming solutions of the polymetallic Kurultykenskoe deposit as an indicator of the possibilities of hidden tin mineralization: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 141-142 (in Russian; translation through the courtesy of A. Kozlowski). Authors at Geochemistry Institute of Siberian Branch of Academy of Sciences, USSR.

The deposit belongs to the tin-tungsten zone of Zabaykal'ye and genetically is connected with tin ore deposits. Vertical zonality indicated by fluid inclusions is very distinct. From Fifth Ore Body toward the First and Second Ore Body the following changes of gas-liquid inclusions are characteristic:

Mineral	Quartz		Sphalerite		Galenite	
Ore body	5th	1st&2nd	5th	1st&2nd	5th	1st&2nd
pH	8.9	9.2	5.7	7.6	6.1	7.7
Na/K	0.7	4.5	1.0	1.4	1.2	1.9
Li/Na	0.76	0.43	0.13	0.10	0.10	0.07
Li/K	0.62	0.84	0.14	0.11	0.15	0.06
F/Cl	0.62	0.30	1.6	0.32	1.1	0.3

Deep acid solutions of F-K composition (enriched in Li), became alkaline and of Cl-K type (with increased Rb) at more shallow levels. (Authors' abstract)

MARTIN, R.F., & MACLEAN, M. H. , 1973, Crystal growth forms in Hawaiitic lavas of Heimaey, Iceland (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 5, no. 7, p. 726-727. Authors at Department of Geological Sciences, McGill University, Montreal 110, Quebec, Canada.

The lavas and bombs of the earlier, more differentiated stages of the recent Heimaey eruption contain microphenocrysts of plagioclase, olivine, titanomagnetite and ilmenite, set in a groundmass containing the same phases. A variety of crystal forms occurs in these phases. Plagioclase laths, not obviously zoned, have short prolongations from the corners; the U-shapes host crystalline matrix identical to that away from the crystal. Olivine crystals are more strikingly skeletal, many bound by crystal faces, and usually enclosing a very irregularly-shaped, lobate inclusion of pristine brown glass. Incomplete skeletons of olivine also occur in the specimens; these may be bound by one or two planar faces, the remainder of the grain having smooth, curvilinear boundaries, many with re-entrants. These forms grade into lobate,"blobby" grains devoid of crystal faces. Similar textural gradations are very well developed in titanomagnetite, but less so in ilmenite. The lobate texture is here interpreted as a growth form typically developed where minerals grow rapidly in a viscous medium at moderate degrees of supercooling.

This interpretation finds support in the occurrence of the same phases in the matrix, the absence of mineralogical evidence for resorption, and the duplication of growth forms grading from classic skeletons to lobe-textured grains in synthetic olivine-magnetite-wustite assemblages grown while quenching melts of known thermal history. The terms resorbed and corroded, used by many to describe such crystals, must be avoided because of the unambiguous but misleading genetic connotation. (Authors' abstract)

MASSON, Daniel, MARTIN, René, RICHARD, Claude, and TOURET, Jacques, 1973, Gas chromatographic study of carbon dioxide fluid in the granulite facies: C. R. Acad. Sci. Paris, v. 276, Ser. D, (22 Jan. 1973), p. 461-464 (in French).

Chemical analyses of the CO_2 inclusions in granulite facies rocks reveal the possible presence of hydrocarbons (CH_4) in essentially pure CO_2 fluid with a melting point of -57°C. (Authors' abstract)

MATSUBAYA, Osamu, and SAKAI, Hitoshi, 1973, Oxygen and hydrogen isotopic study on the water of crystallization of gypsum from the Kuroko type mineralization: Geochemical Journal, v. 7, p. 153-165. Authors at Institute for Thermal Spring Research, Okayama University, Misasa, Tottori 682-02, Japan. (In English)

The $\delta^{18}O$ and δD values of water of crystallization of gypsum from the Kuroko type mineralization in Japan mostly fall in narrow ranges from -6 to -8 and from -75 to -90 ^{o}/oo, respectively.

While the mineralization has generally been accepted as of submarine hydrothermal origin, the present results indicate that the gypsum ores are in isotopic equilibrium with meteoric waters instead of sea water. The most plausible interpretation for this observation is that the primary submarine anhydrite or gypsum was hydrated or re-equilibrated with meteoric waters after the uplifting of the deposits. However, there is some evidence that meteoric hydrothermal solutions might have been involved in certain stages of Kuroko mineralization at Shakanai. The $\delta^{18}O$ and δD values of gypsum of the Tsutsumizawa deposit in Hanaoka, Northeast Honshu, fall on a line with a slope ($\delta D/\delta^{18}O$) of -5.3. This suggests that the deposit was formed by fractional hydration of an anhydrite deposit under a limited supply of water, of which isotopic ratios were similar to present-day meteoric waters. Gypsum ores of Noto and Osaka-Matsushiro, Southwest Honshu, are isotopically quite different from most of other Kuroko deposits. These gypsum ores seem to have been hydrated by hydrothermal waters which isotopically are significantly shifted from meteoric waters. (Authors' abstract)

MATSUBAYA, Osamu, SAKAI, Hitoshi, KUSACHI, Isao, and SATAKE, Hiroshi, 1973, Hydrogen and oxygen isotopic ratios and major element chemistry of Japanese thermal water systems: Geochemical Journal (Japan), v. 7, p. 123-151 (in English). First author at Inst. for Thermal Spring Research, Okayama Univ., Misasa, Tottori-Ken 682-02, Japan.

More than 140 thermal waters of Japan were studied isotopically and chemically. Some are isotopically and chemically best explained as the mixtures of local meteoric waters and a saline brine of $Cl^- = 43{,}700$ ppm, $\delta^{18}O = +8‰$ and $\delta D = -30$ to $-25‰$. Many of the thermal waters along the ocean coasts are isotopically intermediate between oceanic and local meteoric waters and are considered to be mixtures of the two types of water. Acid to neutral thermal waters of volcanic affiliation indicate varying degrees of isotopic shifts, but they are supposed from their δD values to be essentially derived from recycled meteoric water. (Authors' abstract, greatly abbreviated by E.R.)

MAZOR, E., and FOURNIER, R.O., 1973, More on noble gases in Yellowstone National Park hot waters: Geochimica et Cosmochimica Acta, v. 37, p. 515-525. First author at the Israel Atomic Energy Commission and the Weizmann Institute, Rehovot, Israel.

Water and gas samples from research wells in hydrothermal areas of Yellowstone National Park, U.S.A., have been mass spectrometrically analyzed for their rare gas contents and isotopic composition. In agreement with previous findings, the rare gases have been found to originate from infiltrating run-off water, saturated with air at 10 to 20°C. The atmospheric rare gas retention values found for the water varied between 3 and 87 percent. The fine structure of the Ar, Kr and Xe abundance pattern in the water reveals fractionational enrichment of the heavier gases due to partial outgassing of the waters. Radiogenic He and Ar have been detected. No positive evidence for magmatic water contribution has been found. Nevertheless, additions of magmatic waters free of rare gas can not be excluded, but if present the proportion is significantly less than 13 to 36 percent. (Authors' abstract)

MEHNERT, K.R., BÜSCH, W., and SCHNEIDER, G., 1973, Initial melting at grain boundaries of quartz and feldspar in gneisses and granulites: N. Jb. Miner. Mh., H. 4, p. 165-183.

In order to study initial melting processes in rocks of high metamorphic grade, e.g. gneisses, granulites and feldspar-bearing quartzites, hydrothermal experiments were carried out at varying temperatures, H_2O pressures and time intervals. The formation of melts at quartz/feldspar boundaries (K feldspar and plagioclase) was investigated qualitatively and, with respect to the thickness of such melts, also quantitatively. Series of photomicrographs reveal many petrographic details about the progress of reactions from the surface towards the interior of the rock specimen. Problems concerning the applicability of the model to melting processes in the deep crust of the earth are discussed.

From microprobe scanning profiles across grain boundaries it can be seen that melting starts at very fine-grained, often sub-microscopic poly-phase contacts of mineral aggregates following the grain boundaries. The composition of the melt was determined by microprobe analysis. (Authors' abstract)

MELNIKOV, F.P., 1973a, System analysis of ore deposits: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 36-38 (in Russian; translation provided through the courtesy of N.P. Ermakov). Author at Moscow University.

It is known that the formation of ore deposits is a complex, long and multistage process. The complexities of this process depend on the many components taking part in it.

The structural, morphological, mineralogical and geochemical investigations that do not give full presentation about peculiarities of mineral formation processes, do not determine the general factors of ore formation. Mineral thermometrical physico-chemical and structural petrophysical investigations of deposits, recently started, are the new step in the knowledge of understanding their formation. These investigations gave a number of new factors, opening our mind on the processes of mineral and ore formation and their dynamic development.

It is obvious that a knowledge of the essence of processes resulting in concentration of one or a group of elements in a definite area of Earth's crust and exposure of general regularities of the processes are possible only by investigation of a whole complex of thermodynamic parameters and components taking part in these processes, and their connection and interaction.

A number of investigators consider the ore deposits as original systems, consisting of different components (parts, elements, subsystems) being in definite causal-investigatory relationship. It is believed that investigation of deposits as complex systems can be fruitful. It is necessary to point out that system analysis of ore deposits required from investigators not only thorough knowledge of all components of ore systems in their different correlation, but also logical restoration of the parameters and processes that resulted in formation of a deposit.

Gas-liquid inclusions in minerals are the connected team in all chains of events. Investigations of them permit us to understand the dynamics of changing thermodynamic parameters and physicochemical conditions of ore forming system.

The problem of system analysis of ore deposits is complex. Its decision will require working out a number of questions concerning methods. For this discussion we present a structural model of ore forming systems. The interaction of mineral forming solutions and host rocks, and the role of thermodynamic parameters and tectonic movements on the different stages of evolution of this system are analyzed. The processes of heat and mass interchange, crystallization and dissolution, and chemical reaction attendant to ore formation are examined. The construction of a structural model of the ore forming system reveals the interrelations between its elements, and provides an idea about the system and its evolution in time and space. (Author's abstract).

MELNIKOV, F.P., 1973b, The phase transformations in microsystems of inclusions at low temperatures: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 39-40 (in Russian; translation provided through the courtesy of N. P. Ermakov). Author at Moscow University.

Cryometric investigations of solutions in inclusions is becoming widespread. Freezing temperatures of solutions and gases are used for revealing their quantitative and qualitative characteristics. The investigations in the region of low temperatures permits observation of different processes and phase changes in microsystems of inclusions at various temperatures.

We have noted some pecularities in the physicochemical phenomena of inclusions at low temperatures. Further investigations in this region have given a number of new factors. It turned out that the region of low temperatures for microsystems of inclusions are as full of different information as the region of high temperatures.

The changing of solution structure by cooling, the types of freezing, morphological peculiarities of newly formed crystalhydrates, and a number of other phenomena depend on composition and concentration of solution. To understand this dependence is to get at the possibility of revealing the peculiarities of solutions in inclusions by the dynamics of the processes and by phase transformations.

During the experiments we have made a motion picture and fixed physicochemical phenomena and phase transformations, happening in inclusions by cooling, freezing and melting. (Author's abstract).

MEL'NIKOV, F.P. and BAZAROV, L.Sh., 1973, Cryometric studies of inclusions: Program of the Fourth Regional Meeting on Thermobarogeochemistry of Mineral-Forming Processes, at Rostov-on-Don, 24-30 Sept., 1973: Rostov-on-Don, USSR (in Russian). (Part of an inclusion training session; No abstract in Abstracts volume.)

MEL'NIKOV, F.P. and POLYANSKIY, Ye. V., 1973, Temperature zoning and stages of formation of the main ore vein of the Bom-Gorkhon tungsten deposit, Western Transbaikal: Akad. Nauk SSSR, Doklady v. 212, no. 2, p. 446-449, (in Russian; translated in Doklady Akad. Sci. USSR, v. 212, p. 61-64, 1974; abstract in Int. Geol. Rev., v. 15, no. 11, p. 1362, 1973.) Authors at M.V. Lomonosov State University, Moscow.

Zonations, up-dip and cross-vein (fig. 4), decreptograms of inclusions in vein quartz (fig. 3), and temperature-time sequence of the regimes in the mineralogenesis indicate an almost isothermal mineralization in stage I (480-500°C in the core of the body and up to 520°C on the periphery) and a considerable thermal differentiation in the next two stages. These findings and the geological position of the vein (fig. 1) suggest a relatively free inflow of the stage I solution into the fissure, the host of the vein, and a rather intensive tectonic factor, in ore itself, in the last two stages of the process. (Authors' abstract).

MERINO, Enrique, 1973, Chemical relationship between interstitial brines and diagenetic minerals in Tertiary sandstones of the Kettleman North Dome Oilfield, California (abst): Amer. Geophys. Union, Trans. (EOS), v. 54, no. 4, p. 488.

MEYER, H.O.A., and SVISERO, D.P., 1973, Mineral inclusions in Brazilian diamonds (extended abst.): in Internat. Conf. on Kimberlites, Extended Abstracts of Papers, L.H. Ahrens, et al., eds.: Univ. of Cape Town, Rondebosch, Cape Town, South Africa, p. 225-228. Authors at Dept. of Geosciences, Purdue Univ., West Lafayette, Indiana 47907.

MIKHAYLOVA, G.V., KUNIN, L.L. AND NAUMOV, G.B., 1973, Application of laser for analysis of gaseous-liquid inclusions in fluorite: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 288 (in Russian; translation through the courtesy of A. Kozlowski). Authors at Vernadskiy Inst. of Geochemistry and Analytical Chemistry, Acad. Sci., of USSR, Moscow.

During investigation of composition of G-L inclusions in minerals it is very important to have a clean method of opening them. In this paper the methods of mechanical breaking under vacuum, thermodestruction, and use of a focussed laser bean were evaluated. Natural fluorite bearing inclusions filled mainly by H_2O and CO_2 was used. Released gases were condensed on an element cooled by liquid nitrogen, and during graduated heating they went into a gas analyser. (...).

Data were obtained on the kinetics of releasing of H_2O & CO_2 and on relative concentration of these compounds in four samples of fluorite.

Results of the studies prove that for determination of the average composition of inclusions the heating method is better, and for inclusions with low internal pressure the use of a laser gives good results. About 10^{-5} mm^3 of gas can be analyzed, i.e., an inclusion containing about 10^{-5} mm^3 of gas. (Authors' abstract, abbreviated by A.K.)

MILASHEV, V.A., 1972, Physico-chemical conditions of kimberlite origin: Leningrad, "Nedra" Pub. House, 176 pp. (In Russian; abstract through the courtesy of A. Kozlowski).

T of disappearance of anomalous piezobirefringent zones in diamonds around inclusions of garnet, olivine and pyroxene, under atmospheric pressure, are as follows: 1080 - 1200°C. Taking into account thermal expansion and linear shortening under pressure, T of probable crystallization of diamonds were calculated as 1700 - 2100°C under P 30 - 50 kbars (p. 92).

Carbonate alteration of kimberlites followed during 3 T stages. Occasionally there was partial replacement by celestite in the middle stage (see table).

Calcite also occurs, bearing only one-phase liquid inclusions, testifying to crystallization at $T \leq 50$°C. Magnetite occurring in kimberlites gave T_D 350-650°C with maximum at 400-540°C.

Kimberlite pipe	Mineral	T_H of gaseous-liquid inclusions, °C		
Udachnaya-Vostochnaya	Calcite	410	340-210	180-150
Dal'nyaya	do.	450-405	275-185	160-110
Nachal'naya	do.	-	250-160	140-100
Sytykanskaya	do.	400	280-190	160-130
Zarnitsa	do.	-	190-180	140-110
	Blue celestite		350-240	
	Pink celestite		255-215	

Note: These values taken from the author's Figure 16, p. 99. The data on T_H of calcite and celestite were cited by the author from his earlier paper: MILASHEV, V.A., 1965, Petrochemistry of kimberlites from Yakutia and factors of their diamond-bearing nature: Trudy NIIGA v. 139, "Nedra" Pub. House.

MIRONOVA, O.F., 1973, Gas-chromatographic analysis of mineral disseminations: Jour. Anal. Chem., v. 28, no. 8, p. 1561-1564 (in Russian). Author at V.I. Vernadsky Inst. of Geochemistry and Analytical Chemistry, USSR Acad. of Sci., Moscow.

Gas-liquid disseminations in minerals can be analyzed for CO_2, CH_4 and H_2O by the gas chromatography method. Conditions for the determination, the sensitivity and precision of the method are given. (Author's abstract).

MIRONOVA, O.F., NAUMOV, G.B., and FROLOV, E.V., 1973, Chromatographic determination of gas concentration in inclusions of mineral-forming media: Geokhimiya, 1973, no. 10, p. 1514-1521 (in Russian with English abstract; full translation available from Amer. Geol. Inst.). Authors at V.I. Vernadsky Institute of Geochemistry and Analytical Chemistry, USSR Academy of Sciences, Moscow.

A method of gas-chromatographic analysis of inclusions with the use of the polymeric sorbent Polysorb has been proposed, which permitted determination of methane, carbon dioxide and water from one weighed sample (of the order of 0.5g) with 0.1, 2.4 and 2.5 μg sensitivity respectively and a relative error within the ranges of 5%. A method of opening the inclusions and of gas transfer to the chromatographic column has been elaborated. Results of the analysis of inclusions in quartz (Pamir) are given, where CH_4 concentration (0.14 mol/1000g H_2O) has been determined for the first time. The oxidation-reduction potential of the mineral-forming solution has been calculated according to the results of analysis. (Authors' abstract)

MIRONOVA, O.F., NAUMOV, V.B., and SALAZKIN, A.N., 1973, The investigation of gas-fluid inclusions with hydrogen sulphide in quartz, Eastern Transbaikal: Geokhimiya, 1973, no. 12, p. 1838-1845 (in Russian with English abstract; trans. in Geochem. Internat., v. 10, no. 6, 1974, p. 1350-1356). Authors at V.I. Vernadsky Institute of Geochemistry and Analytical Chemistry, USSR Academy of Sciences, Moscow.

The hydrogen sulphide in gas-fluid inclusions was detected as a result of microscopic, thermometric and cryometric investigations of these inclusions in quartz from Eastern Transbaikal. The method of gas chromatography determination of hydrogen sulphide in association with CH_4, CO_2, H_2O was suggested. Polysorb was used as a sorbent. The detectable limit of H_2S determination is $5 \cdot 10^{-6}$g. The concentration of all noted species of gases in gas-fluid inclusions in quartz was determined. Their partial pressures as well as the partial pressure of hydrogen were evaluated by thermodynamic calculations. The dependence of sulphate-ion activities as well as the redox potentials of solutions in inclusions from pH values is established. (Authors' abstract)

MIROSHNICHENKO, L.A., and GULUAEV, A.P., 1972, Lime skarns of magmatic stage and their connection with ore mineralization (exemplified by a skarn-greisen deposit), in Papers of All-Union Symposium, Alma-Ata, 1972, Kazakh Scientific-Research Institute of Mineral Raw Materials, and Inst. of Geological Sciences, Academy of Sciences of Kazakh SSR, part 1, Alma-Ata 1972, pp. 165-172. (In Russian; abstract through the courtesy of A. Kozlowski). Authors at Inst. of Geological Sciences, Acad. of Sci., Kazakh SSR, Alma-Ata.

Decrepitation temperatures of skarn minerals: pyroxene, garnet, and vesuvianite, are in the range 500-460°C (deposit name not given). The ore minerals present are cassiterite, scheelite, galena, and chalcopyrite.

MISHINA, N.B., KOPLUS, A.V., AND KHITAROV, D.N., 1973, Peculiarities of physico-chemical conditions of formation of fluorite ores at Dzhungarian Alatau: Abstracts of papers from the Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 116-117 (in Russian; translation through the courtesy of A. Kozlowski). Authors at All-Union Institute of Mineral Raw Materials, Moscow - VIMS.

Formation of fluorites in the S. Dzhungarian metallogenetic zone of Kazakhstan took place during a temp. drop from 230 to 50°C. Early fluorite cyrstallized at 230-190°C, commercial fluorite ores formed at 170-100°C, and the last generation crystallized from remnant solutions at 90-50°C. The second stage had an additional temperature maximum at 170-140°C. Triple water leachates showed that the solutions were of Na-Ca-F-HCO_3-Cl composition. The cation composition depends upon the wall rocks. The solutions in inclusions in fluorites from monzonites are enriched in K (up to 38%), and those in dark varieties of fluorite are enriched in Ca (up to 58%). (Authors' abstract)

MITCHELL, R.H., 1973, Theoretical aspects of gaseous and isotopic equilibria in the system C-H-O-S with application to kimberlites (extended abstract): in Internat. Conf. on Kimberlites, Extended Abstracts of Papers, L.H. Ahrens, et al., eds.: Univ. of Cape Town, Rondebosch, Cape Town, South Africa, p. 231-234. Author at Dept. of Geology, Lakehead University, Thunder Bay, Ontario, Canada.

MOORE, J.G., and LOCKWOOD, J.P., 1973, Origin of comb layering and orbicular structure, Sierra Nevada batholith, California: Geol. Soc. Amer. Bull., v. 84, p. 1-20. Authors at U.S. Geological Survey, 345 Middlefield Road, Menlo Park, California 94025.

A new descriptive term, comb layering, is proposed to replace the informal term Willow Lake-type layering, first introduced by Poldervaart and Taubeneck (1959) to describe layering in granitoid rocks in which constituent crystals are oriented approximately perpendicular to individual layers. Comb layering is widespread in plutonic rocks of California and is commonly associated with orbicular diorites. Evidence from a detailed study of three localities in the Sierra Nevada indicates that comb layering cannot have formed from silicate magma, and further suggests that the layers have been deposited by large volumes of aqueous fluids that migrated upward along contacts between magma and wallrock or along the interface between magma and previously solidified melt. Comb layering and orbicules are largely restricted to structural traps into which upwardly migrating, solute-rich water was channeled owing to its low density. The comb layers grew on the solid walls of fluid-filled channels, whereas orbicules formed by precipitation of comb layers on bobbling inclusions suspended within the upward-flowing fluid. (Authors' abstract, shortened)

MOORE, J.G., and SCHILLING, J.G., 1973, Vesicles, water, and sulfur in Reykjanes Ridge basalts: Contr. Mineral. and Petrol., v. 41, p. 105-118. First author at U.S. Geological Survey, Menlo Park, California 94025.

Dredge hauls of fresh submarine basalt collected from the axis of the Reykjanes Ridge (Mid-Atlantic Ridge) south of Iceland were taken aboard R/V TRIDENT in 1967 and 1971. The samples show systematic changes as the water depth of collection (and eruption) decreases: radially elongate vesicles and concentric zones of vesicles appear at about 700 m depth and are conspicuous to shallow water; the smoothed volume percent of vesicles increases from 5% at 1000 m, 10% at 700 m, to 16% at 500 m, and the scatter in degree of vesicularity increases in shallower water; specific gravity decreases from 2.7 ± 0.1 at 1000 m to 2.3 ± 0.3 at 100 m.

Bulk sulfur content for the outer 2 cm averages 843 ppm up to a depth of 200 m, then drops off rapidly in shallower water owing to degassing. Sulfur content below 200 m is independent of depth (or geographic position), and the melt is apparently saturated with sulfur, but the excess cannot escape the lava unless another vehicle carries it out. Only shallower than 200 m, where intense vesiculation of other gases occurs can excess sulfur be lost from the lava erupting on the sea floor.

$H_2O^{+110^\circ}$ averages about 0.35 percent and $H_2O^{+150^\circ}$ about 0.25 percent, and both apparently decrease in water shallower than 200 m as a result of degassing. H_2O^+ (below 200 m) decreases with distance from Iceland or increasing depth, presumably as a result of either adsorption of water on the surface of shallower, more vesicular rocks; or more likely due to the presence of the Iceland hot mantle plume supplying undifferentiated primordial material, relative to lavas of the Reykjanes Ridge supplied from the low velocity layer already depleted in volatiles and large lithophile elements. The $H_2O^{+110^\circ}/S$ ratio of lava erupting below 200 m water depth ranges from 3 to 5 which is comparable to reliable gas analyses from oceanic basaltic volcanoes. (Authors' abstract)

MOORE, W. J., 1973, Igneous rocks in the Bingham mining district, Utah: U. S. Geological Survey Professional Paper No. 629-B.

Igneous rocks in the Bingham area include two small monzonitic stocks, a series of younger latitic breccias and flows. The igneous rocks were emplaced or erupted over a period of about 8 million years in latest Eocene and early Oligocene time (39-31 million years ago). Progressive increases in silica content and in proportions of alkali feldspar to plagioclase suggest that the rocks were derived from a single magma source. Stratigraphic reconstruction gives a maximum depth of cover of 7,500 feet at the time of monzonitic plutonism. The magma system was probably fluid-undersaturated (P fluid < P load) early in the igneous history, but separation of a fluid phase occurred at least twice in the later stages of magmatism. This enrichment in hydrous fluids is considered to be a further consequence of the same differentiation process that led to increasingly silicic or potassic bulk compositions or both. Vertical displacement and concomitant erosion of fault-bounded blocks of roof rock may have facilitated emplacement of the intrusive complex at the present level of exposure. (Author's abstract)

MOROZOV, S.A., KOMOV, I.L., ELINSON, M.M. AND MATROSOV, I.I., 1973, Geochemical peculiarities and mechanism of formation of rock-crystal bearing deposits of Pamir: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 182-183 (in Russian; translation through the courtesy of A. Kozlowski). Authors at Inst. of Geol., Acad. Sci. of Tadzhikistan SSR, All-Union Scientific Research Inst. for Synthesis of Mineral Raw Materials, IGEM, Acad. Sci. of USSR, Tomsk State Univ.

1. Rock crystal at Pamir occurs in quartz veins genetically connected with magmatic activity of Alpine age. Their formation may be divided into three stages: 1) T ca. 500°C, P not lower than 1000-1500 bars; formation of veins not bearing rock crystal; 2) T=450-350°C, P ca. 1000 bars, rock-crystal-bearing veins, rock crystal has crystallized at the end of this stage at T=400-300 (sic)°C & P=ca. 1000 bars; 3) T=300-100°C & P=800-300 bars, crystallization of main mass of rock crystal. For crystallization of high-quality rock crystal stable thermodynamic conditions are necessary (at Pamir T=290-220°C & P=900-650 bars, rarely lower).

2. Quartz-forming solutions were (. . . .) highly concentrated (280-40g/1) solutions of sodium silicates with Cl^-, HCO_3^-, SO_4^{2-}, K, Mg, Ca, Fe, Ba, Al, CO_2, H_2, and N_2. Sometimes O_2 was found. During T drop an increase of H_2/CO_2 ratio is observed, but during forming of rock, the role of CO_2 again increases. (Authors' abstract)

MOSKALYUK, A.A., 1973, Determination of the composition of mineral-forming solutions by the method of aqueous extracts: summary of thesis, 80 pp. (in Russian): Leningrad, Ministry of Geology USSR. Author at VSEGEI, Leningrad.

A summary of fluid inclusion analyses, including analytical techniques, and 11 analyses by the author for K, Na, Ca, Sr, Ba, SiO_2, Cl, F, SO_4, HCO_3 and pH in inclusions in quartz. (E.R.)

MUENOW, D.W., 1973, High temperature mass spectrometric gas-release studies of Hawaiian volcanic glass: Pele's tears: Geochimica et Cosmochimica Acta, v. 37, p. 1551 to 1561. Author at Chemistry Department, University of Hawaii, Honolulu, Hawaii 96822.

The identification of gaseous molecular species and mechanisms of their release from glassy lava have been investigated with a high temperature mass spectrometer. Using Pele's tears as representative of quenched liquids of Hawaiian tholeiitic basalts, it was found that volatiles are released at low temperatures by a rate-limiting diffusion mechanism and, at temperatures in the softening range of the glass, by bursting of bubbles trapped near the vaporizing surface of the sphere-like particles.

Gases released by bursting gave pressure surges and were found to be water vapor, CO_2 and CO. Those released principally by diffusion, and in some cases generated by thermal degradation and further reaction with the sample, include H_2, O_2, N_2, S_2, H_2S, SO_2, SO_3, COS, HCl, HF and NH_3. Average mole percent compositions of the volatiles H_2O, CO_2 and SO_2 relative to the total gas released were found to be 95 percent, 3.5 percent and 1 percent, respectively. Minor concentrations of organic constituents, previously unobserved in volcanic gas analyses, were also found. Fragmentation patterns and gas release behavior suggest that these are derived from a mixture of low-molecular weight saturated and unsaturated acyclic hydrocarbons (C_1-C_4). (Author's abstract)

MULLIN, J.W., 1972, Crystallisation (2nd Ed.): Cleveland, CRC Press, 480 pp.

A general review of crystallization mechanisms, processes, and results, including several pages on inclusion formation. (ER).

MULLIS, Josef, POTY, Bernard, and LEROY, Jacques, 1973, New observations on inclusions of methane in quartz of Val d'Illiez, Valais, Switzerland: C. R. Acad. Sci., Paris, v. 277, Ser. D, (10 Sept., 1973), p. 813-816 (in French). First author at Inst. Min. and Petrog., Univ. Fribourg, CH 1700, Fribourg, Switzerland.

Microthermometric studies of prismatic and scepter quartz show that they were formed from both a homogeneous aqueous solution containing methane, and a heterogeneous one, with a separate methane phase. Crystallization temperature was 240-260°C, at a pressure of about 1600 bars. (Authors' abstract)

MUNSURI, A.S., 1973, El cuarzo: Boletin del Inst. Gemologico Español, v. 2, no. 4, p. 7-18 (in Spanish).

A review with brief discussion (and photomicrographs) of liquid and solid inclusions (ER).

MYSEN, Bjørn O., and BOETTCHER, A.L., 1973, Phase relations in peridotite-H_2O-CO_2 systems with controlled H_2O and f_{O_2} (abst): Amer. Geophys. Union, Trans. (EOS), v. 54, no. 4, p. 480.

NASH, J.T., 1973, Geochemical studies in the Park City district: I. Ore fluids in the Mayflower mine: Economic Geology, v. 68, p. 34-51. Author at U. S. Geological Survey, Denver, Colo. 80225

Ore bodies in the Mayflower mine, Park City district, Utah, are localized along a normal fault zone which cuts Mississippian sedimentary and Tertiary intrusive rocks. Fissure filling and replacement Pb-Zn-Cu-Ag-Au mineralization occurs in both sedimentary and intrusive host rocks over a known vertical distance of 3,000 feet. The paragenesis of three major recognized veins in the mine is nearly the same, consisting of early quartz, anhydrite, hematite, and pyrite ± chalcopyrite, followed by sphalerite and galena, grading into pyrite + chalcopyrite + hematite, in turn followed by quartz + carbonate and minor anhydrite, followed by sphalerite and chalcopyrite. Deep, early veins outside of the Mayflower ore zone are characterized by quartz, K-feldspar, biotite, pyrite, and anhydrite, and some also contain magnetite, amphibole or chalcopyrite; these veins contain halite-bearing and gas-rich inclusions which are not known from the ore zone. The deep, early fluids had 34 to 44% salinity, homogenization temperatures of 315° to 430°C, and at times were boiling. Fluid inclusions in samples from the three ore-bearing veins, which contain only simple two-phase inclusions with consistent phase proportions, indicate a marked change in the fluids prior to ore deposition. Homogenization temperatures range from 220° to 300°C, and probably require a pressure correction of $\sim$+10°C. Freezing tests indicate salinities in the range 0.3 to 11 wt %NaCl equivalent; no CO_2-bearing phases were detected at reduced temperatures. Near-surface veins, presumably contemporaneous with the Mayflower ore zone, show evidence for boiling and suggest that there was $\sim$90 bars pressure at the present Mayflower vein outcrop. The distribution of fluid densities, temperatures, boiling, and key minerals in time and space indicates a dramatic change from very hot dense postmagmatic fluids to cooler, relatively low salinity fluids at the onset of economic base-metal deposition, probably concurrent with normal faulting. The changes in the physical properties of the hydrothermal fluids are believed to reflect the structural and magmatic evolution of the area. (Author's abstract)

NASH, J.T., and CUNNINGHAM, C.G., Jr., 1973a, Fluid-inclusion studies of the fluorspar and gold deposits, Jamestown district, Colorado: Economic Geology, v. 68, p. 1247-1262. First author at U.S. Geological Survey, Denver Fed. Center, Denver, Colo. 80225

The Jamestown district, Boulder County, Colorado, is a major producer of fluorspar; prior to 1940, gold, gold-telluride, and lead-silver ores were mined. Fluorite occurs as a primary mineral in phases of the composite sodic granite stock at Jamestown and in breccia zones, stockworks, and pipe-shaped bodies in and adjacent to the stock. Gold and telluride mineralization occurs with and without fluorite in veins peripheral to the stock. A great variety of fluid-inclusion types is present in the district, reflecting chemically and physically diverse fluids. Fluid inclusions in early-stage quartz from the fluorspar deposits have filling temperatures of 250° to 375°C, salinities of 20 to 30%, and boiling is indicated at many locations. Most inclusions associated with the main fluorite stage have salinities of at least 26% to more than 50% and filling temperatures in the range of 250° to 350°C. Probable cognate fluorite on the inclusion walls and as many as ten daughter minerals precipitated from some primary inclusions in fluorite attest to the presence of salt and CaF_2-rich polycomponent fluorspar-depositing fluids. Carbon dioxide-rich liquids and vapors were present during and after the main period of fluorspar deposition.

Gold-bearing veins contain fluid inclusions indicating that two fundamentally different types of fluids were present. Inclusions in pregold quartz and fluorite have filling temperatures which range up to 375°C, and most have very high salinities, comparable to those from the fluorspar deposits, suggesting that early quartz and fluorite of the gold-bearing veins was roughly contemporaneous with the main period of fluorspar deposition. Fluid inclusion and other thermometric data (Kelly and Goddard, 1969) suggest that gold and telluride deposition occurred at temperatures below 300°C. Fluid inclusions most directly associated with gold deposition have filling temperatures in the range 205° to 270°C and have about 4% salinity. These data suggest that the gold-bearing fluids either evolved from the fluorite-bearing fluids or were later unrelated hydrothermal pulses introduced on reopened structures.

Boiling occurred at many locations that were at relatively high elevations or adjacent to the sodic granite stock. From the interpretation that boiling occurred and from the heterogeneity of CO_2 contents, we deduce that fluid pressures were low and variable, commonly near 150 bars, but ranging to as much as $\sim$500 bars when CO_2 pressures were high; these determinations are compatible with the depth of cover estimated from geomorphic reconstruction using the Flattop peneplain. The absence of strong thermal or salinity zonation of fluids relative to the outcropping stock suggests that fluids were emanating from a larger intrusive body at depth. (Authors' abstract)

NASH, J.T., and CUNNINGHAM, C.G., Jr., 1973b, Fluid inclusion studies at Bagdad, Arizona (abst.): Geol. Survey Research, 1973, U.S. Geol. Survey Prof. Paper 850, p. 5.

Quartz-chalcopyrite and quartz-molybdenite veins from the porphyry copper deposit at Bagdad contain halite-bearing fluid inclusions with salinities of 30 to 35 weight percent and homogenization temperatures in the range from 233° to 310°C. Somewhat later primary and pseudosecondary inclusions with 5.8 to 9.2 weight-percent salinity homogenized at temperatures in the range from 302° to 373°C. Boiling occurred, but was rare, indicating that the depth of cover had to be somewhat greater than about 6,200 ft. The disparity in homogenization temperatures of the high- and moderate-salinity inclusions is the reverse of that commonly observed and may indicate that the former were trapped under higher pressures. (Authors' abstract)

NAUGHTON, J.J., 1973, Volcanic flame: source of fuel and relation to volcanic gas-lava equilibrium: Geochimica et Cosmochimica Acta, v. 37, p. 1163-1169. Author at Hawaii Institute of Geophysics and Chemistry Department, University of Hawaii, Honolulu, Hawaii 96822.

Flame formation at or near volcanic vents is a somewhat unusual phenomenon, but during October 1970 true flames were observed to issue at intervals from a series of vents in a lava tube or from spatter cones associated with the new eruptive center (Mauna Ulu) on the southeast rift of Kilauea volcano, Hawaii. This situation was similar to that under which successful volcanic gas collections have been made in the past in Hawaii and elsewhere. After several attempts two gas samples were collected successfully between flaming episodes. Analysis showed these to be chiefly water vapor with a small amount of hydrogen and carbon dioxide. The probable source of the hydrogen in the gas is explained on the basis of the high-temperature equilibria involved. The flame-forming properties of dilute mixtures of hydrogen and noncombustible gas were studied and the most dilute mixtures that would produce flames under volcanic conditions were measured (flammability limit). Intermittent flaming can be ascribed to the periodic attainment of the flammability limit for hydrogen in the volcanic gas mixture, which was found to be achieved in one of the collected samples. (Author's abstract)

NAUMOV, G.B., 1973, Utilization of gaseous-liquid inclusions analyses and thermodynamic calculations to characterize the ore-forming fluids: Abstracts of papers at the Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 23-24 (in Russian; translation through the courtesy of A. Kozlowski). Author at Inst. of Geochemistry and Analytical Chemistry, Acad. of Sciences USSR, Moscow.

During investigation of ore-forming processes, very valuable data on the composition ore-forming solutions and concentrations of ore elements may be obtained from the analysis of fluid inclusions. However, the small dimensions of inclusions and low concentrations of ore elements make reliable, immediate determinations difficult. Sufficiently precise analytical data can now be obtained for the essential hydrochemical and gaseous scarce components of hydrothermal solutions, and combination of such data with thermodynamic calculations of mineral equilibria provides additional quantititave data.

In the paper examples are presented of quantitative calculations of acidity and Eh potential of hydrothermal solutions with limiting concentrations of some components based on results of fluid inclusion analyses. Such calculations are very effective and may give more precise results than immediate determination of trace elements in inclusions by the water leachate method.

Examples of the use of similar information for prospecting for raw material deposits are presented. (Author's abstract)

NAUMOV, V.B., KHAKIMOV, A.Kh. AND KHODAKOVSKIY, I.L., 1973, On carbon dioxide solubility in concentrated chloride solutions at high temperatures and pressures: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 153-154 (in Russian; translation provided through the courtesy of A. Kozlowski) Authors at Vernadskiy Inst. of Geochemistry and Analytical Chemistry, Acad. Sci. of USSR, Moscow.

In six quartz crystals from rock-crystal-bearing veins of W. Pamir, inclusons bearing liquid CO_2 and 1-5 daughter minerals (halite, sylvite and others) were investigated. Amount of CO_2 in such concentrated solutions (as indicated by conductometric an chromatographic analyses) equals 80-140 g per 1000 g H_2O. T_H of inclusions = 410-490°C, T_D = 220-280°C. Density of essentially-carbon-dioxide inclusions formed during solution boiling is high: 0.50-0.88 g per cm^3. Pressure determined by use of P-T-V data of CO_2 and T_H & T_D ranges from 800 to 2850 bars, with an average value 1500 bars.

Thermodynamic analysis of the solubility of CO_2 in pure water and in aqueous solutions of NaCl were made. Using published experimental data, the coefficients in equations of CO_2 solubility versus T, P & ionic strength of solutions were determined. Extrapolation to the values of quartz formation (T 450°C, P 1500*bars, μ 5-7) points to a high stability of CO_2.
*(Note;in Russian text the value P 150 bars is printed, but comparing with the above data on pressure during quartz crystallization, it is believed to be a typographical error and should be 1500 bars, A.K.) (Authors' abstract)

NAUMOV, V.B., NESTERENKO, G.V., LOSERT, I., and CHAVEZ, L., 1973, Thermobaric conditions of the formation of some copper deposits in Chile: Geokhimiya, 1973, no. 8, p. 1163-1169 (in Russian with English abstract; translated in Geochem. Internat., v. 10, no. 4, 1974, p. 875-880). First author at V.I. Vernadsky Institute of Geochemistry and Analytical Chemistry, USSR Academy of Sciences, Moscow.

As a result of gas-liquid inclusion studies it has been found that the copper deposits of Chile were formed from concentrated chloride solutions (up to 35 weight %) in a wide temperature range (430-40°C) and under high perssures (300-1200 bar). (Authors' abstract)

NAUMOV, V.B., AND POLYAKOV, A.I., 1973, Thermobaric conditions of crystallization of volcanic rocks of basalt-rhyolite type of the rift zone of Iceland: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes: Rostov, Rostov Univ. Press, p. 214 (in Russian; translation through the courtesy of A.Kozlowski). Authors at Vernadskiy Inst. of Geochem. and Analytical Chem., Acad. Sci. of USSR, Moscow.

1. Iceland is an area of Neogene-Quarternary basalt volcanism with the association basalt-andesite-rhyolite; dikes of dolerites and granophyres, and rare gabbro-granophyric massifs also occur.

2. T_H of primary melt inclusions in phenocrysts in lava flows, dikes and intrusives were studied by the quenching method. Results:

Rock	Minerals	T_H, °C	Remarks
Basalt family	Pyroxene, plagioclase	1320-1200	Usual temps.
Andesites	Plagioclase	1270-1190	Not numerous data
Acid rocks	Feldspar, quartz	1200-900	Lowest T for granophyres from dikes and hypabysal massifs

3. Inclusions of superdense CO_2 found in olivines and plagioclase from basalt point to P values during crystallization of phenocrysts of ca. 3000 - 4500 bars, i.e., depth ca. 10-15 km. (Authors' abstract,

modified by A.K.)

NELSON, R.C., 1973, Fluid inclusions as a clue to diagenesis of carbonate rocks (abst.): Geol. Soc. America Abstracts with Programs, v. 5, no. 7, p. 748. Author at Dept. of Geology, Univ. of Missouri-Columbia, Columbia, Missouri 65201.

Textural relationships are normally used to solve the diagenetic history of ancient carbonate rocks. However, those methods force one to interpret the "effects" of diagenesis and leave the "causes" to speculation. The knowledge of the nature of diagenetic fluids may provide the "causes" for some diagenetic fabrics. Minute samples of mineral-forming and epigenetic solutions that have been trapped in most carbonate rocks as fluid inclusions can afford this knowledge. In this study, part of the fluid record of a carbonate rock has been determined through the application of fluid inclusion homogenization and freezing techniques to the cementation of a crinoidal biosparite. The Fernvale Limestone, an Upper Ordovician unit with syntaxial cement habit, has been selected for this study from samples collected across northern Arkansas.

Fluid inclusions in the Fernvale are predominantly two-phase (gas-liquid) inclusions with homogenization temperatures over the range 85°-170°C, and a distinct mode between 110°-150°C. Freezing point depression analyses revealed many saline inclusions from 5 to 25 wt% NaCl. The presence of a hot brine of probably post-Pennsylvanian age in the subsurface of the study area has previsouly been demonstrated from fluid inclusion studies from the Northern Arkansas Zinc District by Leach in 1972. The close correlation of Leach's data with those of the Fernvale suggests a common brine.

Petrographic evidence for major diagenetic changes in the Fernvale is not convincing, but neomorphism and strain features have been recognized; however, the inclusion data have shown conditions capable of causing textural changes. Two-phase fluid inclusions have since been recognized in other carbonates, and the potential use of this tool in assessing diagenetic conditions seems unlimited. (Author's abstract)

NESMELOVA, Z.N. AND TRAVNIKOVA, L.G., 1973, Microincluded gases in fossil salts: Abstracts of papers from the Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 166 (in Russian; translation through the courtesy of A. Kozlowski). Author at All-Union Scientific-Research Geological-Prospecting Inst.

Gases of sylvite, halite and carnallite from the Verkhnekamskoe and Starobinskoe potassium deposits were investigated. Gases were separated by dissolving the salt in water in a special vacuum apparatus. Analysis was made by gas chromatography. Inert gases were separated by melting the samples in vacuum.

The amount and composition of gases are connected with composition of parent minerals. The maximum amount of gases is in sylvite (up to 200 ml per kg); halite from the same salt horizons contains one tenth as much gas.

The gases are mainly CH_4 and N_2, with minor methane homologs, H_2, CO_2, H_2S, rare gases, etc. In individual cases H_2 and CO_2 were the main components.

Investigation of the amounts of inert gases in salts and their isotopic ratios indicates that Ar and He are radiogenic and syngenetic with the salts.

The combination of saturation by gases with microelements (Pb, Cu, Br, etc., (sic)), isotopic composition of hydrogen of the water of cyrstallization of the salts, peculiarities of chemical composition and mode of occurrence of gases in rock salt, as well as many other geochemical regularities, are difficult to explain on the basis of primary-sedimentary theory of salt formation from sea water of shallow basins. (Authors' abstract)

NEWMAN, R.C., 1973, Infra-red studies of crystal defects: London, Taylor and Francis Ltd., 187 pp.

Includes a considerable discussion of effects of hydrogen in alkali + alkaline earth halides that would be pertinent in any attempted study of fluid inclusions in fluorite by IR. (ER).

NEWTON, Robert C., and GOLDSMITH, Julian R., 1973, "Hydrothermal" reactions with traces of H_2O at high pressures (abst): Amer. Geophys. Union, Trans. (EOS), v. 54, no. 4, p. 482.

NIXON, P.H., ed., 1973, Lesotho Kimberlites: Maseru, Lesotho National Development Corp., 350 pp. (in English with Russian abstracts).

This book consists of 37 individual papers by various authors, particularly on the mineralogy and origin of ultrabasic nodules in kimberlites. Approximately 600 new electron microprobe analyses of the phases present are tabulated, and considerable field and petrographic evidence of gas-solid intrusion phenomena, of pertinence to any study of fluid inclusions in such materials. The 5-page index has only one entry for fluid inclusions (p. 227). (ER)

NOONER, D.W., UPDEGROVE, W.S., FLORY, D.A., ORO', J., and MUELLER, G., 1973, Isotopic and chemical data of bitumens associated with hydrothermal veins from Windy Knoll, Derbyshire, England: Chemical Geology, v. 11, p. 189-202. First author at Dept. Biophys. Sci., Univ. Houston, Houston, Texas.

A comparative study of the stable C isotopes, aliphatic and aromatic hydrocarbons, and normal fatty acids in 4 differentiated org. phases (bitumens) is given. The results provide additional evidence that the org. matter at Windy Knoll is of biogenic origin. They also indicate that normal alkanes were removed from or depleted in some of the bitumens. (Authors' abstract, abbreviated by E.R.)

OEN, I.S., 1973, A peculiar type of Cr-Ni-mineralization; cordierite-chromite-niccolite ores of Málaga, Spain, and their possible origin by liquid unmixing: Econ. Geol., v. 68, p. 831-842.

Mineralogical evidence indicates crystallization below 1,300°C but above 800°C and at pressures below 5-10 kb. Polyphase arsenide inclusions in chromite suggest crystallization of chromite-niccolite rocks from immiscible chromite-rich and arsenide-rich liquids, and other features suggest liquid immiscibility of a silicate and an oxyarsenide magma. (Author's abstract, greatly abbreviated by E.R.)

OHARA, MAKOTO, and REID, R.C., 1973, Modeling crystal growth rates from solution: Englewood Cliff, N.J., Prentice-Hall, Inc., 272 pp.

A mathematical treatment of the many proposed models for crystal growth from solution that is pertinent to several problems of inclusion study. (ER).

OHMOTO, Hiroshi, 1973, Origin of hydrothermal fluids responsible for the Kuroko deposits in Japan (abst.): Econ. Geol., v. 68, p. 139. Author at 220 Mineral Sciences Building, The Pennsylvania State University, University Park, Pennsylvania 16802.

The isotopic compositions of both hydrogen and oxygen of fluid inclusions from sulfide minerals in the Kuroko deposits lie in narrow ranges: $\delta D = -26$ to -18 °/oo and $\delta O^{18} = -1.6$ to -0.3 °/oo, respectively. These values suggest that the hydrothermal fluids were predominantly sea water which mixed with lesser amounts of meteoric water. The sulfur isotopic composition of sulfide minerals, which range in δS^{34} values from +8 to -6 °/oo, are compared with the chemical environments of ore deposition estimated from the stability relationships of the Kuroko minerals (pyrite, chalcopyrite, bornite, sphalerite, galena, barite, sericite and quartz) and the depositional temperature (150-300°C). It revealed that the sulfur in the ore-forming fluids was also of sea water origin (i.e., $\delta S^{34} \simeq +20$ °/oo).

A hydrothermal model which involves the circulation of sea and meteoric waters through the unconsolidated volcanic sediments, the increase of temperature by shallow intrusions of rhyolite, and the reactions with volcanic rocks (decrease in pH and oxidation state, and increase in alkali and heavy metal contents) is proposed to explain the geochemical and isotopic data. The model is compatible with the paleogeography of the area at the Middle Miocene time, and the texture and mode of occurrence of the ores. (Author's abstract)

O'NEIL, J.R., & SILBERMAN, M.L., 1973, Stable isotope relations in epithermal Au-Ag deposits, Western U.S.A. (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 5, no. 7, p. 783. Authors at U.S. Geological Survey, 345 Middlefield Road, Menlo Park, California 94025.

Oxygen isotope ratios have been determined on dated (K-Ar) mineral separates of hydrothermal potassium feldspars from 16 epithermal Au-Ag deposits located in California, Nevada, and Idaho. δO^{18} values for 14 samples range from +0.7 to -8.2, indicating, by their O^{18} depletion, a dominant meteoric water component in the hydrothermal fluids. Deuterium measurements of fluid inclusions in quartz, feldspar, and fluorite support this contention.

Potassium feldspars from the Imlay and Tenmile districts have considerably heavier δO^{18} values of +6.3, and +11.3, respectively. However, their inclusion δD values of -94.6 and -97.0, respectively, confirm the meteoric water origin of these fluids. Apparently, the waters in these two districts exchanged O^{18} with country rocks before mineralization.

Dominant involvement of meteoric water in deposits of this type is apparently a general phenomenon. Consequently, stable isotope ratios of hydrothermal minerals from dated epithermal deposits may be useful paleoclimatic and paleotopographic indicators. (Authors' abstract)

O'NEIL, J.R., SILBERMAN, M.L., and FABBI, B.P., 1973, [Stable isotope studies at Bodie mining district, California]; Geol. Sur. Research, 1973, U.S. Geol. Sur. Prof. Paper 850, p. 153-154.

Stable isotope and chemical analyses were made of altered host rocks, vein minerals, alteration clays, fluid inclusions, modern spring waters, and unaltered rocks of the area of this typical epithermal Au-Ag deposit.

The results indicate that a hydrothermal convective system was set up by the interaction of a cooling shallow intrusion and local meteoric water. The water traveled to depth where it picked up ore constituents and SiO_2, K, Rb, and Sr without significant shifts in the stable isotobe ratios of the water. The altered rocks have equilibrated to various degrees with an ore fluid of constant K:Rb, O^{18}/O^{16} and D:H ratios. Deposition of ore took place over the approximate temperature range 215° to 245°C. From C^{13}/C^{12} ratios of minor calcite a volcanic source of CO_2 is postulated. There is a pronounced similarity in chemical and isotope compositions between the ore fluid and modern spring waters in the area.

Bodie is the first deposit examined in which the entire ore deposition took place from virtually isotopically unaltered ground water. Other epithermal deposits from the Western United States are currently under investigation and are showing patterns similar to those observed at Bodie. (Authors' abstract).

O'NEIL, J.R., SILBERMAN, M.L., FABBI, B.P, and CHESTERMAN, C.W., 1973, Stable isotope and chemical relations during mineralization in the Bodie mining district, Mono County, California: Econ. Geol., v. 68, p. 765-784.

Stable isotope and chemical relations have been determined in a typical epithermal Au-Ag deposit located in the Bodie mining district of California. Analyses were made of altered host rocks, vein minerals, alteration clays, fluid inclusions, modern spring waters, and unaltered rocks of the area.

The results indicate that a hydrothermal convection system was set up by the interaction of a cooling shallow intrusion and local meteoric water. The water traveled to depth where it picked up ore constituents and SiO_2, K, and Rb, without significant shifts in the stable isotope ratios of the water. The altered rocks have equilibrated to various degrees with an ore fluid of constant K/Rb, O^{18}/O^{16} and D/H ratios. Deposition of ore took place over the approximate temperature range 215°-245°. From C^{13}/C^{12} ratios of minor calcite, a volcanic source of CO_2 is postulated. The chemical and isotope composition of the ore fluid is strikingly similar to that of modern spring waters in the area.

All ore deposition at Bodie took place from essentially isotopically unaltered ground water with $\delta O^{18} = -13$ °/oo and $\delta D = -98$ °/oo. (Authors' abstract)

OVCHINNIKOV L.N., and MASALOVICH, A.M., 1973, Special points of mineral crystallization in the processes of hydrothermal ore forming: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 11-12 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Inst. of Mineralogy and Geochemistry of Rare Earth Elements, Moscow.

The stability of the composition of hydrothermal solutions and physico-chemical parameters of ore forming in significant degree can be connected with the properties of solutions and with the interaction between solutions and wall-rocks and earlier crystallized minerals.

1. During the investigations of water and electrolytes there are found three special temperature points. In values of dissociation constants of various electrolytes, degrees of hydrolysis of salts,

variations of composition of complex compounds and special features of water there occur breaks in the curves at 165, 250 and 330°C. Special points are less distinct on the diagrams of solubility of minerals in water and aqueous solutions of electrolytes versus temperature, because dissolution is connected with decomposition of minerals, complex-forming, reforming of complexes, hydrolysis and other phenomena.

2. These properties prove significant changes in the solvent. The increase of electrolyte concentration and other factors influencing the water structure change the temperature of the breaks in the curves. Especially mobile is the 3rd special point lying at 330°C on the saturation curve. Thus, during the change of the degree of filling with solvent from 30 to 60% the point moves from 330 to 362°C.

3. The position of the special points ascertained during the analysis of the experimental data agrees very well with the methods of thermobarometry. The stage of acid removal of silicate rocks beginning from 420-400°C in the hypogene hydrothermal deposits is connected with the stage of deposition of ore minerals, the later parts of which in the increasing process of ore formation take place at 350, 270 and 160°C. The temperatures are in agreement with temperatures of individual special points, which, probably,is not accidental. On the other hand, the agreement supports the significance of thermobarometric methods. (Authors' abstract).

PABST, Adolf and SHARP, W.N., 1973, Kogarkoite, a new natural phase in the system Na_2SO_4-NaF-NaCl: Amer. Mineral., v. 58, p. 116-127.

This monoclinic phase, $Na_2SO_4 \cdot NaF$, was found in the Lovozero alkaline massif, Kola Peninsula, USSR, and a hot spring sublimate in Colorado (E.R.). (Editor's note: It can be expected as a daughter mineral in inclusions.)

PALEY, L. Z., AND POLYKOVSKII, V.S., 1973, On temperature conditions of origin of gold deposits at Tyan'-Shan': Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 44-45 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at MINGEO of Uzbek SSR.

Analysis and comparison of results of mineralogical and geochemical investigations on endogenetic mineralizations of gold in Uzbekistan permit their characterization from the specific mineral associations which are believed to be the gold ore formations.

Probably the highest-temperature formations are the quartz-gold ores formed at transitional to great depths (2000-6000 m). For these ore-rich quartzes the highest temperature of decrepitation were noted (600-580-450-420-380°C).

For gold ore formations from depths that are moderate (1500-2000 m), transitional (1000-1500 m) and near surface (1000 m), a lowering of temperature of ore-forming solutions is typical. Thus the decrepitation temperatures of quartz are as follows: quartz-carbonate-pyrite-chalcopyrite-gold, 350-200°C; carbonate-chalcedony-mixed sulphides-gold, 380-360-310-270°C; chalcedony-pyrite-pyrargyrite-küstellite-gold, 270-250°C; quartz-calcite-antimonite-cinnabar-gold, 280°C. (Author's abstract)

PALMOVA, L.G., and NOVIKOV, V.P., 1973, Temperature conditions of phenite formation in the area of upper Elkonkan (Yakut ASSR): Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press p.248 (in Russian; translation provided through the courtesy of N.P. Ermakov). Authors at Moscow Ordzhonikidze Geological Prospecting Institute, USSR.

The area is situated within a projection of crystalline basement formed of Precambrian metamorphic rocks. The Mesozoic stage of activity in the area is marked by the renovation of ancient faults and formation of new ones with intrusions of alkaline and (calc-alkaline?) compositions as well as hydrothermal processes. The alkaline metosomatism caused by alkaline intrusives is distinguished by a longer duration, multistage of mineralogenesis and sequence of mineral associations out of which albite-aegirine and feldspar-aegirine-quartz have been studied.

The area displays brecciated zones, minor veins, veinletlike and nestlike bodies with some sulfides (pyrite, chalcopyrite, bornite, pyrrhotite).

Gas-fluid inclusions in minerals (albite, aegirine, quartz) were investigated by homogenization and decrepitation methods to determine the temperature conditions of formation. The investigations showed the presence of three types of inclusions in all the minerals. Phase compositions of gas-fluid inclusions of the first (primary) and the second (pseudosecondary) types are quite similar. From these thermometric results, the albite aegirine phenite formed at 320-350°C, and feldspar-aegirine-quartz at 210-320°C. The aqueous extraction method and determination of carbon dioxide contents gave the opportunity to establish the type of mineral-forming solutions. (Authors' abstract).

PAN, Yuh-Shyi, and YMPA, P.J.M., 1973, The Mexican type tin deposits - its occurrence, chemistry and physical conditions of deposition (abst): Geol. Soc. Amer. Abstracts with Programs, v. 5, no. 7, p. 762. Authors at Department of Geology, Columbia University, New York, N.Y. 10027.

Tin deposits in Mexico occur in acidic volcanics, mainly rhyolite, and present a distinct type. Cassiterite and wood-tin veins are found along the flow banding of shallow intrusive rhyolites whose intrusive nature is indicated by steep flow bandings (70-90°) and two-feldspar temperatures of 660-680°C. In and on top of this rhyolite occurs a breccia formation of funnel shape. The breccia marks a change of oxidation state from magnetite-quartz-fayalite (80% Fe) to magnetite-hematite. On top of the breccia formation rests a cap rhyolite with clear extrusive flow texture. During tin mineralization the breccia pipe offered a channelway for the uprising solutions and the cap rhyolite acted as an impermeable layer. The matrix of the breccia is generally mineralized. X-ray fluorescence data of many breccia formations show tin contents of 0.1% or more, bearing the potential of being large volume, low grade tin deposits.

Although not reported before, intense montmorillonization (at Sombrerete, Zacatecas) was found to be the principal alteration process rather than the kaolinization and illitzation found elsewhere, indicating a high pH value (8-9) and very high Na+/H+ ratios (10^5 and up at low temperatures) of the mineralizing solutions. Appreciable amount of indium (0.4%) existing in cassiterite as trace element is shown by microprobe studies.

Contrary to the common belief that non-sulfide tin veins are of rather high temperature (>400°C), low temperatures of the mineralizing solutions are indicated by new films of cassiterite and wood-tin formed in a few years, crusting of euhedral cassiterite on wood-tin, fluid inclusion data, heating and recrystallization experiments, etc. Temperatures cannot have been higher than 150°C. (Authors' abstract)

PANASENKO, G.P., 1973, Contribution to the question of the influence of paleohydrogeological conditions on hydrothermal ore formation in Donbass: Abstracts of papers from the Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 133-135 (in Russian; translation provided through the courtesy of A. Kozlowski). Author at Rostov Univ.

Donbass coal basin is a great artesian basin of two-stage development: sedimentary stage and infiltration stage. Sedimentary stage (Carboniferous-Lower Permian) was characteristized by continuous small-cycle sedimentation of large mass of mainly clayey-sandy sediments. As indicated by geological data, metamorphic processes took place at 70-300°C.

In the following part of abstract author gives the detailed description of hydrothermal solution circulation, without fluid inclusion data. (Author's abstract, abbreviated by A. K.)

PANINA, L.I. and SHATSKIY, V.S., 1973a, Traprock and ultramafic alkalic rocks of the Yessey carbonatite intrusion: Akad. Nauk SSSR Doklady, v. 209, no. 1, p. 184-187 (in Russian; translated in Doklady Acad. Sci. USSR, v. 209, p. 144-147; abstract in Int. Geol. Rev., v. 15, no. 5, p. 616, 1973.) Authors at Institute of Geology and Geophysics, Siberian Division, USSR Academy of Sciences. Novosibirsk.

States of aggregation and conditions of crystallization of these two kinds of the melt were not the same, judging by analysis of primary and secondary inclusions in the rock-forming minerals (represented in figs. 1A, 1B), including the softening and homogenization temperatures. The ultra-basic alkalic melt could not have been derived from a basaltic magma. Remarkable differences in chemical composition of the same minerals (pyroxene, olivine, etc.) in the two kinds of the rock give further support to the idea that the two magmas originated in two different magmatic hearths and that the basaltic hearth was not as deep as the ultrabasic-alkalic. (Authors' abstract)

PANINA, L.I. and SHATSKIY, V.S., 1973b, Inclusions of melt in magnetite-apatite rock of the Yessey carbonatite intrusion: Akad. Nauk USSR, Doklady v. 209, no. 2, p. 455-457 (in Russian; translated in Doklady Acad. Sci. USSR, v. 209, p. 149-151, 1974; abstract in Int. Geol. Rev., v. 15, no. 3, p. 619, 1973). Authors at Institute of Geology and Geophysics, Siberian Division, USSR Academy of Sciences, Novosibirsk.

Primary two-phase (glass and gas) and single-phase ("tempered" glass) inclusions and the recorded effects of temperatures up to 1100°C on size and shape of their host cavities (fig. 1A), and the variety of secondary inclusions in the same rock (fig. 2B) are interpretable only as direct evidence of derivation of the magnetite-apatitic rocks from a melt. Such a hypothetical magnetite-apatitic melt may have been parted (by immiscibility), either from a carbonatitic or an ultrabasic-alkalic magma. (Authors' abstract)

PANOV, Ye.N., 1973, Use of inclusions in quartz as indicators of origin for correlation of granitoids: Vses. Mineral. Obshchest., Zap., v. 102, no. 2, p. 171-181 (in Russian).

Correlation of Transbaikalian granitoids was proposed on the basis of the nature of the polyphase (melt) inclusions and decrepigrams. (E.R.)

PASHKOV, Yu.N., and PILOYAN, G.O., 1973, On the theory of the decrepitation method: Abstracts of papers at Fourth Regional Meeting on Thermobarogeochemistry of Mineral-Forming Processes at Rostov-on-Don, 24-30 Sept., 1973: Rostov, Rostov Univ. Press* (In Russian; translation provided by Dr. E.I. Dolomanova of I.G.E.M., Moscow). Authors at IGEM, USSR Academy of Sciences, Moscow. * p. 292-293

The problem of stress distribution over the cross-section of the spherical surface of a hollow sphere, taken from the elasticity theory (L.D. Landau and E.M. Lifshits, 1965), is discussed as applied to the decrepitation method. For an isotropic body in polar coordinates, equilibrium equation is described in general by formula:

$$\frac{1}{r^2} \quad \frac{d(r^2u)}{dr} = \text{const} = 3a \text{ (sic.)}$$

Considering only shear stress, which is the main factor of sphere wall failure, and assuming external pressure, P_2, is zero ($P_2=0$ for the thermobaric method and $P_2=1$ for the sound decrepitation method, but $P_1 >> P_2$), we obtain, following a number of transformations:

$$P_{cr} = \frac{\delta_{cr}(L^3 - 1)}{2 + L^3}$$

where $L = \frac{R_2}{R_1}$, R_2 is the distance from the center to the outer wall of an inclusion, R_1 is the inclusion radius, δ_{cr} is the critical yield strength, and P_{cr} is the critical pressure inside the hollow sphere.

Assuming the grains of the fraction under study contain inclusions of a single genetic type (i.e., filled to one and the same extent), we obtain the pressure value causing the failure of the inclusion, and this value depends only on the inclusion size and its position in the grain. (Authors' abstract).

PATTON, T.C., GRANT, A.R., and CHENEY, E.S., 1973, Hydrothermal alteration at the Middle Fork copper prospect, Central Cascades, Washington: Econ. Geol., v. 68, p. 816-830.

The Middle Fork Deposit has hydrothermal alteration assemblages similar to southwestern United States porphyry copper deposits, but differs from them in that it (1) occurs in medium-grained quartz dioritic-granodioritic intrusive rocks of batholithic dimensions, (2) has linear, structurally controlled zones of alteration and mineralization, (3) has potassium silicate alteration assemblages remarkably deficient in quartz, (4) lacks a peripheral propylitic zone, (5) contains pyrrhotite as a major sulfide mineral, and (6) has virtually no supergene enrichment. Despite these differences, the Middle Fork deposit appears to belong within the broad spectrum of porphyry copper deposits although diverging widely from the unifying model of Lowell and Guilbert (1970). (Authors' abstract, greatly abbreviated by E.R.)

PAWLOWSKA, Jadwiga, 1973, Physico-chemical conditions of formation of Lower Silesia barite deposits: Petrographical-Mineralogical and Geochemical Research in Poland, v. 9, p. 1-113 (Geol. Inst., Warsaw, Bull. 267)(In Polish with Russian and English abstracts and resumes, 5 pp. each).

Results obtained in the course of examinations of the well known deposits at Stanislawów, Boguszów, and Jedlinka, Lower Silesia, are presented. On the basis of the principal thermodynamic criteria the succession of formation of the individual mineral paragenetic associations have been studied along with the metasomatic reactions between the minerals. To study the formation temperatures of the minerals decrepitation and homogenization as well as sphalerite and sulphur isotope methods have been adopted. The barite-sulphide association of the main hydrothermal phase at Stanislawów was formed at a temperature of 100° to 300°C, barite of generation I from Boguszów at 140° to 300°C, while lower temperatures--120° to 190°C--have been assigned to two remaining barite associations from Boguszów. The highest temperatures at Jedlinka--from 180° to 260°C-- have been recognized in the third paragenetic association, the lowest ranging from 150° to 225°C--in the middle calcite-barite association.

In the second part of this paper data on the liquid inclusions and thermal waters have been compiled from the available literature and the author's own studies presented. The main indicators so established subsequently served to determine the chemical composition of the hydrothermal solutions from which the Lower Silesia barites crystallized. Studies were conducted for each process and each paragenetic system: silicification and haematitization, carbonate-ferruginous, barite-sulphide, and barite-calcite parageneses. For each paragenetic association the main chemical parameters of the solution have been presented along with their mineralization, acidity, stability limits of theminerals, and relation to the oxygen, sulphur and CO_2 pressures. In cases when the stability of the mineral was controlled by the course of electrochemical reaction in the solution the respective Eh--pH graphs have been constructed. As a result of the present studies the hydrothermal origin of the deposits examined has been proved. (Author's abstract)

PERING, K.L., 1973, Bitumens associated with lead, zinc and fluorite ore minerals in North Derbyshire, England: Geochim. et Cosmochim. Acta, v. 37, p. 401-417. Author at U. S. Geological Survey, 345 Middlefield Rd., Menlo Park, Calif. 94025

A bitumen deposit in north Derbyshire, England, is described and studied using the techniques of gas chromatography, infra-red spectrophotometry and elemental analysis. The bitumens are associated with lead-zinc-fluorite ore minerals concentrated along an unconformable contact between the Carboniferous Limestone and the overlying shales. Three varieties of bitumen are distinguished and are compared with the dispersed bitumens in both the Carboniferous Limestone and the Edale Shales, with crude oils believed to be derived from these shales, and with inclusions in the hydrothermal mineral fluorite, associated with the limestone-shale contact. One of the varieties recognized, a brittle brown solid, contains aliphatic hydrocarbons very similar to those of the shales and to those of the crude oils likely derived from these shales. The other two are a viscous oil and a brittle, black solid, which geologic evidence suggests were originally derived from the limestone. They contain a very complex mixture of aliphatic hydrocarbons quite different from those in the limestone, however. Aliphatic hydrocarbons isolated from fluorite, which is hydrothermally formed, in nearby massive deposits are almost identical to those of the limestone and shale. This observation indicates that alteration of the aliphatic hydrocarbons in the sediment by hydrothermal fluids is an unlikely explanation for the origin of the complex mixtures of hydrocarbons in the viscous oil and brittle, black solid. On the basis of indirect evidence of high nitrogen content, presence of unsaturated hydrocarbons, and suitability of the environment for bacterial growth, it is suggested that selective bacterial alteration of the aliphatic hydrocarbons is the main process responsible for their present composition. A geologic history for the deposit is postulated that involves a two-phase introduction of bitumens. Each phase is suggested to have begun as a pulse of warm saline fluids migrating along the shale-limestone unconformity passed through the topographic high at Windy Knoll. Microbial oxidation of the bitumens may have taken place during the deposition process or, more likely, as a recent secondary oxidation process. (Author's abstract)

PERSIKOV, E.S., and OSORGIN, N.Yu., 1973, Chromatographic analysis of gases emanating from rocks and minerals during heating up to the melting point: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 302-303 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Inst. of Geol. and Geoph. of Siberian Branch of Acad. Sci. of USSR, Novosibirsk.

A special gas chromatograph was made for analysis of small amounts of gases (H_2, N_2, O_2, Ar, He, CO_2, SO_2, H_2S, CO, CH_4) released from rocks and minerals during heating up to their melting temperature. In the chromatograph highly sensitive detectors of heat conductivity (catharometers) were used, made in the Institute of Catalysis of SB AS USSR. Minimum volumes of gas which can be analysed range from 10^{-5} to 10^{-3}ml, and at maximum - 5×10^{2}ml(sic).Weight of sample of mineral may vary over a wide range: 10 - 10^4mg. As the gas-flow medium He and Ar were applied. The chromatograph permits observation of the kinetics of release of gases from the sample during heating.

The gas mixture released from the sample at known temp. is transported by the gas stream through a tube with anhydron into the accumulation reservoir of the chromatograph. H_2O vapor is absorbed by anhydron and the amount of water is determined by weighing. The water-free gas mixture from the accumulation reservoir can be analysed many times. (Authors' abstract)

PETRICHENKO, O.I., and SHAYDETSKAYA, V.S., 1973, Determination of Eh and chemical composition of solutions of individual inclusions: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 315-316 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Inst. of Geol. and Geochem. of Fuels of Acad. Sci. of Ukrainian SSR, L'vov.[1]

Determination of K^+, Mg^{2+}, Ca^{2+}, Cl^- and SO_4^{2-} in highly-concentrated solutions of individual inclusions is made by use of capillaries. Analysis is made on the basis of the amount of precipitate formed under action of suitable reagent and subsequent centrifugal separation. Reactions are made in conic capillaries (3-5 to 20-50 μm). By this mode one may determine one element in a volume of solution = 0.000n to 0.00n mm^3. The error is independent for each element and falls in the ranges 15-43%, the sensitivity of method is 0.5mg/ccm, and analysis is possible for inclusions 0.0n mm long. As reagents substances were chosen which give fine and stable precipitates with one element. Proposed method was verified on 850 synthetic solutions, and the data were calculated by statistical methods. Curves and formulae were obtained relating the amount of element in solution and amount of precipitate.

Measurement of Eh of solutions of individual inclusions was made by use of a special Pt electrode connected with calomel electrode (standard) on apparatus LPM-60M. Pt electrode consists of a Pt needle 0.03-0.05 mm thick and flattened on the end, covered with a conic capillary 2-4 mm long and with the diameter of the sharp end = 5-10 μm. Similar construction is necessary for taking solution from an individual inclusion with capillary. The solution ought to fill capillary and to contact the Pt electrode. Electrode is connected through a 1x2 cm glass filled with saturated KCl solution with connected calomel electrode. The method was verified on standard solutions with Eh -400 mV to +480 mV; error = 25 mV. Eh by this method can be measured in inclusions 0.0n-0.n mm long, filled by 0.0mm^3 of solution.(Authors' abstract)

[1/] In the Russian text "Novosibirsk" is printed; probably a misprint.

PETRICHENKO, O.Y., SLIVKO, O.P., and SHAYDETSKAYA,V.S., 1973, Geochemical characteristics of the genesis of salt formations in the Solotvin Basin, Transcarpathia: Geol. Geokhim. Goryuch. Kopalin (Akad. Nauk Ukr. RSR), no. 35, p. 37-41 (in Ukrainian with Russian summary).

PETROVIC, Radomir, 1973, The effect of coherency stress on the mechanism of the reaction albite + $K^+ \rightleftharpoons$ K-feldspar + Na^+ and on the mechanical state of the resulting feldspar: Contr. Mineral. and Petrol., v. 41, p. 151-170. Author at Dept. Geology, Northwestern Univ.,Evanston, Ill., 60201

Coherency stress and coherency strain energy generated by Na^+-K^+ ion exchange in alkali feldspars are calculated using an isotropic model, and deformation of single crystals of alkali feldspars exposed to molten alkali chlorides at $P_{H_2O} < 1$ bar is described. Coherency stress in alkali feldspars can reach 10-20 kb. When it is large, partial relaxation by fracture and/or plastic deformation takes place under anhydrous conditions, but temporary build-up of stress is unavoidable even under hydrothermal conditions. Because of coherency strain energy, a thin layer of an end-member alkali feldspar produced by cation exchange on a grain of the other end-member alkali feldspar would be unstable with respect to dissolution. Therefore, under hydrothermal conditions one end-member alkali feldspar replaces the other by dissolution and precipitation. The mechanism of the reaction

$$Na_xK_{1-x}AlSi_3O_{8(\text{feld.})} + yK^+ \rightleftharpoons Na_{x-y}K_{1+y-x}AlSi_3O_{8(\text{feld.})} + yNa^+$$

is primarily controlled by P_{H_2O} and by $\Delta K/(Na+K)$, the difference between the equilibrium value and the initial value of the atomic $K/(Na+K)$ ratio of the feldspar. When $[\Delta K/(Na+K)]$ is small, the reaction proceeds by cation exchange. When $[\Delta K/(Na+K)]$ is large, cation exchange still occurs if P_{H_2O} is very low, but under hydrothermal conditions replacement by dissolution and precipitation occurs. (Author's abstract) (Editor's note--Probably pertinent to several aspects of fluid inclusion formation during replacement.)

PETROVSKAJA, N.V., and VASILIEV, V.I., 1973, Evidence from electron microscopy on gaseous inclusions in quartz from the Balei deposit as an indication of the boiling of hydrothermal solutions: Abstracts of papers at Fourth Regional Meeting on Thermobarogeochemistry of Mineral-Forming Processes at Rostov-on-Don, 24-30 Sept., 1973: Rostov, Rostov Univ. Press* (In Russian; translation provided by Dr. E.I. Dolomanova of I.G.E.M., Moscow). * p. 299-300

1. The concept of boiling of hydrothermal solutions, following their movement to shallower depths, is derived from an analysis of the general geology of metalliferous deposits and confirmed by mineralogical-thermometrical data obtained during recent years. The manifestations of such phenomena have been studied insufficiently, which limits their genetic application.

2. The authors have taken the mineralized quartz of the Balei deposits as a case in point and tried to find out whether or not it is possible to detect, by electron-microscopy technique, inclusions of gases emanating during the boiling of the solutions. They believe that the emerged gas bubbles must have adhered to the growing faces of crystals, including those of quartz. Similar phenomenon has been experimentally proved (works by Acad. A.V. Shubnikov) and was assumed by one of the authors in studying gaseous inclusions in gold.

3. Replicas of the fracture surfaces exhibit numerous small isometric dimples on the walls of flattened inclusions which are referred to, on some evidence, as cavities of gaseous inclusions in quartz. They differ from other types of inclusions in morphology and the character of wall surfaces. The dimples appear to form owing to adherence of gas bubbles to crystal faces. These faces ceased to grow in these places while continuing to develop in the adjacent areas, so individual bubbles or their groups were finally entrapped by the crystal. That the dimples are arranged in linear zones parallel to the growing faces of quartz microcrystals indicates that the bubbles followed the then microrelief as well as the structural defects on the crystals.

4. The cavities of gaseous inclusions occur within definite zones of quartz growth, which suggests repeated boiling of solutions and makes it possible to judge the succession of these phenomena. (Authors' abstract).

PIPEROV, N.B., and PENCHEV, N.P, 1973, A study on gas inclusions in minerals. Analysis of the gases from micro-inclusions in allanite: Geochim. et Cosmochim. Acta, v. 37, p. 2075-2097. Authors at Institute of General and Inorganic Chemistry, Bulgarian Academy of Sciences, Sofia 13, Bulgaria.

In order to determine the chemical composition of the gases from micro-inclusions in allanite a comparative study, using the methods of heating to decrepitation and grinding in vacuum was undertaken. The dependence of gas composition on the grain size was studied, too. The analysis of gases was carried out in a vacuum apparatus for microanalysis; the measurement was volumetric. The experiments using the decrepitation method were made in the temperature interval 200-1100°C. CO_2, H_2, CO, CH_4, N_2, He, and water were identified and determined. However, a considerable part of these gases is probably due to chemical reactions. By grinding in a vacuum ball mill, only small amounts of H_2, N_2, and He were evolved. Some experiments showed that CO_2 and H_2O are strongly adsorbed on the ground material, thus being lost for the analysis.

The results obtained from these two methods were supplemented with data obtained from a new method for studying the composition of gas inclusions, by tracing the gas composition as a function of the sample grain size. Using an approximate model it was shown that this dependence should be non-linear (hyperbolic). The amount of gases, due to inclusions, decreases parallel to the decrease in size of the mineral grains down to a certain limiting size. This dependence could not be observed if the grains are smaller than this limiting value. The method offers a possibility for taking into account the amounts of gases having another origin (desorption, chemical interactions, etc.), using the experimental plots. The results from the three series of experiments showed that the gas phase of inclusions in examined allanite consists mainly of CO_2. The other gases which were found by the decrepitation method could not be unambiguously ascribed to inclusions. (Authors' abstract)

PIZNYUR, A.V., 1973, Theoretical modeling of postmagmatic mineral-forming systems: Akad. Nauk SSSR Doklady, v. 208, no. 1, p. 177-180 (in Russian; translated in Doklady Acad. Sci. USSR, v. 208, p. 59-62, 1974; abstract in Int. Geol. Rev., v. 15, no. 2, p. 234, 1973.) Author at Ivan Franko State University, L'vov.

The PVT phase model of the $NaCl-CO_2-H_2O$ system (fig. 1), which represents the endogenic postmagmatic solutions, is based upon the data of Takenouchi and Kennedy (1968), Dolgov (1970), and others. This model shows isochors and critical curves of H_2O, H_2O-CO_2, $NaCl-CO_2$ (with specific volumes and densities), granitic solidus in the presence of aqueous fluid, supercritical CO_2 in inclusions in kyanite, geothermobars, the field in which CO_2 is heavier than H_2O, the alpha-beta transformation of quartz and decay of the fluid into "gas" and "brine," PT prerequisites of the homogenization of inclusions of CO_2, complete miscibility of H_2O and CO_2, gaseous, liquid, and fluidal states, magmatic hearths with the associated parabolic thermobars, the mean lithostatic pressure, and other phenomena and relationships, some of which are elaborated in thermobaric sections of the model (fig. 2). (Author's abstract)

PIZNYUR, A.V., DOROSHENKO, Yu. P., BOGOLEPOV, V.G. SMIRNOV, A.M., and TORCHINYUK, R.N., 1973, On thermobarogeochemical conditions of formation of rare metal deposits in Central Kazakhstan: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 64-65 (in Russian; translation through the courtesy of A. Kozlowski). Authors at L'vov University; Kazakh Institute of Raw Materials-KazIMS-, Alma-Ata; Central Caucasian Geological Office -CKGU-, Karaganda.

Rare metal deposits (R.M.) of Central Kazakhstan are connected with ultraacid granitoids of Permian age. Areas of intensive development of ore mineralization are often combined with fields of occurrence of acid dikes. Deposits are composed of veins bearing Mo, W, and complex R.M. ores.

Character of mineral-forming solutions (composition, temp., pressure) at each stage of ore deposition varied: during formation of Mo ores, solutions were mainly of the Cl, Na type with subordinate amounts of K and alkaline earth elements. Tungsten ores are accompanied by occurrence of inclusions rich in CO_2, F, HCO_3^-, Na, K, Ca and Mg. In minerals of complex R.M. ores inclusions bear solutions with significantly higher amounts of F and subordinate amounts of bicarbonate. Na and K strongly prevail over Ca and Mg.

Mo ores are the highest temperature ones (over 430-270°C), W and complex R.M. ores formed a pressure of 600-900 atm. and at high- and moderate temperatures (homogenization temp. of minerals of productive stages). Ore forming solutions boiled at early stages of mineralization process. (Authors' abstract)

PIZNYUR, A.V., & POLETAEV, A.I., 1973, On thermobaric conditions of explosive breccia formation, exemplified by Cu-Mo Kounrad deposit: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30, Sept. 1973: Rostov, Rostov Univ. Press, p. 107 (in Russian; translation through the courtesy of A. Kozlowski). Authors at L'vov Univ., & Kazakh Inst. of Natural Raw Materials, Alma-Ata.

In the Kounrad deposit there are two breaks in mineralization caused by intrusion of rocks of a dike series and origin of explosive breccias. The first break occurred after intensive silicification of rocks (formation of secondary quartzites). The ascending front of explosive gases penetrated fractures of minerals of secondary quartzites forming liquid inclusions. Gases were saturated with chlorides at temp. 330-390°C and P = 1100-1300 atm.

After formation of pyrite and Mo mineral associations and essential Cu ores, there occur second stage breccias consisting of quartz with molybdenite, pyrite, and other minerals. Temperature ranged from 410 to 460°C and P from 1600 to 1800 atm, and the inclusions bear significant amounts of CO_2. Later chalcopyrite and sphalerite-galena associations have crystallized, accompanied by barite, siderite and other minerals. (Authors' abstract)

POLLARD, C.O., Jr., and WAGNER, C.E., 1973, Strains associated with chemical boundaries in a sector-zoned elbaite tourmaline crystal (abst.): Geol. Soc. America Abstracts with Programs, v. 5, no. 5, p. 426. Authors at School of Geophysical Sciences and Engineering Experiment Station, Georgia Institute of Technology, Atlanta, Georgia 30332.

The sector-zoned elbaite crystal R6538 (Smithsonian) is light green in the first-order prism sectors and dark green in the second-order prism sectors. A partial chemical analysis (excluding boron, lithium, fluorine, and water), by microprobe, shows minor differences only in SiO_2 and Al_2O_3 between types of sectors. No measurable cell-parameter differences across sector boundaries have been detected. Concentrations of faults are observed at all the sector boundaries. The basal component of the fault vector characteristic of any particular sector boundary lies normal to that boundary, for all the fault vectors whose orientations could be determined. Only one boundary (roughly parallel to a first-order prism face and separating sectors behind first- and second-order prism faces) was describable purely by a fault vector, with no lattice misorientation. Misorientations occur at the rest of the sector boundaries, each involving a rotation of less than 40 seconds of arc around an axis parallel to the boundary normal; these misorientations occur on boundaries that are roughly parallel to second-order prism faces. The orientational and fault-vector relationships were discerned utilizing variations of x-ray diffraction topography. (Authors' abstract)

POLYVYANNYY, E.Ya., DAVIDENKO, I.V., NAYDENOV, B.M., and BOGOLEPOV, V.G., 1973, Argon in gas-liquid inclusions in quartz from mica-bearing and ceramic pegmatites: Geokhimiya, 1973, no. 12, p. 1881-1886 (in Russian;

translated in Geochem. Internat., v. 10, no. 6, 1974, p. 1385-1380). First author at Kapakh Mineral Raw Materials Research Institute, Alma Ata.

Argon in gas-liquid inclusions in quartz from pegmatites is found to have a juvenile and atmospheric component; many samples contain both low-temperature and high-temperature inclusions. The parameter τ, based on the ratios of total and atmospheric argon for these two classes of inclusions, is directly related to the economic significance of muscovite mineralization in the pegmatites studied. -G. Czamanske

POMARLEANU, Vasile, MOVILEANU, Aurelia, MURARIU, Titus, and MIHALKA, Stefan, 1973, The study of polymetallic mineralization in the Ruschita area, Romania: Rom., Com. Geol., Dari Seama Sedin., v. 59,(1972), no. 2, p. 81-104 (in Romanian, with English and French summary).

POTY, Bernard, WEISBROD, Alain, and STALDER, H.A., 1973, Temperature and pressure of crystallization of fissure quartz in the French and Swiss Alps (abst.): Reunion annuelle des Sci. de la Terre, Paris, March, 1973, Soc. Géol. de France, p. 343 (in French). First author at Centre de Recherches Pétrographiques et Géochimiques, C.O. no. 1, 54500 Vandoeuvre les Nancy.

Studies of the ratio K/Na in the inclusions indicate the solutions were equilibrated with adjacent feldspars, and show a systematic increase in the ratio with T and P of formation (from 360-545°C and 2300-3750 bars). (E.R.)

POWELL, R. and SMITH, F.W., 1973, Pressure-temperature estimates for a late metamorphic event in the Dalradian in the Scottish Highlands: Nature Physical Science, vol. 244, no. 135, pp. 70-71. First author at Department of Geology and Mineralogy, Parks Road, Oxford.

Fluid inclusion studies on quartz from veins in garnet grade amphibolite facies rocks provide pressure and temperature information compatible with the results of geothermometric work on carbonates combined with thermodynamic calculations on the carbonate bearing assemblages. Freezing studies showed $NaCl \cdot 2H_2O$ and CO_2 hydrate. Data from both inclusion studies and the carbonates are compatible with metamorphism at ~500°C and 1500 bars pressure. (ER).

PRINZ, Martin, MANSON, D.V., HLAVA, P.F., and KEIL, Klaus, 1973, Inclusions in diamonds: Garnet lherzolite and eclogite assemblages (extended abstract): in Internat. Conf. on Kimberlites, Extended abstracts of Papers, L.H. Ahrens, et al., eds.: Univ. of Cape Town, Rondebosch, Cape Town, South Africa, p. 267-270. First author at Dept. of Geology, Inst. of Meteoritics, Univ. of N.M., Albuquerque, New Mexico 87131.

PROSOLOV, E.M., and TOLSTIKHIN, I.N., 1973, Isotopes of noble gases from inclusions in minerals: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 164 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at VNIGRI, IGGD AN SSSR.

Distribution of isotopes of He and Ar was investigated in more than 100 natural samples. Average content of Ar^{40} - $0.9 \times 10^{-6} cm^3/g$, and He^4 - $8 \times 10^{-6} cm^3/g$. Ar^{40}/Ar^{36} ratio is generally about 2,000 (i.e., 15% of atmospheric argon) and proves the significant role of surface water and gases in fluid formation. He^3/He^4 ratio changes from 10^{-9} to 10^{-5}, often permitting the determination of the source of the helium (radioactive minerals, "normal" granites, mantle exhalations).

Contamination of mineral-forming fluids with atmospheric gases was investigated in various samples with various degree of degradation. The regular 10-fold change of Ar^{40}_{atm}, content (and other parameters) was ascertained for bodies ranging from chamber pegmatites to low-temp. hydrothermal veins. For example, the amount of Ar^{40}_{atm} varies from 0.07×10^{-6} to 2×10^{-3} cm^3/g.

Ratios He^3/He^4 and $He^4/Ar^{40}_{radioact.}$ depend on composition of substance in which the gases originated and they were used by the authors for determinations of the source of fluids, as shown by pegmatites of Volhyn.

The amount of radiogenic gases in inclusions, their partial pressures, and their isotope ratios — all such data are important for K-Ar and (U and Th) — He dating of rocks and minerals, and for the solution of the problem of "surplus" gases. Data on these problems (will be) given in the paper. (Authors' abstract)

PURDY, J.W, and STALDER, H.A., 1973, K-Ar ages of fissure minerals from the Swiss Alps: Schweiz. Min. Petr. Mitt., v. 53/1, p. 79-98. First author at Sub-department of Geophysics, Oliver Lodge Laboratory, Oxford Street, P.O. Box 147, Liverpool L 69 3 BX, United Kingdom.

K-Ar ages of the fissure minerals muscovite, adularia, and biotite from the Swiss Alps are presented. The samples have been selected from the Aar and Gotthard massives and the Pennine nappes.

The relationship among the various fissure minerals and rock micas is not everywhere identical. In the Pennines, fissure micas and adularia are equal to or less than the rock mica ages and show cooling age patterns similar to the rock mica age patterns. Some of the fissure muscovites, younger than the rock micas from the same region, are interpreted as crystallization ages. In the Gotthard, fissure muscovites give crystallization and/or cooling ages while the biotites and adularia contain excess argon. In the Aar massive the adularia ages range from 11-65 m.y. indicating that some have excess argon (up to $2 \cdot 10^{-5}$ cm^3/g STP). The divergence in age relationships can be understood from a consideration of the critical closure temperatures for the diffusion of radiogenic argon from the various minerals; the temperature of the country rock when the mineral solutions entered the fissure and the cooling rate of the country rock after the fissure minerals formed.

In the Aar massive there is a relationship between the CO_2 content of the fluid inclusions in the adularia or coexisting quartz and the K-Ar age; CO_2 being present in the "younger ages" and absent in the adularia of "older age." Nonetheless, a clear distinction between meaningful crystallization ages and high ages due to excess argon is not possible from the data of the present investigation. (Authors' abstract)

REBROVA, K.P., SHCHEKOLDIN, A.A., and BAZURIN, A.Z., 1973, Gaseous-liquid inclusions as catalysts for the polymorphic inversion of vein quartz into cristobalite: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 277 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at State Scientific-Research Inst. of Quartz Glass, Leningrad.

The mechanism of the inversion process was investigated by microscopy of cooled samples that had been calcined at 1450-1500°C for 1-10 hours under vacuum.

1. Cristobalite develops first near the walls of voids and healed fractures, on which precipitates of salts were deposited after opening of inclusions. Later the center of quartz blocks between inclusions inverts.

2. Under all applied experimental conditions the degree of conversion to cristobalite of milky-white quartz is higher than that for granulated quartz.

3. Significant and uniform saturation of milky-white quartz by gas/liquid inclusions with large amounts of volatiles (up to 2.848 cm^3 per 100g of sample) and high salt concentration cause the quickest transformation of quartz into cristobalite.

(Authors' abstract, abbreviated by A.K.)

REMESHILO, B.G., 1973, Physico-chemical conditions of formation of certain beryllium minerals in "zanorysh" pegmatites of Volhyn: Abstracts of papers at Fourth Regional Confernece on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1974: Rostov, Rostov Univ. Press, pp. 178-179 (in Russian; translation provided through the courtesy of A. Kozlowski) Author at Inst. of Geology and Geochemistry of Fuels, Acad. Sci. of Ukrainian SSR, L'vov.

In Volhynian "zanorysh" (i.e., cavity-bearing; Ed.) pegmatities the accessory Be mineralization is expressed by forming of beryl, phenacite, bertrandite and euclase, of which the first two minerals were studied in more detail. Beryl crystals were formed in two ways: by crystallization from pegmatite -forming solution, and by metasomatic alteration of other minerals (. . .).

1. Crystal growth took place from weakly alkaline solutions (pH of solutions in inclusions 7.5-8.5±0.2), with low concentration of salts (up to 7 wt % of NaCl in H_2O).

2. The major ions were: K, Na, F, HCO_3; among gases CO_2 (up to 70 vol. %) and N_2 (up to 15 vol. %) prevailed.

Temp. interval of origin of beryl crystals in zanoryshes (cavities) 350-415°C, and for metasomatic crystals - up to 500°C. Boiling phenomena were noted.

Phenacite forms two generations strongly differing in habit: rhombohedral phenacite I and long-prismatic phenacite II. Inclusions and parageneses were investigated. (Author's abstract, abbreviated by A.K.)

REMESHILO, B.G. and VOVK, P.K., 1973, Two types of phenakite crystals from the rock-crystal pegmatites of Volynia: Akad. Nauk SSSR, Doklady, v. 213, no. 6, p. 1395-1398 (in Russian; translated in Doklady Acad. Sci. USSR, v. 213, p. 148-150, 1975; abstract in Int. Geol. Rev., v. 16, no. 3, p. 364-365, 1974). Authors at Institute of Geology and Geochemistry of Fossil Fuels, Ukrainian Academy of Sciences, L'vov.

Two generations of accessory phenacite occur in the Volynian pegmatites: I, rhombohedral and II, dolichoprismatic. T_H for I is 370-385°C; for type II it is 130-160°C. The crystal habit is a function of T, P, and pH of origin. (ER)

REYF, F.G., 1973, Inclusions of melt in quartz of postorogenic granites of central Buryatiya and the pressures and temperatures accompanying their formation: Akad. Nauk SSSR, Doklady, v. 213, no. 4, p. 918-921 (in Russian; translated in Doklady Acad. Sci. USSR, v. 213, p. 172-174, 1975; abstract in Int. Geol. Rev., v. 16, no. 2, p. 241, 1974). Author at Buryat Section of the Siberian Branch of the USSR Academy of Sciences, Ulan-Ude.

Pink granites, essentially K feldspar-biotitic, occur in massifs as large as several thousand km^2. Their spatial association with ruptures and incontrovertible allochthonism are evidence of their origin at relatively shallow depths. The primary inclusions in quartz in these granites consist essentially of magmatogenic muscovite and quartz and a generally small volume of gas. Homogenization pressures and temperatures of the inclusions, the character of the homogenization, other evidence, and calculations derived therefrom, with suitable corrections, show the pressures at which the granites originated were several kilobars greater than the lithostatic pressure. It was this "excess" of pressure that forcibly propelled the intrusions outward and upward from the sites of their origin, at temperatures in vicinity of 800°C. (Author's abstract)

RICH, R.A., 1973, A regional fluid inclusion study of Paleozoic metamorphic rocks in New England (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 5, no. 7, p. 780-781. Author at Department of Geological Sciences, Harvard University, 20 Oxford Street, Cambridge, Massachusetts 02138.

Fluid inclusions have been found on healed fractures in syn-metamorphic quartz lenses from Paleozoic metapelites, metacarbonates, and metavolcanics from the biotite to staurolite zones of the east flank of the Green Mountain anticlinorium. Predictably, one-phase vapor or liquid two-phase vapor + liquid, and liquid CO_2-bearing two- and three-phase inclusions have been observed. Of special interest, though, is the discovery of inclusions containing saturated brines. Typical saline inclusions contain all of the following phases which are given in order of decreasing volume: brine, halite crystal, vapor, and one or two birefringent crystals. Some of these inclusions contain liquid CO_2 (10 volume % or less) as an additional phase. Observations of fluid inclusions indicate that the compositions of metamorphic fluids varied greatly through time and space in the area studied.

The occurrence of the saline inclusions has been found to be restricted to a relatively narrow stratigraphic zone in Silurian and younger metasediments which lie just above a major regional unconformity. The available evidence suggests that brine generation occurred during pre-peak prograde metamorphism through the solution of evaporite beds. If this is true, then a previously unknown evaporite, possibly correlative with the Salina evaporites of New York, occurs as a member of the lower portion of the post-Ordovician sequence of the east side of the Green Mountain anticlinorium. (Author's abstract)

RIDGE, J.D., 1973, Volcanic exhalations and ore deposition in the vicinity of the sea floor (abst.): Econ. Geol., v. 68, p. 140. Author at 103-A Mineral Sciences Building, The Pennsylvania State University, University Park, Pennsylvania 16802.

Recent work by Haas has made available information on densities and vapor pressures of solutions of differing salinities at temperatures up to 330°C. From these data it is possible to predict the behavior of volcanic exhalations of various degrees of salinity as they approach the sea floor. Particular attention is devoted to solutions of 5.0 weight percent NaCl and 20 weight percent NaCl, two fluids that approximate quite closely the salinities of what Roedder termed: (1) normal hydrothermal fluids and (2) fluids typical of stratiform deposits of low-temperature conditions of origin. It is apparent that solutions above 220-230°C cannot reach a sea floor on which the depth of water is 600 feet or less in the liquid state but will boil at some appreciable depth beneath the sea floor. Such boiling would result in the precipitation of all constituents of the ore fluids of significantly lower vapor pressure than water. The principal such constituent would be salt, and no sulfide deposits, the major constituent of which is salt, are known. It follows, therefore, that ore fluids probably never get close to the sea floor of shallow seas at temperatures high enough to permit boiling. Ore fluids significantly above 230°C can reach the sea floor in the fluid state only if the depth of the sea in the area in question is well above 600 feet, for example, solutions at temperatures of ±300°C reach the sea floor in the liquid state only if the depth of sea water approximates 3,000 feet. Ore fluids reaching the sea floor at such depths may be the parents of such fluids as the Red and Salton Sea brines.

None of the low-temperature deposits with which I am acquainted, however, have the characteristics that I would expect of materials precipitated from volcanic exhalations making contact with sea water immediately above the sea floor. Of course, any such characteristics that the deposits once possessed may have been destroyed by metamorphism, plus remobilization. In all examples of stratiform deposits known to me, however, the epigenetic relations shown to the host rocks by the ore minerals seem to me to be better explained as due to primary deposition from ore fluids moving through solid rock than by metamorphic changes (in the broad sense) occurring after the deposition of the ore minerals. (Author's abstract)

RIDLEY, W.I., and BRETT, Robin, 1973, Petrogenesis of basalt 70035: Amer. Geoph. Union Trans. (EOS), v. 54, no. 6, p. 611-612.

Includes the first description of anomalous low-K silicate melt inclusions in lunar ilmenite (74 SiO_2, 16 Al_2O_3, 8 CaO, and only 0.01 K_2O). (E.R.)

RITTER, C.J., 1973, Some geochemical aspects of the gold-quartz veins of the Lamaque mine, Val D'or area, Quebec: Geol. Soc. Amer. Abstracts with Programs, v. 5, no. 2, p. 213. Author at Geol. Dept., Univ. of Dayton, Dayton, Ohio 45469.

Trace amounts of Na, Ca, Al, Mg, Fe, Mn, Cu, and Ti occur in the sheet-like, lensoid, veins. The concentrations of the trace elements, with the exception of higher Na, are similar to most other types of quartz, including non-gold-bearing hydrothermal veins. A large percentage of the trace elements probably occur in secondary fluid inclusions, which make up approximately 0.2-0.5 percent of the total volume of the quartz. It is proposed that the inclusions were formed by the redistribution of trapped, primary (vein-forming) fluids during cataclasis, and that the fluids are located close to their original positions. Trace element values are higher in the thinner parts of veins. Presumably, more fluid inclusions were trapped in these areas. Gold precipitated very late in irregular fractures in cataclastic quartz and in fractured pyrite, in both the veins and wall rock. The trace element concentrations in a quartz vein at a given place are fairly uniform, and accurate analyses can be determined from a relatively small sample. Drift, blasting round, muck assays most accurately reflect Au values.

Polynomial trend surfaces show that Au and some trace element concentrations vary systematically over the veins. Trend surfaces and simple and multiple regression analyses indicate significant correlations among the values for Au, certain trace elements and vein width. Most notable are inverse correlations between Au and some trace elements, particularly Na. Statistical analysis of chemical and physical data from gold-quartz veins may be of practical value in surface and underground exploration, evaluation and development. (Author's abstract.)

ROBERSON, C.E., and SCHOEN, Robert, 1973, Fluorite equilibria in thermal springs of the Snake River basin, Idaho: Jour. Research U.S. Geol. Survey, v. 1, no. 3, p. 367-370. Authors at U.S. Geological Survey, 345 Middlefield Road, Menlo Park, California 94025.

Some thermal water sources of the Snake River basin, Idaho, are near saturation with respect to fluorite. That mineral was identified by X-ray diffraction in precipitates induced in three water samples by adding sodium fluoride. The derived solubility product (K_{SO}) for zero ionic strength was close to that calculated from Latimer's thermodynamic data ($10^{-9.77}$). The relative ease of precipitation of fluorite from these water samples indicates that equilibrium with respect to fluorite may occur in some ground-water systems. (Authors' abstract)

ROBERTS, S.A., 1973, Pervasive early alteration in the Butte district, Montana (abst.): Econ. Geol., v. 68, p. 909-910. Author at Dept. of Geological Sciences, Harvard University, Cambridge, Mass. 02138.

Four pre-Main Stage pervasive alteration effects in the Butte district have been studied and mapped. Distribution of this pervasive alteration coincides closely with the distribution of early potassium silicate ("EDM") and quartz molybdenite veinlets, and in some cases can be shown to have been caused by such veinlets. Grades of molybdenum and disseminated copper show a positive correlation with the intensity of this pervasive alteration.

Compositions of coexisting Fe-Ti oxides formed (during) the pervasive alteration show that the fluids responsible for this event had temperatures above 550°C. These data are in good agreement with thermometry (fluid inclusions, Ed.) done independently on the early vein assemblages.

The center of the early alteration dome in plan view is near the center of the later Main Stage zoning pattern, and its direction of elongation, N70°W, is similar to the general trend of the Main Stage vein structures. This suggests that the two types of mineralization, though chemically and temporally distinct, are somehow genetically related. (Author's abstract, greatly abbreviated by E.R.)

ROBERTSON, R.H.S., 1973, Vein quartz near Dalwhinnie, Inverness-shire, Scotland: Scottish Journal of Science, v. 1, pt. 3, p. 175-182.

Vein quartz of high purity (99.70% SiO_2) occurs as a dike-like "reef" up to 85 feet wide and traceable for > 1 mile. Material at the outcrop and loose in the soil is very white. Within the outcrop it is dull gray. Decrepigrams show similar peaks at 300-500; 900, and 1000°C, but the two high temperature peaks are much stronger in the white quartz. (ER).

ROBINSON, B.W., 1973, The origin of mineralization at the Tui mine, Te Aroha, New Zealand, in the light of stable isotope studies (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 5, no.7, p. 783. Author at Institute of Nuclear Sciences, D.S.I.R., Lower Hutt, New Zealand.

Within the old Hauraki goldfield, the Tui Mine is 130 km NNW of the Taupo volcanic zone and thermal water is found close to the mine. Mineralized quartz veins occur in hydrothermally altered, Tertiary andesites which overlie Mesozoic greywackes. The Tui vein paragenesis is (1) pyrite + chalcopyrite, (2) galena + sphalerite, (3) minor pyrite and chalcopyrite, and (4) minor hematite, barite, cinnabar, kaolinite and carbonates.

Stable isotope studies indicate temperatures of formation of 400 ± 80°C (5 sulfide pairs, stage (1)), 320 ± 60°C (18 sulfide pairs, stage (2)) and 150 ± 30°C (barite-water, stage (4)). δS^{34} values of the sulfides range from +5 to -3‰ (CDT) and show a 2‰ decrease with time. The vein mineralogy suggests a corresponding decrease in pH and increase in oxidation potential of the ore fluid. Thus late barite with $\delta S^{34} = +16$‰ fixes the $\delta S^{34}_{\Sigma S} = +16 \pm 1$‰ for the system. Hence at 350°C H_2S and HSO_4 in the ore fluid would have δS^{34} values of +5 and +24% respectively, indicating a probably magmatic plus greywacke source for the sulphur.

Te Aroha thermal water shows an oxygen isotope shift of 4‰ relative to meteoric water (δO^{18} -5.5‰ SMOW, δD -30‰ SMOW). Waters extracted from sphalerite and quartz fluid inclusions and calculations from isotopic studies of quartz and kaolinite indicate ore fluid values of δO^{18} 0 ± 0.5‰ δD-17 ± 1‰ (stage (2)) and δO^{18} -1.0 ± o.2‰, δD-24 ± 1‰ (stage (3)). An ultimate meteoric origin for the ore fluids is postulated.

Published Pb isotope data (Copper and Richards) suggest the Pb to be derived from the greywackes. Many comparisons with present day geothermal systems can be made. (Author's abstract)

ROBINSON, B.W., & BADHAM, J.P.N., 1973, The geochemistry and origin of the Great Bear Lake silver deposits, N.W.T., Canada (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 5, no. 7, p. 782-783. First author at Institute of Nuclear Sciences, D.S.I.R., Lower Hutt, New Zealand.

Samples from the Terra, Norex, Silver Bay and El Bonanza mines show a paragenetic sequence of: uraninite + hematite, Co-Ni-arsenides + silver, dolomite + sulfides and Sb-Bi-Ag sulfosalts + bismuth. These vein-type U deposits occur within pendants of Aphebian (∿1800 m.y.) intermediate and felsic volcanic rocks lying in a granitic complex interpreted as the orogenic belt of the Hudsonian Coronation geosyncline. Sulfides are common in the volcano-clastic rocks and around the plutons.

The temperatures of mineralization in the silver veins, as suggested by the minerals and their isotopic composition, are about 120°C (early), 200°C (main stage) and <200°C (late). A δO^{18} value for the ore fluid of approximately +2‰ SMOW is calculated from the isotopic composition of the dolomites which also have constant δC^{13} values of around -4‰ PDB. δS^{34} values of the sulfides are generally constant at around -1‰ CDT. Hematite in the veins suggests the ore fluid had a high oxidation potential whereby the isotope data are in accord with a constant fluid chemistry: pH =5, $\Sigma S = 10^{-2}m$, $\Sigma C = 1m$, $\delta S^{34}_{\Sigma S} = +30 \pm 5$‰ and $\delta C^{13}_{\Sigma C} = -4 \pm 2$‰. The isotopic values for the water and the sulfate suggest an origin in sea water trapped within the volcanics.

U-Pb ages (1450 m.y.) for the pitchblende imply contemporary diabase intrusions acted as the heat source for the mineralization. Discrepant Pb-Pb ages for the galenas (1625 m.y.) suggest the mineralization to be consanguineous with the orogenic cycle and would also account for the constant isotopic values. However the high oxidation potential of the ore fluid is difficult to reconcile with a magmatic origin. Magnetite is common both in the volcanics and intrusives. (Authors' abstract)

ROBINSON, B.W., and OHMOTO, H., 1973, Mineralogy, fluid inclusions, and stable isotopes of the Echo Bay U-Ni-Ag-Cu deposits, Northwest Territories, Canada: Econ. Geol., v. 68, p. 635-656.

At the Echo Bay mine, vein type U-Ni-Ag-Cu deposits occur along NE-SW-trending fracture zones in ca. 1,800 m.y. old andesitic tuffs.

The mineralization stages within veins of the Echo Bay mine are: 1. Quartz-hematite stage. 2. Pitchblende stage. 3. Co-Ni arsenides with native silver and bismuth stage. 4. Early acanthite stage. 5. Main sulfide and dolomite stage. (Within this stage, acanthite, chalcopyrite, bornite, sphalerite, and galena occur in up to three phases of mineralization.) 6. Late native silver stage. 7. Mckinstryite stage.

Both primary and pseudo-secondary fluid inclusions, in the dolomite and quartz of the later stages, contain NaCl crystals. The heating experiments on these samples and the analyses on the extracted fluids indicate a salt concentration of about 30 weight percent and K/Na atomic ratios of ~0.4 to ~0.2.

The temperatures of mineralization suggested by the occurrence of native bismuth and mckinstryite, the fluid inclusion filling temperatures, the sulfur isotopic compositions of coexisting sphalerite and galena, and the oxygen isotopic compositions of coexisting quartz and hematite were: around 120°C for the first four stages, about 200°C for stages 5 and 6, and below about 95°C for the last stage. The original depth of ore deposition suggested from the temperature and the stratigraphic data was between 2.5 and 4.5 km.

The oxygen isotopic compositions of quartz, hematite, calcite, and dolomite samples, together with the temperature data, suggest that the oxygen isotopic composition of hydrothermal water was nearly constant throughout the entire depositional stages with δO^{18} values of +1.0 ± 2.5 °/oo (SMOW). These $\delta O^{18}_{H_2O}$ values suggest very little, if any, contribution of magmatic water in the Echo Bay ore-forming fluids.

The δC^{13} values of dolomite and calcite of different stages are similar and within the range of -4 to -1.5 °/oo (PDB). However, the δS^{34} values of the vein sulfides show a very large spread of ~50 °/oo, with a definite trend of increasing δS^{34} values toward later stage sulfides: from ca. -22 °/oo for the earliest sulfide (acanthite), ~-4 to ~+20 °/oo for stage 5 sulfides, to ca. +27 °/oo for the last stage sulfide (mckinstryite). This wide range in the δS^{34} values of the hydrothermal minerals contrasts with the uniform δS^{34} values (+2 to +5 °/oo) of the pyrite in the host rock tuffs.

The data on the mineralogy, temperature, and the sulfur and carbon isotopic compositions of the hydrothermal minerals were used to evaluate the chemistry of hydrothermal fluids. Both the mineralogical and the isotopic data appear to be best explained if: (1) the oxidation state of the fluids decreased continuously with time from that within the hematite stability field, through near the pyrite-hematite-magnetite triple point, to near the pyrite-pyrrhotite-magnetite triple point (also near the quartz-magnetite-fayalite boundary), (2) the pH remained relatively constant at around 4.0, (3) ΣS content decreased from $\sim 10^{-2}$ to $\sim 10^{-4}$ toward the later stages, (4) ΣC content decreased from ~ 1 m to $\sim 10^{-2}$ toward the later stages, (5) ΣAg concentration in the fluids decreased from ~ 1 ppm to ~ 0.1 ppm toward the latter stages, and (6) the mean isotopic compositions of sulfur and carbon in the fluids remained constant at $\delta S^{34}_{\Sigma S} = +25 \pm 3$ and $\delta C^{13}_{\Sigma C} = -5 \pm 2$ ‰.

The $\delta O^{18}_{H_2O}$ and $\delta S^{34}_{\Sigma S}$ values and the initial high oxidation state of the hydrothermal fluids possibly reflect an origin as surface water. A model which involves the circulation and boiling of sea water caused by the intrusion of diabase at about 1,450 m.y. ago is presented to explain the concentration of salts, enrichment of O^{18}, reduction of oxidation state, decreasing of pH of the fluids, and leaching of heavy metals from volcanic rocks. (Authors' abstract)

RODZYANKO, N.G., 1973, Thermobarometry of endogenous metal deposits in connection with their systematics and the revision of prospecting criteria: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 31-32 (in Russian; translation provided through the courtesy of A. Kozlowski). Author at Rostov University.

In some ore-bearing intrusives the phenomenon of inclusion differentiation has occurred taking into account the phase composition of inclusions (Trufanov 1972). Probably parent magmas for the ore fluids have also caused differentiated distribution of inclusions: in granitic massifs, towards the apical parts, the amount and dimensions of inclusions increase and the main type becomes gaseous; in ore-bearing granitoids with minor ore-generating features, inclusions are distributed more evenly, without concentration in the apical parts, which proves more equilibrated conditions of intrusion crystallization.

The temperature evolution of skarn ore deposits, not suitable for homogenization studies for reason of low transparency of fine grained minerals, were investigated by the decrepitation method. Ore bodies that are not distinguishable visually may be distinguished easily by decrepitation of light fraction. (Abstract abbreviated by A.K.).

ROEDDER, Edwin, 1973a, Fluid inclusion studies of ore deposits in Southeast Missouri (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 5, no. 4, p. 345. Author at U.S. Geological Survey, Reston, Va., 22092.

Editor's note: This paper was presented at the North-Central section meeting, Columbia, Mo., but the abstract was not printed. The main points are as follows:

Many inclusions, at least some of probable primary origin, were studied in calcite and sphalerite, mainly from the Viburnum and Fletcher mines. Much metastability was encountered in the cooling runs. Freezing temperatures were mainly in the range -20 to -28°C, corresponding to very saline brines. Homogenization temperatures ranged from 82 to 145°C. (ER).

ROEDDER, E., 1973b, Fluid inclusions from the fluorite deposits associated with carbonatite at Amba Dongar, India, and Okorusu, South West Africa: Institution of Mining and Metallurgy Trans., Sect. B., v. 82, p. B35-B39 (Bull. 795). (This is a discussion of a paper by Deans, et al. (1972), Metasomatic feldspar rocks (potash fenites) associated with the fluorite deposits and carbonatites of Amba Dongar, Gujarat, India: Trans. Instn.Min. Metall. (Sect. B: Appl. earth sci), vol. 81, p. B1-B9; see

Inclusions in carbonates from the Amba Dongar carbonatite are mainly <1 μm, and consist of liquid plus a small vapor bubble under rather high pressure. Tiny euhedral apatite crystals in the carbonatites have several types of inclusions: 1.) aqueous solution with up to 50 vol.% daughter crystals (isotropic and anisotropic), plus a small bubble; 2.) aqueous solution with large vapor bubble under pressure; and 3.) CO_2 liquid plus vapor, mainly with density ≥ 0.5 g/cm^3 (and homogenizing in the liquid phase). Inclusions in the fluorite from the huge Amba Dongar deposit are mainly aqueous solution and vapor and show homogenization and freezing temperatures (NaCl equivalent) of about 150°, 115°C, and 1.6, 0.8 weight %, respectively, for early and late generations of fluorite. They also contain 3-25 atm of noncondensable gas. Somewhat similar inclusions were found in fluorite from the deposit in carbonatite from Okorusu, South West Africa. (E.R.)

ROEDDER, Edwin, and WEIBLEN, P.W., 1973, Petrology of some lithic fragments from Luna 20: Geochimica et Cosmochimica Acta, v. 37, p. 1031-1052. First author at U.S. Geol. Survey, Reston, Va.

Microscopic and electron microprobe studies were made of polished thin sections of part of a 30-mg sample of 250-500 μm lunar soil returned by Luna 20 from a point between Mare Fecunditatis and Mare Crisium. (...) Analyses of seven melt inclusions are given ranging from basaltic to nearly granitic. Some of the fragments contain 'gas' inclusions (p. 1043 and 1048-1050). Various possible mechanisms of origin of such inclusions are discussed. These inclusions are believed to indicate final crystallization under low pressure near surface conditions. (Authors' abstract, abbreviated and extended by E.R.)

RUB, M.G., TOKSUBAEVA, G.P., AND CHERNOV, B.S., 1971, Composition and genesis of a tungsten-bearing magmatic complex in Primor'ye, pp. 207-216, in Mineralogy and geochemistry of tungsten deposits (Materials of 2nd All-Union Symposium on Mineralogy, Geochemistry, and Genesis of Tungsten Deposits of USSR): Leningrad, Leningrad Publishing House, 344 pp. (In Russian; abstract through the courtesy of A. Kozlowski). Authors at Institute of Geology of Ore Deposits, Petrography, Mineralogy and Geochemistry, Academy of Sciences USSR.

On the basis of Govorov's investigations (1968, Works of III All-Union Symposium on Mineralogical Thermobarometry and Geochemistry of Deep Mineral-forming Solutions, Moscow) of fluid inclusions in quartz of biotite hornfels, scheelite, quartz-scheelite-arsenopyrite and quartz-pyrrhotite veins of that region one may ascertain that the general type of mineral-forming solutions is constant: Na-Ca-sulfate-bicarbonate. Those data prove that during formation of intrusive tungsten-bearing complex, carbonate rocks were significantly assimilated by ascending granitic magma.

RYABOV, V.V. and BULGAKOVA, Ye. N., 1973, Conditions of crystallization of hypogene anhydrite in the Talnakh copper-nickel deposit: Akad. Nauk SSSR Doklady, v. 208, no. 2, p. 424-426 (in Russian; translated in Doklady Acad. Sci. USSR, v. 208, p. 128-130, 1974; abstract in Int. Geol. Rev., v. 15, no. 3, p. 367, 1973). Authors at Institute of

Geology and Geophysics, Siberian Division, Academy of Sciences, USSR, Novosibirsk.

Homogenization types (to liquid and to gas) and temperatures (80° to 630°C) of gas-liquid inclusions in anhydrite, in their different paragenetic associations (table 1), analysis (K, Na, Li and pH) of the included solutions, geological position of the accumulation of anhydrite, and other evidence suggest a wide range of T and Eh and a pH optimum (ca. 7.4) at the time of the crystallizations. (Authors' abstract)

RYABOVA, T.V., 1973, On possibilities of use of properties of quartz for evaluation of ore mineralization in the Jurassic shaly complex of Dagestan: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 260-261 (in Russian; translation provided through the courtesy of A. Kozlowski). Author at Inst. of Mineralogy, Geochemistry and Crystallochemistry of Rare Elements.

Analysis of varieties of quartz from the Kizil-Dere deposit, made on a vacuum decrepitophonic apparatus, yielded data on the intensity of decrepitation of GL inclusions (degree of quartz saturation by GL inclusions). The decrepigraphs prove that quartz from the ore bodies contains more inclusions than that from the wall rocks.

Data on loss on ignition in the same samples supported these results. Ore-bearing quartz lost 1.07-1.34% by weight (loss relatively stable); quartz from barren veinlets and wall rocks, only 0.6-0.84%.

T_D of ore-bearing quartz ranges from 280 to 240°C, decreasing from early to late associations; T_D of barren quartz = 210-180°C.

These two groups of quartz contain various trace elements, in various concentrations. Ore quartz bears higher amounts of Cu, Pb, Zn, Mo, Sn, Co, and Ag, plus uniform amounts of V and Ni. For quartz from wall rocks, only Pb, Zn and Sn are comparable with the lowest values from ore quartz; other trace elements occur at the level of sensitivity of the analytical method.

Thus, the differences between quartz of ore bodies of the Kizil-Dere deposit and barren quartz formed in the Aalenian argillite complex support the thesis of genetic autonomy of the two varieties, and may be used for evaluation of quartz zones in the area.

RYE, R.O., and OHMOTO, Hiroshi, 1973, Carbon and sulfur isotopes, and ore genesis: a review (abst): Geol. Soc. Amer. Abstracts with Programs, v. 5, no. 7, p. 790. First author at U.S. Geol. Survey, Denver, Colo. 80225.

Important new developments in carbon and sulfur isotope geochemistry are reviewed with reference to a number of specific ore deposits. In the last few years the carbon and sulfur isotope studies that have made important contributions to ore genesis emphasize that such studies must be coupled with detailed geologic, mineralogic, and other geochemical studies. Under equilibrium conditions, the δC^{13} and δS^{34} of hydrothermal minerals are determined by the physico-chemical conditions of the fluids (T, pH, f_{O_2}) as well as the isotopic composition of carbon and sulfur ($\delta C^{13}_{\Sigma C}$ and $\delta S^{34}_{\Sigma S}$) in the ore fluids. These variables, along with the f_{CO_2} $m_{\Sigma C}$, f_{S_2}, and $m_{\Sigma S}$ of the ore fluids and the mechanism of ore deposition, have been determined in several deposits by combining isotopic and other geochemical data. The important sources of carbon and sulfur in ore deposits must be based on accurate determinations of $\delta C^{13}_{\Sigma C}$ and $\delta S^{34}_{\Sigma S}$ which can be greatly different from the δC^{13} and δS^{34} values of minerals. In enviroments where boiling or mixing of fluids occurred, carbon and sulfur isotopic equilibrium may not be established among hydrothermal minerals and between fluids and minerals. Isotopic equilibrium also may not be attained in low-temperature hydrothermal deposits and in biogenic sulfide deposits involving bacteriologic reduction of sea water sulfates. Data on metamorphosed deposits suggest that sulfur isotopes were locally redistributed during metamorphism, but not on a large scale. (Authors' abstract)

RYE, R.O., and SCHUILING, R.D., 1973, Hydrogen isotope study of a regional metamorphic complex: Geological Survey Research 1973, U.S. Geol. Survey Prof. Paper 850, p. 154.

Hydrogen iostope studies of hydrous minerals of the metamorphic complex at Naxos, Greece show an increase in δD values with decrease in metamorphic grade and indicate approximate hydrogen isotopic equilibrium with muscovite.

Calculations based on the δD data and oxygen isotope temperatures indicate that the δD of the metamorphic fluid averaged about -70±5 per mil in the migmatite and decreased to -5 per mil in the glaucophane zone. The δD values of water in fluid inclusions in quartz segregations are consistent with the trend indicated by the δD data on OH-bearing minerals. The δD data are tentatively interpreted to indicate that water from deep-seated sources was mixed with water derived locally from the rocks during metamorphism and that the percentage of deep-seated water in the metamorphic fluids increased from almost nothing in the glaucophane zone to nearly 100 percent in the migmatite. (Authors' abstract, abbreviated by E.R.)

RYLOV, V.G., 1973, Thermobaric peculiarities of origin of Cu-pyrrhotite ores and physical features of their minerals (exemplified by Kizil-Dere deposit in S. Dagestan): Abstracts of papers from the Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes. 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 113-115 (in Russian; translation through the courtesy of A.Koslowski). Author at Rostov Univ.

This deposit belongs to the Filizchay sulfide type and forms two lens-like bodies 1,500 m long in argillites of Slaty Dagestan. The following types of ore occur there: Cu-pyrrhotite, sulfide, and Zn-sulfide, of massive and veinlet-like texture.

Decrepitation and occasionally homogenization studies were made on monomineralic samples of quartz, calcite, siderite, galena, aragonite, pyrite, pyrrhotite, chalcopyrite, and sphalerite. Quartz gives 3 decrepitation maxima: 440-375 (related to the pyrite-pyrrhotite stage). The last mineral forming processes, at temp. 140-40°C, gave druses of quartz, calcite and aragonite. Inclusions are of gas, liquid-gaseous and gaseous-liquid types. Extremely rare inclusions are polyphase ones with 1- 2 gas bubbles and 2 - 3 daughter minerals. (. . .) Aragonite usually bears liquid inclusions. Homogenization data delineated the following succession of minerals: quartz I, quartz II,quartz III,siderite,quartz IV,calcite, aragonite. Decrepitation gives the succession: pyrrhotite I, pyrite I, pyrrhotite II, chalcopyrite I, pyrite II, chalcopyrite II, sphalerite-pyrrhotite III-pyrite III-galena. Pyrrhotitic mineralization investigated over a 600-meter vertical section shows no distinct temp. zonation with depth (. . .). (Author's abstract, abbreviated by A.K.)

SAKAI, H. & MATSUBAYA, O., 1973, Isotope geochemistry of the thermal waters of Japan and its implication to Kuroko ore deposits (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 5, no. 7, p. 792. Authors at Institute for Thermal Spring Research, Okayama University, Misasa, Tottori-ken 682-02, Japan.

Many of the thermal waters along the ocean coasts have oxygen and hydrogen isotopic compositions between ocean waters and local meteoric waters, suggesting that the thermal waters are mixtures of these two types of water. As a result of interactions with wall rocks, the thermal waters have a higher Ca/Cl and K/Cl and lower Na/Cl and SO_4/Cl than sea water. The sulfur and oxygen isotopic composition of sulfate in the thermal water are the same as sea water sulfate. The isotope and chemical characteristics of the coastal thermal waters may be very similar, if not the same as, the hydrothermal solutions for the Kuroko ores.

Thermal waters in the green tuff formation (host rock for the Kuroko ores on the Japan sea side of Honshu) are recycled meteoric waters. The sulfates in these waters are isotopically similar to the sulfates in the Kuroko deposits ($\delta S^{34} = +20 \sim +24°‰$ C.D.; $\delta O^{18} = 0$ to $-10‰$ SMOW) and are considered to be "fossil" sea water sulfate of Miocene or younger ages. In volcanic thermal water system isotopically lighter sulfates ($\delta S^{34} = -62 + 5‰$; $\delta O^{18} = -6 \sim + 2‰$) are formed by surface oxidation of volcanic S and H_2S. Sulfates with a wide range of δS^{24} and δO^{18} values in some of these waters resulted from mixing of volcanic and sea water sulfate and sulfur isotope fractionations. (Authors' abstract)

SANDOMIRSKIY, S.A. AND RIMKEVICH, V.S., 1973, Temperature conditions of exhalation-sedimentary ore formation of the Ridder-Sokol'noe deposit: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 84-85 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Moscow University.

Polymetallic ores occur in hydrothermal-metasomatic vein-like bodies and as horizons of exhalation-sedimentary ores lying in aleurolites of Middle Devonian Age.

The decrepitation determinations of veinlet and exhalation-sedimentary ores were made (...). The beginning of mass decrepitation is at a temp. 260-320°C with a subsequent fast and sharp increase of amount of impulses. Aleurolite samples do not give any decrepitation effects.

Inclusions in sphalerite are very rare and have minute size (10-20 microns). They are mainly one-phase liquid type. Gas phase is absent or occupies no more than 2% of inclusion volume, and T_h is not higher than 80°C. In carbonates F = 0.95-.97, T_h 90-110°C. (...) (Authors' abstract, shortened by A.K.)

SANIN, B.P., and MARKOVA, M.E., 1973, Comparative characteristics of the chemical composition of cis-Argunya lead-zinc deposits (according to data of gas-liquid inclusions analysis): Ezheg., Inst. Geokhim., Sib. Otd., Akad. Nauk SSSR, 1971 (pub. 1972), p. 233-237 (in Russian). Chem. Abst., v. 79, no. 5, 55913m, 1973.

The multicomponent characteristics of the chemical composition of cis-Argunya deposits were evaluated by several analyses. The wet analyses showed that the fluid inclusions contain K, Na, Ca, Mg, Cl, F, and SO_4. In the dry residue Si, Al, Fe, Pb, and Cu were found. In 75% of the samples Zn, Ag, As, and Ti were identified and in several single specimens, the contents of Sn, Cd, Ga, Co, Ni, Cr, Sb, Ba, and Sr were evaluated. The geological characteristics of the deposits showed different paragenetic association, changes of acidity and alkalinity of hydrothermal solutions, and that the deposits have the same composition but quantitatively the components differ.

SATO, Takeo, 1973, A chloride complex model for Kuroko mineralization: Geochem. Jour., v. 7, p. 245-270. Author at Geological Survey of Japan, 8 Kawada-cho, Shinjuku-ku, Tokyo 162, Japan. (In English)

A chloride complex model for Kuroko mineralization at the Uchinotainishi deposit of the Kosaka mine is constructed. Possible chemical composition of the ore solution and possible physicochemical properties of the ore-forming environments calculated on the basis of the thermochemical data of Helgeson (1969) can be limited to narrow ranges, if more than 1 ppm Cu is assumed to be dissolved in the ascending Kuroko-forming solution.

The model ore-forming environments derived here are consistent with the data of temperature and sulfur fugacity estimated from studies of fluid inclusions, mineral equilibria and sulfur isotopes of the Kuroko deposits. The characteristic mineral zoning of the deposits are explicable by differential precipitation of ore-constituent minerals from the model solutions moving along the gradients of the model ore-forming environments. In order to explain the distribution of sulfate minerals in the deposits, it is necessary to assume mixing of the ascending solution and the coeval seawater.

In comparison with the chemistry of the natural metal-rich brines, the model solutions are low in Na/K ratio, while high in Na/Ca and reduced sulfur to metal ratios. It is suggested that these features might be characteristic of volcanogenic ore-forming solutions, which are likely to retain equilibrium conditions at higher temperatures as a result of their rapid ascent from the source reservoir. (Author's abstract)

SAZONOV, V.D. and ELINSON, M.M., 1973, Spatial and temporal change of gas composition in mineral-forming solutions of Naugarzan: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 165 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at IGEM AN SSSR, Zab. NII MG SSSR.

The fluorite deposit of Naugarzan (Kuraminskiy Chain) is connected with a disjunction zone in granitoids and is a large (...) quartz-fluorite vein. The ore body consists of three mineral associations of various age: quartz-K-spar, fluorite and quartz-sulfide.

Quartz and fluorite were submitted for thermometric and gas analyses. Samples were taken from the middle part of the "Tsentralnyi" field of the vein, on the 1875-1780 m levels.

Quartz rich in gas inclusions is in the first association. It bears numerous primary inclusions with V = 70%, T_H = 250-320°C, and shows ca 240 cm^3/kg of gas released. This gas consists of H_2 with CO_2-4.8%, O_2-3.0%, CO and SO_2-1.4%, and Ar-0.5%.

Fluorite is poor in inclusions, with V = ca. 95%, T_H = 90-75°C at the 1780 m level and 70-65°C at the 1875 m level. The gas lacks CO, Ar, and SO_2, and N_2 appears.

In quartz of the third association primary inclusions with V 85-90% and T_H 125-155°C were found. The amount of gas released was 74-93 cm^3/kg, and it consisted of H_2, CO_2, N_2, and O_2.

At the hanging wall side of vein at the top level the amount of H_2 decreases and the amount of N_2, CO_2 and O_2 increases. (Authors' abstract)

SCARFE, C.M., 1973, Experimental determination of water solubilities in basic melts at 1150°C and 1350°C at 1 and 2 kilobars pressure: Geol. Soc. Amer. Abstracts with Programs, v. 5, no. 1, p. 100-101. Author at Dept. of Geol., Univ. of Alberta, Edmonton, Alberta, Canada, T6G 2E1.

Water solubilities in a number of basic melts at 1150°C and 1350°C at 1 and 2 kilobars are compared with results from previous workers on a weight percent and a molecular percent basis. Results indicate basaltic melts dissolve similar amounts of water to granitic melts at the same temperature and pressure. Melts of picrite and olivine melanephelinite composition, however, have lower solubilities than basaltic melts at 1350°C. At 1 Kbar, solubilities are 1.4 ± 0.5 wt % for a picrite compared to 2.8 ± 0.5 wt % for a tholeiite; at 2 Kbar, 2.7 ± 0.5 wt % compared to 4.1 ± 0.5 wt %. Ultrabasic melts may be depolymerized by network-modifying cations to the extent that hydroxyl groups, which are also network modifiers, find few available sites in the melt network. A complete description of water solubilities in melts as a function of composition, temperature and P_{H_2O} awaits more data on the temperature effect on solubility.

Experimental facilities and supervision at the Dept. of Earth Sciences, Leeds University, are gratefully acknowledged. (Author's abstract.)

SCHEPETKIN, Yu.V., NESTEROV, I.I., KULAKHMETOV, N.Kh., and RYLKOV, A.V., 1973, Application of decrepitation method for correlation of Lower Cretaceous productive horizons at Shirotnoe Priob'ye (W. Siberia): Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 280-281 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at W. Siberian Scientific-Research Gas-Oil Inst., Tyumen'.

Application of the decrepitation method for correlation of Mesozoic sedimentary rocks of W. Siberian Plate was made using the "Pirit" apparatus, and visual estimation by use of microscope MIN-8, on 40-50 detrital grains of size fraction 0.25-0.5 mm. Detritus consists mainly of quartz and feldspars, (mainly quartz) bearing GL inclusions (1-5 in grain) with dimensions 0.01-0.15 mm.

Studies proved that in vertical sections of various areas there are essential differences in the decrepigraphs of individual sandy layers. Layer BS_1 (Hauterivian-Barremian) gave T_D 420°C and 550°C, Layer AB_{2-3} (Barremian) - 480°C. Section layers BV_8 and BV_{10} (vertical distance ca 100m) also differ distinctly. Layer BV_{10} gave T_D = 360-380, 440-460, 530-550 and 720-740°C, layer BV_8 lacks distinct decrepitation or it occurs with varying intensity at T 460°C.
(Authors' abstract)

SENDERVOV, E.E., 1973, On the connection of sodium-potassium ratio in the thermal waters with the equilibria of feldspars: Geokhimiya, 1973, no. 12, p. 1831-1837 (in Russian).

SHAMAZAKI, Hidehiko, and CLARK, L.A., 1973, Liquidus relations in the

$FeS-FeO-SiO_2-Na_2O$ system and geological implications: Econ. Geol., v. 68, p. 79-96.

Iron silicate and iron sulfide liquids coexist in a large volume of the investigated system similar to the $FeS-FeO-SiO_2$ system (MacLean, 1969). Sodium is preferentially concentrated in the iron silicate liquid. Due to the strong attraction of Na_2O to SiO_2, the chemical potential of SiO_2 in melts is decreased considerably so that the phase relations are shifted, compared with the $FeS-FeO-SiO_2$ diagram, toward the SiO_2 corner. The troilite and wustite fields of primary crystallization expand into the two-liquid region. As a result, sulfide and/or oxide minerals appear earlier in the crystallization sequence than in the absence of soda, and the sulfide liquid disappears before the silicate liquid. This crystallization sequence is quite different from that of the Na_2O-free system.

Two invariant points are determined: two liquids + fayalite + wustite + troilite + iron + vapor, 877°±2°C; two liquids + tridymite + fayalite + troilite + iron + vapor, 972°±2°C. The latter point is outside the $FeS-FeO-SiO_2-Na_2O$ system and is closely approximated within the system when this assemblage becomes univariant in the absence of metallic iron.

As shown by MacLean (1969), oxidation of magma increases the size of the field of liquid immiscibility and hence fosters the separation of the sulfide liquid in nature. Na_2O addition retards silicate crystallization facilitating gravitative separation and possible economic concentration of sulfide-oxide melts. (Authors' abstract)

SHAMRAY, I.A. AND GOLIKOVA-ZAVOLZHENSKAYA, A.A., 1973, Temperature conditions of formation of Jurassic metasomatic quartzites of Karpinskiy Bank: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 250-251 (in Russian; translation through the courtesy of A. Kozlowski). Authors at Rostov Univ.

At the Buzginskiy Block of Karpinskiy Bank, limestones are replaced by quartzites. Siliceous material consists of chalcedony and has radial-spherolithic structure; sometimes chalcedonly passes into secondary quartz. All inclusions (in chalcedony and in quartz) are gaseous-liquid, 0.5 to 3-5 μm long. Samples (from boreholes) were studied by the thermovacuum method.

On decrepigraphs some peaks of gas release occur, proving the existence of some generations of inclusions; the first two peaks are asymmetric. Most of peaks (up to 3) occur in the high-temp. part of the decrepigraphs. First maximum occurs for chalcedony at 80-100°C and 100-120°C, and may be connected with T of silica-bearing solutions.

High-temp. maxima occur at 290 to 370 and 390 to 450°C, and probably they are connected with presence of allogenic quartz.

T_D increases in accordance with depth of rock occurrence: depth 687 m, T_D 95 and 410°C; depth 642 m, T_D 82.5 - and 370°C; thus the paleogeothermometric gradient was ~ 25°C. Recent T at the studied area in depth interval 650-700 m do not exceed 40-45°C, and T 86.6°C and 106°C were found at its SE part at depths 1500 and 2000 m, respectively.

Metasomatic quartzites are of telethermal origin (T did not exceed 120°C) and respective thermal surface at moment of silicification laid hypsometrically higher than now. (Authors' abstract, modified by A.K.)

SHANGIREEV, Kh. G, + ALEKSEEV, V.I., 1973, On temperatures of origin of magnetite deposits from Sokolovskiy-Sarbaiskiy region in Turgay: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 102 (in Russian; translation through the courtesy of A. Kozlowski). Authors at K. I. Satpaev's Institute of Geological Sciences of Academy of Sciences of Kazakh SSR, Alma Ata.

Decrepitation (decr.) of inclusions in scapolite from scapolite-magnetite ores (Sokolovka) takes place at 300-350°C, with maxima at 320-450°C, i.e., at lower temperature than in skarn minerals. According to Dymkin (1966), T_h in scapolite of the Kachagarskoe deposit is 380-415°C. Pyroxene and garnet decr. in ranges from 350-400 to 750-800°C, with maxima at 600-800 (pyroxene) and 500-750°C (garnet). Minerals of coarse-grained veins decr. from 280-300 to 650-700°C, i.e., at somewhat lower temp. than those of skarns; for coarse garnet the maximum lies at 500-650°C, for apatite - at 300-480 and 550-650°C. Only coarse-grained pyroxene from veins of the Lomonosovskoe deposit gives T of mass decr. 600-800°C and T_h of primary inclusions - 680-750°C. Epidote decr. takes place at 300-350°C, and quartz decr. (cementing magnetite-pyrite ore, Sololovka deposit) - at 280-400 and 500-550°C. Maximum of decr. of accesory magnetite (mt) lies at 600-800°C (Sokolovka deposit), mt of ores of scapolite sub-type - at 600-650°C (do.), mt of ores of skarn sub-type - at 470-520°C and 580-750°C (Sokolovka and Lomonosovka deposits), mt of monomineral veins 550-700°C (Sokolovka, and Velikiy Talkul'), magnetite of coarse-grained veins - at 450-650°C (Sokolovka and V. Talkul'). (Authors' abstract)

SHATSKIY, V.S., 1973, First data on temperature conditions of crystallization of alkaline rocks of Kurgusul'skiy massif (Kuznetsk Alatau): Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 204 (in Russian; translation through the courtesy of A. Kozlowski). Author at Inst. of Geol. and Geophysics, Siberian Branch, Acad, Sci. of USSR, Novosibirsk.

In pyroxene and nepheline of nepheline syenites of Kurgusul'skiy massif, primary melt inclusions were found, arranged in accordance with growth zones of the (host) mineral. Inclusions in pyroxene are crystallized, and in nepheline - partly crystallized. T_H was 1130-1170 and 930-980°C respectively.

The data testify to the magmatic origin of nepheline syenites and permit determination of the succession of crystallization of minerals. (Author's abstract)

SHCHERBAKOVA, Z.V. AND VARTANOVA, N.S., 1973, Peculiarities of gas-liquid inclusions in granitoid complexes of W. Transbaikal'ye: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 196 (in Russian; translation through the courtesy of A. Kozlowski). Authors at Inst. of Geology and Geophysics, Siberian Branch of Acad. Sci. of USSR.

Gas-liquid inclusions were investigated in rock-forming minerals of granitoid batholiths, subvolcanic and hypabyssal massifs, of both normal and subalkaline type.

Homogenization in the liquid phase (T_H 860-250°C, P 1500-780 atm) is the essential characteristic of inclusions in quartz from the batholiths. T intervals for individual postmagmatic processes were ascertained.

For subvolcanic granitoids of normal type the more typical association is melt inclusions in porphyry-like granites (T_H 970-800°C), crystal-fluid (T_H 650-450°C), plus a small amount of liquid hydrothermal ones (T_H 390-270°C). In micropegmatites only crystal-fluid inclusions were found, testifying to their formation from solutions in equilibrium with melt. The pressure in these crystal-fluid inclusions varies from 3200 to 2000 atm.

Temperatures of beginning of crystallization of hypabyssal syenites of alkaline complex (bearing 3-5 % of quartz) were higher than 900°C at P_{H_2O} not higher than 1000 atm. Under such conditions a crystal-fluid alkline solution (i.e., one that forms crystal-fluid inclusions? Ed.) separates and under its action the paragenetic association arfvedsonite, aegirine and quartz, develops, and hematite and pyrochlor precipitate. T_H of the crystal-fluid inclusions range from 650 to 350°C.
(Authors' abstract)

SHCHURKIN, B.S., 1973, Test of the prediction of deep occurrence of hydrocarbons by use of thermobarogeochemistry methods: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 279-280 (in Russian; translation provided through the courtesy of A. Kozlowski). Author at All-Union Scientific-Research Geological-Prospecting Inst.

The author tried to apply the mineralthermometric methods for studies of a sedimentary complex to evaluate the possibilities for gas and oil in the E rim of the Prikaspiyskaya basin.

Application of these methods together with other geologic studies is worthwhile since the sedimentary complex cannot be studied at greater depth, and the evaluation is necessary for the localization of deep drilling for oil and gas.

For application of mineral thermometric investigations in oil-prospecting geology, the presence of faults with hydrothermal mineralization is necessary in places of prospecting for oil and gas. This is exemplified by the Podgornenskiy anticlinal fold at Aktyubinskoe Priural'ye, where hydrothermal mineralization + occurrence of bitumens in limestone of Kungur Age were found. The author ascertained the following:

a) and b) (same as above)

c) The homogenization method yields the T of mineral origin.

d) The highest T_H was found for celestite (170-180°C)

e) If the highest geothermal gradient, 2-2.5°C/100 m, is assumed for this region, uplift of mineral solutions along fault zones can take place from a depth of 7000-8000 m.

f) These depths may also be assumed for migration of hydrocarbons.
(Author's abstract)

SHEPPARD, S.M.F. and TAYLOR, H.P., Jr., 1973, Hydrogen and oxygen isotope evidence for the origins of water in the Boulder batholith and the Butte ore deposits, Montana (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 5, no. 7, p. 805. First author at Scottish Universities Research and Reactor Centre, East Kilbride, Glasgow, Scotland.

Whole rock and biotite δD-values for 25 plutonic rocks from the composite Boulder batholith (78-68 m.y.) range from -60 to -155 per mil (SMOW). Rocks with $\delta D = -60$ to -100 (14 samples) have "normal" igneous O-18 values and quartz - K-feldspar fractionations. D/H ratios of these "unaltered" rocks probably represent primary magmatic values. Most samples with δD= -100 to -155 have epidote and chlorite alteration, "turbid" feldspars and/or granophyric textures. These altered rocks are depleted in O-18, -4 < δ < 8 per mil (SMOW), and have disequilibrium quartz - K-feldspar O-isotope fractionations. Many are from the early Rader Creek pluton and the margins of the Butte Quartz Monzonite and indicate interaction with ground waters during the cooling of the batholith. Meteoric water/rock ratios were only > 0.5 locally.

At Butte the isotopic data for hydrous alteration minerals and calculated δO-18 water values at the selected temperatures are:

Stage	δD	δO-18	δO-18 water	T°C
Pre-Main stage	-160 to -170	+3 to +5	+5 to +8	400
Main: Central	-115 to -180	-9 to +12	-12 to +8	300
Intermediate	-150 to -165	-4 to +7	-8 to +3	300
Peripheral	-130 to -145	-2 to +6	-8 to 0	275

Meteoric waters were dominant in these fluids. The large variations in δO-18 water for the Main Stage are supported by the quartz data and indicate that fluids of different isotopic composition were present at different times and/or places during the evolution of the alteration assemblages. A dominantly magmatic-hydrothermal fluid has not been detected at Butte. (Authors' abstract)

SHETTEL, Don L., Jr., 1973, Solubility of quartz in H_2O-CO_2 fluids at 5 kb. and 500°-900°C (abst): Amer. Geophys. Union, Trans. (EOS), v. 54, no. 4, p. 480.

SHILIN, A.I., NENASHEV, N.I. AND ZAYTSEV, A.I., 1973, Temperature conditions of forming of the Ilintas ore area (E. Yakutia): Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 251-252 (in Russian; translation through the courtesy of A. Kozlowski). Authors at Inst. of Geol. of Yakutian Division, Siberian Branch of Acad. Sci. of USSR.

Ilintas is a tourmaline-cassiterite-sulfide-type deposit, with non-continuous ore, divided into 4 stages: cassiterite-tourmaline, cassiterite-arsenopyrite-quartz, sulfide-carbonate (sic.). The following geothermometers were used: B.P. Kudinov's (1971) petrochemical geothermometer, Oftedal's (1943) scandium geothermometer (for granitoids), homogenization, and decrepitation of inclusions in quartz of ore bodies.

1. T of parent magma for granodiorite to fine-grained granite was 800-650°C (Kudinov's method).

2. T of crystallization of this magma 600-510°C (Oftedal's method).

3. T_H of G-L inclusions in hydrothermal quartz give 4 intervals: 150-200, 240-300, 320-370 and 400-490°C.

4. T_D (mass decrepitation) of this quartz fall also in 4 groups: 120-180, 220-280, 320-440 and 500-580°C.

(...) (Authors' abstract, with abbreviations by A.K.)

SHILO, N.A., SIDOROV, A.A., and GONCHAROV, V.I., 1973, Use of thermobarogeochemical data for systematics of gold deposits from NE part of USSR: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 92-93 (in Russian; translation through the courtesy of A. Kozlowski)

Authors at North-East Complex Scientific-Research Inst. of Far-East Scientific Center, Acad. of Sciences USSR, Magadan-SVKNII DVNC AN SSSR.

1. (...)

2. In this area the following industrially important gold ore formations occur: plutonic (Au plus RM and Au plus quartz), volcanic (Au plus Ag and Au plus sulfides). They are formed at T 450-50°C and P 1200-5 atm. Plutonic deposits are formed under relatively stable thermodynamic conditions, at high and moderate temperatures; volcanic conditions are very irregular, with inversion phenomena. One may discern high, moderate and low-temperature groups with various mineralogical compositions. (...).

3. The composition of the hydrothermal solutions forming gold deposits is variable. For plutonic deposits the high concentrations of Cl and Na are characteristic, with lower amounts of K, Ca and HCO_3^-, in contrast to the volcanic. In the latter deposits a strong increase of K concentration is typical for productive associations. The gas phase of various deposits is also variable. During formation of plutonic deposits following gases are abundant: CO_2, N_2, H_2, hydrocarbons. In volcanic deposits gas phase consists mainly of CO_2 (but in lower concentrations), O_2, N_2 and low amounts of high-temp. gases: SO_2, H_2S, NH_3, Cl_2, F_2. Plutonic solutions occasionally can be strongly concentrated brines, in contrast to volcanic solutions.

4. (...).

(Authors' abstract, shortened by A.K.)

SHKANDRIY, B.O., and KONOVALOV, I.V., 1973, Thermo-gas-liquid analysis of gaseous-liquid inclusions in quartz veins of gold ore deposits of the Lena River region: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 307 (in Russian; translation provided through the courtesy of A. Kozlowski).

1. Quartz from gold ore deposits from the Lena River region was studied. Samples were crushed to a grain size of 0.5-0.25 mm, and samples of weight 5-10 g were used.

2. Sample was placed in furnace in quartz tube divided into 3 parts. Sample was in middle part and in one of the end parts calcium carbide was placed to produce C_2H_2 during emanation of water. Sample in furnace was washed with inert gas for 1 hour to remove adsorbed gases and water. Then heating was switched on and the sample was heated for 1 hour at the chosen temperature. Middle part of furnace has temp. 500-700°C, part with calcium carbide - 100°C. Gas escaped into gas burette filled with water solution of NaCl with small addition of acid. After the one-hour heating gas volume was enlarged to 100-200 ml by dilution with helium.

3. Analysis of gas was made by use of chromatographs HL-6 and HL-69. The column was 2 m long, 5 mm in diameter was filled by "molecular sieves" NaX for analysis of CO, CH_4, N_2 and O_2; for analysis of C_2H_2, CO_2 (the authors also give symbols: C_2H_2 once more and C_3, which are evidently misprints, A.K.) filled by INZ-600 covered with triethylenedibutarate.

4. Amount of gases is calculated based on the areas of the peaks, with use of standards. (Authors' abstract)

SHLYAPNIKOV, D.S., and SHTERN, E.K., 1973, Influence of CO_2 pressure on Cu solubility in systems: $NaHCO_3$-H_2O-CO_2, $KHCO_3$-H_2O-CO_2 and NaCl-H_2O-

CO_2: in Geosynclinal magmatic formations and their ore production, V.M. Necheukhin and V.A. Marks, eds.: Sverdlovsk, Inst. Geol. and Geochem., Ural Scientific Center, Acad. Sci. USSR, Transactions, v. 102, p. 195-200 (in Russian; translation provided through the courtesy of A. Kozlowski).

Experimental data on malachite solubility at 200°C in these systems prove that the influence of CO_2 on solubility is variable. In $NaHCO_3$ solutions CO_2 pressure increase causes a decrease in the solubility of malachite, and in NaCl solutions the solubility sharply increases. The reasons for these effects are discussed, as well as role of pH and the formation of complexes. $NaHCO_3$ and $KHCO_3$ solutions can transport copper at high concentrations (over 1g/l) and NaCl solutions in wide ranges of concentration under high pressure of CO_2 in the system. (Authors' abstract)

SHUR, A.S., PURTOV, V.K., and SUNGUROVA, Z.N., 1973, Investigation of gas composition in quartz and pyritic ores of various deposits of Ural: in Geosynclinal magmatic formations and their ore production, V.M. Necheukhin and V.A. Marks, eds.: Sverdlovsk, Inst. Geol. and Geochem., Ural Scientific Center, Acad. Sci. USSR, Transactions, v. 102, p. 187-194 (in Russian; translation provided through the courtesy of A. Kozlowski).

The main gas components are as follows: CO_2, N_2, H_2. Carbon dioxide in pyritic ores occurs in significantly lower amount than in quartz, and N_2 is the major gas. The ranges of gas components in quartz from various deposits, as well as from the earlier to later generations in individual deposits, were ascertained. The main factors of gas saturation probably are: various solubility in hydrothermal solutions, density, mobility, etc.

The amount of CO_2 (% of gas vol.): rock-crystal-bearing veins 13.8-89, wolframite-bearing veins 6.9-45.0; the maximum amount of gases was found at the Akmullinskoe deposit (300 cm^3/kg); amount of H_2: 0-61%, amount of N_2+noble gases (RG): 11-81% (in quartz). In sulfide ores: volume of gas 0.38-38 cm^3/kg of sample, composition: CO_2 2.5-46.5%, also 0%; H_2 0-7%; N_2+RG 0-100%; Cl_2 0-0.37%.

Pressure during quartz crystallization at deposits of S. Ural: Akmullinskoe 515-390 bars (CO_2 79-65%, H_2 4%, N_2+RG 17-31%), Zapadnoe 600-800 bars (CO_2 57-63%, H_2 10-15%, N_2+RG 26-28%), Astaf'evskoe 1000-1500 bars (CO_2 31-39%, H_2 0-24%, N_2+RG 36-69%). Thus, the higher pressure, the lower amount of CO_2, accompanied by increase of H_2 and a slight increase of N_2. (Authors' abstract, extended by A.K.)

SILINS, Lauma, PARK, W.C., and PINSON, W.H., Jr., 1973
Strontium and yttrium distribution in fluorites from the Minerva No. 1 ore body, Cave-in-Rock District, Illinois (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 5, no. 7, p. 809-810. First author at Boston University, Boston, Mass., 02215.

Stratiform fluorite-barite-sphalerite ores occur in five stratigraphic horizons of upper Middle Mississippian limestones in the Cave-in-Rock district on the southern rim of the Illinois basin. 99 fluorites from the Minerva No. 1 Mine were studied under cathodoluminoscope and analyzed for Sr and Y by X-ray fluorescence, and compared with fluorites from vein depisits northwest of the district, and with fluorites of various genetic origin. The Illinois fluorite show uniformly low Sr and Y concentrations, with Sr in the Minerva No. 1 Mine averaging 94 ppm and Sr and 32 ppm Y. Vein deposit fluorites show even lower concentrations. Early yellow fluorites average 106 ppm Sr. and late blue-purple fluorites 54 ppm, due to incorporation of Sr in barite which precipitated abundantly after early yellow fluorite. Y contents of two fluorite generations are similar. While no significant variation in Sr content is noted in the vicinity of a pipe-like breccia area of the mine, possibly a conduit for mineralizing solutions, a small but distinct Y increase is found. Several analyses of fluorites from the lower Joppa horizon suggest possible depletion of both elements as compared to the upper Downeys Bluff horizon.

Relatively restricted Sr/Y ratios throughout the mine as compared to those of other deposits indicate limited variation in the depositional environment. The present study indicates inconsistency with a magmatic hydrothermal source of the ore solution; heated formational brines of the Illinois basin, with possible contributions from deeper hypogene solutions, are suggested as the mineralizing agent. (Authors' abstract)

SILLITOE, R.H., 1973, The tops and bottoms of porphyry copper deposits: Econ. Geol., v. 68, p. 799-815.

Although it is now widely accepted that porphyry copper deposits consist of zonally arranged shells of alteration and mineralization centered on high-level, calc-alkaline stocks, the nature of their uneconomic upward and downward extensions remains undocumented. This paper attempts to characterize these upward and downward extensions and to integrate the resulting concepts into a hypothetical model for complete porphyry copper systems. Examples from Chile, Argentina, and elsewhere are used to aid in the substantiation of the model. Programs of exploration for porphyry ore deposits can clearly benefit from the application of a model of this sort. (...)

It may be concluded that during the final stages of construction of stratovolcanoes, fumarolic and hot-spring activity are the surficial manifestations of the efflux of metal-bearing magmatic fluids from magma chambers during retrograde boiling, the interaction of these fluids with the groundwater system and the consequent formation of alteration and mineralization. The proposed model implies that porphyry copper systems effectively span the boundary between the plutonic and volcanic environments. (Author's abstract, greatly abbreviated by E.R.)

SLAUGHTER, J., KERRICK, D.M., and WALL, V.J., 1973, Experimental and thermodynamic study of equilibria in the system CaO-MgO-SiO_2-H_2O-CO_2 (abst): Amer. Geophys. Union, Trans. (EOS), v. 54, no. 4, p. 479.

SMIRNOV, V.I., 1973, On formation properties of some pyrite deposits as indicated by decrepitation data and variation of sulfur isotopes of their sulfides: in Geosynclinal magmatic formations and their ore production, V.M. Necheukhin and V.A. Marks, eds.: Sverdlovsk, Inst. Geol. and Geochem., Ural Scientific Center, Acad. Sci. USSR, Transactions, v. 102, p. 3-10 (in Russian; abstract provided through the courtesy of A. Kozlowski).

Results of decrepitometric investigations of sulfides of the pyritic deposits Filizchay and Urup (Caucasus), Blyava and Komsomol'skoe (S. Ural), Kyzyltash (Tuva) and Uchinatai (Japan), and sulfide sulfur isotope variations were studied. Pyritic deposits of N. Caucasus were formed at pressures of 220-250 atm. The $T_{decr.}$ data were as follows: Filizchay 380-400°C; Urup 240-300°C; Blyava collomorphic pyrite (pyrite-marcasite association) 360-380°C, crystalline pyrite (same assoc.) 340-360°C, pyrite (chalcopyrite-sphalerite-pyrite assoc.) 300-320°C, chalcopyrite (same) 280-300°C, pyrite (quartz-pyrite assoc.) 240-260°C; Komsomol'skoe marcasite (pyrite-marcasite assoc.) 330-350°C, collomorphic pyrite (same) 330-350°C, crystalline pyrite (same) 320-340°C, sphalerite (chalcopyrite-sphalerite-marcasite assoc.) 300-320°C, marcasite (same) 300-310°C, chalcopyrite (same) 290-310°C, collomorphic pyrite (same) 280-310°C, bornite (bornite assoc.) 220-240°C, chalcopyrite (same) 210-230°C; Kyzyltash (Cu and Cu plus Zn assoc.) 350-450°C and (polymetallic assoc.) 200-300°C; Uchinatai (silicate and "yellow" ores) 300 and 280°C, and ("black" ores) 110-120°C.

Two groups of ores were divided: 1) high temp. of sulfide formation plus weak dispersion of sulfur isotope variation compared to meteorite standard, and 2) low precipitation temperature plus wide dispersion of sulfur isotope variation. The ore-forming substance probably differentiated during formation of the hydrothermal-sedimentary pyritic deposits.

SMIRNOV, V.I., et.al., 1973, Nicolas Porfir'yevich Ermakov; Moscow State University., Vestnik, 1973, no. 5, p. 123-215 (in Russian).

A tribute on the occasion of his 60th birthday, including a photo and a short review of Ermakov's career (ER)

SMITH, F.W., 1973a, A simple microscope freezing stage: Mineralogical Magazine, v. 39, p. 366-367. Author at Dept. Geology, Univ. Durham, Durham, England.

A simple and highly verstile microscope freezing stage for studies of fluid inclusions at temperatures down to - 100°C, uses cold N_2 gas as the heat exchange medium. The system was calibrated using standard freezing point capillaries containing the following substances: benzene, +5°C; butyric acid, -6.5°C, bromine -7.2°C; methyl benzoate, -12.3°C; benzonitrile, -13°C; quinoline, -15.9°C; decane, -29.7°C. (ER)

SMITH, F.W. b,1973, Fluid inclusion studies on fluorite from the North Wales ore field: Inst. Min & Metall.; Trans., Sect. B., v. 82, p. B174-176. Author at Department of Geological Sciences, University of Durham, Durham, England.

Homogenization temperatures on primary inclusions (89.8-113.9°C), freezing temperatures (-6.8 to -18.0), and Na/K determinations suggest that the mineralizing fluids were hot (105-130°C) connate brines. (ER)

SMITH, R.K., 1973, Retrograde metamorphism in periclase marble: in the sequence (1) periclase + calcite + V → dolomite and (2) periclase + L → brucite (abst.): Geol. Soc. America Abstracts with Programs, v. 5, no. 6, p. 515. Author at Dept. of Earth Science, Univ. of Northern Iowa, Cedar Falls, Iowa 50613.

Petrographic evidence from marbles of the contact metamorphic aureole around the Alta stock, Utah indicates that during retrograde metamorphism dolomite formed at the interface between periclase and calcite before brucite replaced periclase. Relationships indicating the retrograde sequence are: (1) periclase in contact with calcite, (2) periclase rimmed with dolomite in contact with calcite, (3) brucite pseudomorphs after periclase rimmed with dolomite in contact with calcite,

(4) deformed twinning lamellae of both dolomite and calcite as the result of periclase hydration, (5) brucite veins cut both dolomite and calcite, but (6) calcite and/or dolomite veins never cut brucite. These relations suggest reactions consistent with phase relations of the MgO-CaO-SiO_2-CO_2-H_2O system according to decreasing temperature at constant pressure. Local rather than pervasive development of these relations stresses the necessity of fluids for their development and the importance of fluid composition. Apparently, CO_2-rich fluids at high temperatures evolved to H_2O-rich fluids at lower temperatures around the Alta stock during retrograde metamorphism. (Author's abstract)

SOBOLEV, E.V., AND KVASNITSA, V.N., 1973, Nitrogen in Ukrainian diamonds: Akad. Nauk SSSR Doklady, v. 212, no. 3, p. 709-712 (in Russian; trans. in Doklady Acad, Sci., USSR, v. 212, p. 130-133)

SOBOLEV, E.V., and KVASNITSA, V.N. 1973, Admixture of nitrogen in Ukrainian diamond: Akad. Sci. USSR, Doklady, v. 212, p. 709-712 (in Russian; English abstract in Int. Geol. Rev., v. 16, no. 1, p. 112, 1974.)

Practically the entire assortment of nitrogen centers (N_2, N_s(100), N_s(111), N_3V) is identifiable in diamond from different sources in Ukraine (100 crystals in all). Their N_2 distribution curve is almost the same as for Yakutian diamond (fig. 2). Characteristically, the more transparent and perfect the crystal, the more N_2 centers are found therein, for obscure reasons. Typical ultra-violet absorbtion spectra of Type I Ukrainian and Yakutian diamond are practically the same (fig. 1). (Authors' abstract)

SOBOLEV, V.S., editor, 1970, The facies of metamorphism: Moscow, Nedra Press (in Russian; translated by D.A. Brown: Canberra, Australian Natl. Univ., 1972 and 1973).

This set of five volumes (>1000 pp.), with various parts by different authors, and extensive bibliographies, covers many aspects of fluid/mineral equilibria in nature and experimental systems of interest to fluid inclusions studies. (ER)

SOBOLEV, V.S., DOLGOV, Yu. A., BAKUMENKO, I.T., BAKUMENKO, I.T., and PONOMAREVA, L.G., 1972, Direct determination of temperature and pressure based on inclusions in minerals of metamorphic rocks: Obz. Karty Obshch. Probl. Metamorf., Tr. Vses. Simp. 1971 (Pub. 1972), p. 43-53 (in Russian). Edited by Sobolev, V.S. Akad. Nauk SSSR, Sib. Otd., Inst. Geol. Geofiz.: Novosibirsk, USSR: Chem. Abst., v. 80, 5317r, 1973. Authors at Inst. Geol. Geofiz., Novosibirsk, USSR.

The temps. of the mineral inclusion homogenization (T_H) usually indicate the lowest temp. of their metamorphism. Some examples are given of T_H dets. in metamorphic rocks. The highest (T_H) are obsd. in quartz-granite rocks (880-90°) and quartz-migmatites (820-950°). These inclusions consist mostly of CO_2 and N. The inclusions contg. water have relatively low T_H, i.e. the hydrothermal fluids contg. water have lower temps. than lavas contg. little water. The inclusions in garnet of 2 pyroxene gneisses have T_H = 700-770°. The T_H of quartz and quartzite inclusions (Aldan Shield) are 440° for the liq. phase and 700-50° for the solid phase. The temp. of kyanite formation in the sillimanaite-kyanite-andalusite assocns. is >600° at pressures >8.3 kbar. Some of the inclusions in kyanite consist of N-rare gas mixtures. These inclusions sep. into gas-liq. phases only at temps. <-143° (the crit. point of N is -147°). The inclusions in quartz-chlorite veins (formed from water-contg. hydrothermal fluids) have T_H in the 260-95° range.

SOKOLOV, S.V., 1973, A geothermometric study of carbonatite complexes: Geokhimiya, 1973, no. 10, p. 1473-1480 (in Russian; translated in Geochem. Internat., v. 10, no. 5, 1974, p. 1110-1116).

The magnesium contents of coexisting clinopyroxenes and micas have been used to estimate the formation temperatures for rocks from carbonatite complexes in Yakutia and the Kola peninsula. Homogenization of inclusions (575-620° for carbonatite metasomatites) has been used as an independent geothermometer to confirm that: (1) the biotite-pyroxene diagram given by Perchuk is essentially correct, (2) the magnesium is redistributed between clinopyroxene and biotite as a function of temperature. (Author's abstract, modified)

SOKOLOV, S. V., and EPSHTEYN, Ye. M., 1973, Thermometric studies of carbonatitic metasomatites: Akad. Nauk SSSR Doklady v. 210, no. 1, p. 191-194, (in Russian; translated in Doklady Acad. Sci. USSR, v. 210, p. 174-177 (1974); abstract in Int. Geol. Rev., v. 15, no. 8, 1973, p. 979). Authors at All-Union Research Inst. of Mineral Products, Moscow.

Carbonititization (630-190°C), which succeeds the magmatic stage (>630°C) and precedes the postcarbonatitic (200/195-115/155) stage of the metasomatism, occurs in four temperature phases, the facies of which are reliably identified by several independent methods (fig. 1), as in the Sette-Daban and East Sayan massifs. Homogenization temperatures of inclusions in minerals, the biotite-pyroxene, amphibole-pyroxene, and pyrrhotite-pyrite geothermometers, mass decrepitations, temperatures of decay of solid solutions, and experimental data on stability of minerals indicate the following T limits of the facies, °C: 625/630-515/520; 515/520-400; 400-303/300; 300-200/190. (Authors' abstract)

SOKOLOV, Ya.N., 1973, Temperature of formation of skarn-feldspar-quartz rock-crystal-bearing bodies and chemical composition of mineral-forming soultions: Abstracts of papers from the Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 155-156 (in Russian; translation through the courtesy of A. Kozlowski). Author at VSEGEI, Lenigrad.

Formation of the bodies took place in a wide range of temp., 600°C (and more) down to 130-90°C, essentially from aqueous liquid solutions. During temp. decrease the solutions changed from highly concentrated bicarbonate-Ca-Mg-type to moderate and dilute chloride-bicarbonate-K-Na type and chloride-Na type. Bicarbonate-Ca component increases in bodies localized in rocks rich in CaO. Crystals formed from highly concentrated chloride solutions during rapid crystallization have many defects, especially if the process was accompanied by sharp temp. drops. Slow crystallization in a narrow temp. range from dilute soultions gave perfect, defect-free rock crystals. (Author's abstract)

SOTNIKOV, V.I., AND NIKITINA, Ye. I., 1971, Molybdenum-rare-metal-tungsten (greisen) formations of the Altai Mountains: Novosibirsk, "Nauka" Publishing House 259 pp. (In Russian; the following is an abstract, through the courtesy of A. Kozlowski, of pp. 198-200, entitled "On temperatures and composition of the mineral-forming solutions.")

Maximum T_h from quartz of metasomatites is 500-550°C, and the main interval is 400-500°C. Characteristic temps. for vein quartz (quartz-wolframite veins) are 350-470 and 300-430°C. The main ore stage took place at temp. 380°C (decrep. data). Vein quartz from veins bearing quartz plus late sulfides gives T_h 280-380°C.

Six water leachates of quartz analysis prove the following composition of fluids: Si 1-7%, Al 0.1.-0.14%, Fe 0.03-0.3%, Mg 0.05-0.26%, Mn 0.03-0.14%, Ca 0.6-2.3%, Ti 0.01-0.14%, K 0.1-1.3%, Na 0.3-3.7%, Ni 0.01-04%, F 0.06-0.14%; pH of water leachates was 5.25-5.5.

SOTNIKOV, V.I. AND PROSKURYAKOV, A.A., 1973, Thermometric analysis of explosion breccia from the Obkoronda deposit: Vyssh. Uchebn. Zaved., Geol. Razved, No. 10, p. 65-68, USSR (in Russian).

SPERA, Frank J., 1973, Thermodynamic basis for predicting water solubilities in silicate melts and implications for the mantle (abst): Amer. Geophys. Union Trans. (EOS), v. 54, no. 11, p. 1222.

STEPANOV, G.N., 1971, Skarns and greisens of the Vostok-2 deposit, pp. 234-242, in Mineralogy and geochemistry of tungsten deposits (Materials of 2nd All-Union Symposium on Mineralogy, Geochemistry and Genesis of Tungsten Deposits of USSR): Leningrad, Leningrad Univ. Publishing House, 344 pp. (In Russian; abstract through the courtesy of A. Kozlowski). Author at Far-East Geological Institute.

Skarns and greisens of the Vostok - 2 deposit (scheelite, pyrrhotite, chalcopyrite, sphalerite mineralization) are the result of continuous action of regularly evolving high-temperature hydrothermal solutions (decr. temp. of pyroxene + 500-520°C). Greisens and quartz-sericite metasomatites formed at 450°C from moderately acid solutions; quartz-scheelite veins with greisen rims probably formed from neutral to weakly alkaline solutions at 420-350°C (T_h in quartz).

STERN, Charles, and WYLLIE Peter J., 1973, Melting relations of oceanic sediment and basalt-andesite-rhyolite-H_2O compared at 30 kb (abst): Amer. Geophys. Union, Trans. (EOS), v. 54, no. 4, p. 481.

STEWART, M.K., and FRIEDMAN, Irving, 1973, Deuterium fractionation between aqueous salt solutions and water vapor (abst): Amer. Geophys. Union, Trans. (EOS), v. 54, no. 4, p. 486.

STRAKHOV, L.G., and CHERNENKO, A.I., 1973, Zoning of iron-ore deposits of the Angara-Ilim type, Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 275-276 (in Russian; translation provided through the courtesy of A. Kozlowski).

1. Horizontal zoning at skarn-ore districts of the Angara-Ilim type is expressed mainly by quantitative ratios of minerals of high- and low-temp. associations. In the subcentral zone pyroxene, garnet, and Mg-magnetite are widely developed; in the peripheral zone, calcite, chlorite and serpentine prevail. Zonality is expressed indistinctly, because low-temp. minerals were precipitated last, accompanied by general temperature decrease, and they overlap the subcentral zone, partly replacing the high-temp. minerals. T_H and T_D support this thesis of T decrease.

2. Vertical zoning of the deposit is expressed by a regular change in the mineralogical composition of the ores and the metasomatites surrounding the ores, increase in the amount of low-temp. minerals (calcite, chlorite, serpentine, and zeolites occur in upper zones with significant amounts of quartz, chalcedony and sulfides), and decrease of T_D and T_H of inclusions in calcite of 4-11°C per each 100 m.

3. For the deepest zones of the deposit, T_H and T_D of calcite is typically 200-220°C. In the horizontal plane these values are lower in the neighbourhood of wall rocks (down to 180-190°C). T decrease from center to periphery on the upper zones of the deposit is significantly greater: from 180-200°C to 80-160°C in the most distant veins and vugs.

4. In spite of a significant T decrease of the fluids in the upper parts of the Angara-Ilim type deposits, especially in the peripheral zones, veins of calcite (sometimes with deposits of Iceland spar), quartz, and sulfide develop, often including agate, chalcedony, amethyst, or jasper, accompanied by barite, zeolite, gold, cinnabar, polymetal sulfides, Ni, and platinoid mineralizations. T_H and T_D of Iceland spar (Ilimpeyskiy district) = 60-140°C, of chalcedony = 60-120°C.

5. (...) (Author's abstract, abbreviated by A.K.)

TARJAN, I., and MATRAI, M., 1972, Laboratory manual on crystal growth: Budapest, Akad. Kiado, by arrangement with UNESCO, 250 pp.

Includes some discussion of skeletal growth, of pertinence to problems of inclusion trapping. (ER).

TASHKER, E.M., 1973, Gaseous-liquid inclusions in quartz and their influence on process of preparation of transparent quartz glass: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 277-278 (in Russian: translation provided through the courtesy of A. Kozlowski). Author at All-Union Scientific-Research Inst. of Synthesis of Artificial Mineral Raw Materials, Alexandrov.

1. GL inclusions in quartz cause the formation of gas bubbles in melting quartz glass, and chemical compounds present in the vacuoles disturb the homogeneity of the glass. Improvement in the quality of quartz raw material may be reached by two ways: 1) removal from the concentrate of grains that are intensely turbid (from GL inclusions); this way has great value for cleaning granular quartz; and 2) removal of gas, liquid and solid phases from the vacuoles.

2. Significant decrease in contamination by Na, K, Ca, Mg, Al, Ti, and Mn, in GL inclusions is achieved by (leaching) quartz fractions <0.01 mm by chemically pure solvents. Most effective is a solution of HF.

3. It is possible to clean quartz fractions of size 0.2 mm without change in grain size, from elements occurring in GL inclusions by initial

thermal decrepitation, filling the opened vacuoles by solvents under ultrasonic radiation and removal of dissolved material by heating and washing (Tashker, Nyussik et al. 1972).

TAYLOR, H.P.a, 1973, The application of oxygen and hydrogen isotope studies to problems of hydrothermal alteration and ore deposition (abst): Geol. Soc. Amer. Abstracts with Programs, v. 5, no. 7, p. 834-835. Author at California Institute of Technology, Pasadena, California 91109.

O18/O16 and D/H analyses of hydrothermal minerals and fluid inclusions can provide data on temperatures and attainment of equilibrium, but they are principally useful as isotopic tracers in determining the origin of the H_2O involved in ore deposition. This results from the fact that the different sources of H_2O in the Earth's crust, namely primary magmatic metamorphic, oceanic, connate, and meteoric, all exhibit different δD and/or δO^{18} values. Recent studies have provided quantitative data emphasizing the importance of meteoric H_2O in many hydrothermal fluids. Epizonal igneous intrusions emplaced into permeable country rocks (e.g. highly fractured volcanic areas) act as gigantic "heat engines" that set up long-lived hydrothermal convention systems that persist throughout the crystallization and cooling of the intrusion. The amounts of magmatic water in such systems are negligible compared with the very large amounts of heated meteoric ground water. Certain epithermal ore deposits and their associated propylitic alteration zones in volcanic terrances (Western Cascades, Tonopah, Comstock, Goldfield, San Juans) were formed by such low-O_{18} meteoric fluids; the very high water/rock ratios imply that such ore-bearing fluids are relatively dilute H_2O. If the country rocks are less permeable, as in many prophyry copper environments, less outside water is available and dominantly magmatic-hydrothermal fluids are isotopically identified as the source of the biotite-K feldspar alteration in the core zones of the porphyry stocks. A less pronounced meteoric-hydrothermal circulation, perhaps involving Na-Ca-Cl brines in the country rocks, is set up outside the stock. Such solutions are responsible for the pyrite-sericite and hypogene clay alteration zones in the outer portions of the stock. These zones tend to collapse and enroach on the central zone with time, and the Cu ore bodies commonly occur near this boundary. At a much later stage, after erosion, supergene clay formation may occur, and this can also be distinguished from the hypogene clay alteration by means of δO^{18} and δD analyses. (Author's abstract)

TAYLOR, H.P., Jr., 1973b, O^{18}/O^{16} evidence for meteoric-hydrothermal alteration and ore deposition in the Tonopah, Comstock Lode, and Goldfield mining districts, Nevada: Econ. Geol., v. 68, no. 6, p. 747-764.

Oxygen isotope analyses were obtained for 50 whole-rock samples, 26 vein quartz samples, 4 calcites, and 1 adularia from the volcanic rocks, intrusives, and hydrothermal veins at Tonopah, Goldfield, and the Comstock Lode. At Tonopah, the δO^{18} values are as follows: Mizpah trachyte (-5.9 to +3.3); West End rhyolite (-4.7 to +1.5); Sandgrass andesite (-6.0); main-stage vein quartz (-5.1 to -1.8); late, euhedral quartz crystals (-3.2 to +0.7). The δD values of 5 of these rocks vary from -135 to -152. These materials are thus depleted in O^{18} by about 5 to 15 per mil and in D/H by about 60 to 70 per mil, relative to values in "normal" igneous rocks. The postmineralization Oddie rhyolite and Fraction volcanic breccia, however, have much higher δO^{18} values (+2.5 to +9.5). The hydrothermal alteration and ore deposition therefore must have been produced by heated meteoric ground waters ($\delta O^{18} \approx -13$, $\delta D \approx -100$) that had undergone very little or no O^{18} enrichment as a result of exchange or addition of magmatic water. Various models suggest that this involved very high water/rock ratios (>2) and occurred at about 250°-300°C. Although the δO^{18} of quartz is higher (+1.5 to +3.0), the range of whole-rock δO^{18} values at the Comstock Lode is similar to that at Tonopah: Alta andesite (-4.1 to +4.7); Davidson diorite stock (-2.6 to -0.8). At Goldfield, somewhat higher whole-rock δO^{18} values are observed: altered volcanic rocks (+1.7 to +5.8); ore zones (-3.8 to +3.8). These data also indicate a dominant meteoric ground-water component in the hydrothermal fluids, but they suggest smaller water/rock ratios at Comstock and lower temperatures of alteration at Goldfield. It is concluded that most epithermal gold and silver ore bodies in highly faulted piles of altered volcanic rocks probably were deposited by meteoric-hydrothermal solutions heated and set into convective circulation by interaction with epizonal igneous intrusions. (Author's abstract)

TAYLOR, Hugh P., Jr. and FORESTER, Richard W., 1973, An oxygen and hydrogen isotope study of the Skaergaard intrusion and its country rocks (abst): Amer. Geophys. Union, Trans. (EOS), v. 54, no. 4, p. 500.

TERESHCHENKO, S.I. AND LITOVCHENKO, E.I., 1973, Formation conditions of fluorites from Pridnestrov'ye from mineral thermometry data: Abstracts of papers from the Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 124-125 (in Russian; translation through the courtesy of A. Kozlowski). Authors at IGFM AN Ukrainian SSR, Kiev.

1. Geological features proving the hydrothermal origin of fluorite mineralization at Pridnestrov'ye are listed. A typical paragenesis is: fluorite, calcite, quartz, pyrite, barite, galena, sphalerite, and cinnabar.

2. (. . .) Fluoritic sandstone cement at the villages of Bakhtyn, Vinozh, Novosyolki, and Skazintsy, bears essentially gasesous inclusions with T_h 470-415 and 395-350°C. Most inclusions are of the gas-liquid type, homogenizing in the liquid at temp. 298-250°C. Gas-liquid inclusions homogenizing at temp. 225-175, 160, 140, 110°C are very numerous. The latter are connected with healed fractures. Individual inclusions of liquid CO_2 with T_h 30°C were found. (Authors' abstract, abbreviated by A.K.)

THEODORE, T.G., and NASH, J.T., 1973, Geochemical and fluid zonation at Copper Canyon, Lander County, Nevada: Econ. Geol., v. 68, p. 565-570. Author at U.S. Geol. Survey, Menlo Park, California.

In addition to extensive analytical geochemical studies, mapping of high-salinity inclusions was found to aid in outlining the probable area of circulation of copper-bearing fluids along hydrologic controls by lithology and intensity of fracturing. This provides an additional exploration guide. (E.R.)

TITARENKO, A.V., 1973, Thermometric investigations of barite from the Belorechenskoe deposit: Abstracts of papers from the Fourth

Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 131, (in Russian; translation through the courtesy of A. Kozlowski) Author at Rostov Univ.

Three varieties of barite were recognized: I - prismatic, II - platy-prismatic, III - tabular. In all varieties three types of inclusions were found: primary, secondary, and pseudosecondary. Primary and pseudosecondary incl. are gas-liquid, and the rare secondary ones are mainly liquid. The degree of fill is 85-95% and the inclusion dimensions 1 to 100 micrometers. Formation temp. of barite was determined by the homogenization, thermoacoustic, and thermovacuum decrepitation methods. Barite I precipitated at 75-100°C, barite II at 70-85°C, and barite III at 60-75°C. In a 300-m vertical section of the deposit, the temp. of the same barite variety did not change. (Author's abstract)

TKACHENKO, V.P., SOKOLOV, Ye. M., AND GORBACH, A.M., 1973, On some features of the formation of the tungsten deposit Kti-Teberda in N. Caucasus, as revealed by inclusion data: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30, Sept., 1973: Rostov, Rostov Univ. Press, p. 58-59 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Rostov University.

Inclusions investigations were made on minerals of complex veins of deposit of Kti-Teberda to determine temp., phase state and chemical composition of tungsten-bearing solutions.

Vein mineral formation was divided into 2 parts: high-temperature (rare-metal stage) and moderate-temperature plus low-temperature (polymetallic). Upper temp. boundary of the rare-metal stage is fixed by the temp. of feldspar decrepitation 360-330°C; for scheelite and quartz the interval of decrep. temp. is somewhat lower: 320-240 and 300-230°C respectively. The lowest-temperature inclusions were found in calcite of the polymetallic stage (100-120°C).

Scheelite vein formation took place from relatively highly concentrated solutions (400-600 g per liter), as evidenced by the presence of inclusions bearing fluid and crystals, mainly halite and sylvite.

For ore-bearing zones of the deposit the similarity of phase composition of inclusions and temp. regimes of precipitation of main rock- and ore-forming minerals were ascertained.

In a vertical cross-section of deposit the regular increase of temperatures of mineral formation downward was ascertained and minerals of polymetallic stage are replaced by the rare-metal wolframite-scheelite association. (Authors' abstract)

TOMILENKO, A.A., and CHUPIN, V.P., 1972, Inclusions in quartz of migmatites and granites of the Verkhnealdansk suite of the Iengrsk series: Obz. Karty Obshch. Probl. Metamorf., Tr. Vses. Simp. 1971 (publ 1972), p. 54-56 (in Russian). Edited by Sobolev, V.S. Akad. Nauk SSSR, Sib. Otd., Inst. Geol. Geofiz.: Novosibirsk, USSR. Authors at Inst. Geol. Geofiz., Novosibirsk, USSR. Chem. Abst., v. 80, 5318s, 1973.

The inclusions of the title rocks contain gases (CO_2 90.4%, NH_3, H_2S, SO_2, HCl, HF), recrystallized solids (m.p. 720-860°), and/or liquid CO_2. The homogenization temperature of the inclusions in quartz of migmatites is 820-950°, in quartz of granitic rocks it is 880-960°. The metamorphic processes leading to the formation of the title rocks occurred in the 850-950° range and 6.0-6.5 kbar pressure. The hydrothermal liquid from which these rocks were formed contained relatively little water; the inclusions do not contain any detectable concentrations of water or O.

TOURAY, Jean-Claude, 1973, Fluid inclusions; deciphering the messages: Recherche, v. 4, No. 38, p. 896-897, (in French).

A short popular account. (ER)

TOURAY, J.-C., 1973, Evidence (from fluid inclusions) of fossil geothermal areas (abst.): Reun. Annu. Sci. Terre (Programme Resumes) 1973, p. 398, 1973 (in French). Author at Lab. de Géol. Appliquée, Univ. d'Orleans, Cédex France.

A brief discussion of the inclusion evidence for fossil geothermal areas - abnormally high geothermal gradient and saline solutions from the boiling of the fluids, with a possible example from Voltennes. (E.R.)

TOURET, Jacques, 1973, CO_2 fluids in the granulite facies (abst.): Réunion annuelle des Sci. de la Terre, Paris, March, 1973, Soc. géol. de France, p. 225 (in French). Author at Univ. Lab. de Geol. Struct., C.O. n° 140, 54037,France.

A summary of microthermometrical data (particularly on the melting point of frozen CO_2 inclusions) and chromatographic data on decrepitated samples showing hydrocarbons present, and the significance in metamorphic terraines (ER)

TREIVUS, E.B., and PETROV, V.S., 1973, Investigation of solution inclusions in magnesium sulfate septahydrate crystals: Kristallografiya, v. 17, no. 6 (1972), p. 1266-1268 (in Russian; translated in Soviet Physics-Crystallography, v. 17, no. 6, p. 1111-1112). Authors at Leningrad State University.

The mechanism of formation of point-like and planar-type inclusions was investigated by telescopic microscopy during growth and related to variations in growth parameters (Prandtl, Grashof, and Nusselt numbers). (E.R.)

TRUFANOV, V.N., KURSHEV, S.A., MAISKII, Yu.G., and USHAK, A.T., 1972, Phase equilibria in ultracidic differentiates of granitic magmas at high temperatures and pressures: Mezhdunar. Geokhim. Kongr., (Dokl.), 1st 1971 (pub. 1972), v. 1, p. 617-627 (in Russian). Edited by Vinogradov, A.P. Akad. Nauk SSSR, Inst. Geokhim. Anal. Khim.: Moscow, USSR. Authors at Rostov. Gos. Univ., Rostov-on-Don, USSR. Chem. Abstracts, v. 80, 147752g, 1973.

An experimental procedure was evolved for the direct observation of gas-solid inclusions in rock samples at ≤1200° and ≤1200 atm. when the applied pressure was such that the decrepitation underwent phase transitions analogous to the phase transitions in magma during its solidification. The samples studied include quartz from the Caucasian and Kazakhstan granites. The inclusions of these samples contained CO_2 which at 450-500° was absorbed by the liquid phase of the inclusion, which separated into two liquid phases of different density. Cooling the samples did not cause the reappearance of CO_2. The new phases were metastable silicates, which after three years began to decompose, giving off CO_2. The experiment indicates the possibility of metastable compd. formation during the differentiation of magma and the effect of their subsequent decomposition on the rock structure.

TRUFANOV, V.N., MAYSKIY, Yu.G. AND DRONOV, V.S., 1973, Influence of gamma radiation on phase state and phase inversions of fluid inclusions in quartz: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 289 (in Russian; translation through the courtesy of A. Kozlowski). Authors at Rostov Univ.

Previously specific phase inversions were known in inclusions in quartz under the action of thermodynamic activation in autoclaves at T 500-600°C and P 1000-1500 atm. Separation of metastable supercritical fluids formed during such activation, to form 2 or more immiscible phases, lasts some months at room T. In processes of formation of endogenic mineral parageneses similar phenomena display a seemingly significant role, but they have not been investigated sufficiently.

For evaluation of influence of external factors on metastable CO_2-H_2O solutions, experiments were made with irradiation of inclusions by gamma-rays (...) having a maximum energy of 23.5 MeV. It was ascertained that radiation accelerates phase phenomena in inclusions and causes the enlargement of number of inclusions with beginning of phase separation, in comparison with specimens which were not subjected to irradiation.

Observed activation of kinetic processes can be explained by loss of energy by electrons, formed during interaction of radiation with the substance and having an energy of some hundreds eV. Energy of twisting and rotation of molecules received during impacts by electrons, during ca. 10^{-13} sec., transforms into sufficient heat for activation of molecules contained in a volume of radius 10^{-7} to 10^{-6} cm; the energy of activation is some tens of Kcal per mol. (Authors' abstract, with abbreviation by A.K.)

TRUFANOV, V.N., MAYSKII Yu. G., and USHAK, A.T., 1973, Ontogeny and phylogeny of fluid inclusions in minerals: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 19-20 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Rostov University.

Each mineral is a physico-chemical system, in which the dialectic junction of solid and fluid phases is realised. Fluid inclusions ought to be investigated as existing in time and space, from the moment of origin to the moment of destruction (ontogeny), and, on the other hand, in the light of the regular evolution of the system mineral/solution in the scale of geological time (phylogeny).

The ontogenetic investigations of inclusions prove that there exist maximum and minimum size ranges (critical sizes) of vacuoles depending upon the lattice parameters of mineral, degree of disequilibrium of the mineral/parent solution system and the mechanism of trapping and later evolution of microsamples of fluids.

Average inclusion size, their amount by volume in the crystal, the degree of fluid phase saturation, density, concentrations of fluids and other parameters change with regularity during the growth of crystals in various deposits. A structural and genetic classification of "mineral-solution" systems was proposed, in which all the fluid inclusions of minerals are divided into three large groups: a) phase inclusions, b) clathrate compound inclusions, c) free fluid-forming atomic groups (Trufanov, 1972).

In the phylogeny of inclusions the main property is the effect of duplication of those general features of inclusion evolution in ore bodies, deposits and ore fields, which were ascertained for one mineral. Fluid inclusions may be also used as "geological chronometers."

On the basis of experimental data on coefficients of intracrystalline and intergranular diffusion, the age of fluid inclusions about 1 micrometer in size at 500°C does not exceed 30-50 thousand years, and inclusions with average size 15-20 micrometers - 100-150 m.y. (Authors' abstract).

TRUFANOV, V.N., and RODZYANKO, N.G., 1973, Essential achievements and perspectives of development of thermobarogeochemistry of ore-forming processes at the Northern Caucasus: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 15-16 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Rostov University.

The ore bodies of tungsten and molybdenum, chalcopyrite, mercury and polymetals, barite and ceramic materials were investigated by the methods of thermobarogeochemistry. The thermodynamic parameters and sequence of origin of ore parageneses, optimal values of TPX-parameters of crystallization of vein and ore minerals, the connection of ore localization with the geochemical stages were ascertained. The new schemes of evolution of sources of ore-forming fluids depend on pulsating separation of the fluids.

On the other hand, the theoretical principles of decrepitometry and thermobarometry, the new constructions of laboratory equipment and the methodical questions of investigation of inclusions were developed (vacuum decrepitometer VD-2, decrepitometer RUD-1, homogenization and decrepitation stage GD-1, stage for infrared thermometry of fluid inclusions etc.).

The effect of "double homogenization of inclusions" as well as the phenomenon of thermodynamic activation of mineral-forming solutions with their change into metastable supercritical state and the stages (thermodynamic) of origin of the main genetic types of Northern Caucasus deposits, were ascertained. The thermobarometric data obtained are used for the solution of various questions.

In the near future, regional investigations of endogenetic deposits, ore-bearing intrusives and volcanic complexes to ascertain the genetic connections between magmatism and ore-forming processes will be continued. (Authors' abstract).

TSEPIN, A.I., and DOLOMANOVA, E.I., 1973, Application of X-ray microprobe in the study of the chemical composition of solids in vacuoles in minerals: Abstracts of papers at Fourth Regional Meeting on Thermobarogeochemistry of Mineral-Forming Processes at Rostov-on-Don, 24-30 Sept., 1973: Rostov, Rostov Univ. Press p.303-305 (In Russian; translation provided by Dr. E.I. Dolomanova of I.G.E.M., Moscow). Authors at IGEM, USSR Academy of Sciences, Moscow.

The composition of solids in open vacuoles in cassiterite, tourmaline, and quartz was studied with the use of an MS-46 microprobe. Owing to the fact that both the relief of the vacuole floor and the amounts of solids, which are very small, do not satisfy the basic requirements of quantitative analysis, it was practically impossible to make quantitative measurements of the element content in the solids. Hence the characteristics are necessarily qualitative: the distribution of elements over the floor and the walls of a vacuole, their associations, and the correlation between the distribution of different elements. The procedure of qualitative and semiquantitative analysis of the composition of sediments was developed. (Favorable conditions are needed to obtain results: the vacuole should be large - 100 μm, should not be too deep, and the solid should be fairly large, namely > 1 μm).

Three types of solid were recognized: (1) crystals, (2) grains varying in size and shape, and (3) fine-dispersed solid, varying in thickness, on vacuole walls.

The studied solids were always water-insoluble compounds, or slightly soluble compounds, because most soluble compounds were probably removed from opened vacuoles during the polishing of the specimen. This is confirmed by the absence of compounds containing Cl and alkaline elements in many specimens.

Even a qualitative analysis, however, is difficult to conduct. First, if the vacuole is very deep, X-rays from its floor are screened by its walls. Second, the radiation from the vacuole edge located closer to the spectrometer, and from the adjacent areas is also screened, partly or entirely, by the edge itself so the element distribution pattern is greatly distorted. Microanalysers with a large angle of X-ray selection essentially overcome the first difficulty, and by rotating the specimen and by photographing the vacuole in various positions relative the spectrometers, the second difficulty can be eliminated. Then the overall element distribution pattern is a superposition of particular distribution patterns.

The following anions were detected in the composition of the solids found in vacuoles: S, P, Cl, P (sic.), N, and their associations with Ca, Fe, Al, Mg, Ni, Cu, Zn, Cr, K, Na, Sn, Mn, Ti, Ag, Pb, Bi, Cd, and others. These sediments appear to be sulphates, phosphates, chlorides, sulphides, etc. Salts of carbonic acid could be among them, as liquid and gaseous carbon dioxide and carbonates were often found in vacuoles by other methods. But since the minerals were coated with pure carbon to provide stable performance of the instrument, it was not involved in the X-ray microprobe analysis.

It will be also noted that H_2, N_2, H_2O, CO_2, CH_4, and CH_3X (where X is F or Cl) were determined by the methods of gas analysis and infrared spectroscopy in the contents of vacuoles. This suggests the complex composition of the solutions in vacuoles in minerals. (Authors' abstract).

TUGARINOV, A.I., KHODAKOVSKIY, I.L., and ZHIDIKOVA, A.P., 1973, Physicochemical conditions for molybdenite production in hydrothermal uranium-molybdenum deposits: Geokhimiya, 1973, no. 7, p. 975-984 (in Russian; translation in Geochem. Internat., v. 10, no. 4, 1974, p. 731-739). Authors at Vernadskiy Institute of Geochemistry and Analytical Chemistry, Academy of Sciences of the USSR, Moscow.

An examination of fluid inclusion data and experimental laboratory data suggests that Mo and U can be transported simultaneously as hexavalent compounds in the presence of small amounts of H_2S ($\sim 10^{-7}$M) at about 150°C. (E.R.)

TURINGE, A.P. AND KIEVLENKO, Ye. Ya., 1973, Some genetic peculiarities of rock cyrstal formation in Somalia: Abstracts of papers from the Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov

Univ. Press, p. 121 (in Russian; translation through the courtesy of A. Kozlowski). Authors at 6th All-Union Productive Company of Geology Ministry USSR, Moscow.

Rock crystal deposits occur in quartz veins and pegmatites of granite-gneisses of the Precambrian Darburuk-Djebile series. Investigated specimens were taken at Mandera, Abdel Kadr and in the pegmatite Vay-Vay at Bur-Mado. In all quartz crystals gas-liquid inclusions occurred only the basal parts, with 60-90% filling and some CO_2. T_h in liquid are as follow: Mandera 255-260-265-275-280°C; Abdel Kadr 160-180-220-240-285-290-295-300°C; Vay-Vay 160-210-220-260-310-320-340-370°C. (Authors' abstract, abbreviated by A.K.)

TYUTYUKOV, I.A. and BETELEV, N.P., 1973, Some freezing characteristics of salt solutions similar to mineralized waters at depth and brines of salt deposits: Akad. Nauk SSSR, Doklady, v. 213, no. 6, p. 1392-1394 (in Russian; translated in Doklady Acad. Sci. USSR, v. 213, p. 217-219, 1975; abstract in Int. Geol. Rev., v. 16, no. 3, p. 364, 1974). Authors at Research Institute of Foundations and Underground Structures, Moscow.

Time-temperature in freezing NaCl solution (170 g/l) with or without stirring (fig. 1), and the effect of mixing on freezing temperatures of differently composed aqueous mixtures of Na, Ca, Mg, Cl, SO_4, HCO_3 (table 1, fig. 2) prove that the composition-freezing T relationship is not linear, but quite intricate, even for NaCl only, and that additions of $MgCl_2$ and $CaCl_2$ lower this temperature significantly. These findings are particularly relevant to calculations of the flow of brines in oil fields of the permafrost zone, as well as in geocryological-hydrogeological studies. (Authors' abstract)

UCHAMEYSHVILI, N.Ye. AND ZAGRYAZHSKAYA, G.D., 1973, Physico-chemical conditions of formation of polymetallic deposits in the Sadonskiy region, as indicated by investigation of gas-liquid inclusions in minerals and isotopic composition of sulfur in sulfides: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 148-149 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Vernadsky Inst. of Geochemistry and Analytical Chemistry, Acad. Sci. USSR, Moscow

Isotopic investigations of S in sulfides and composition of gas-liquid inclusions in vein and ore minerals from polymetallic deposits of the Sadonskiy region indicate three stages of mineral formation. Commercial ores formed during the two earlier stages. Changes of isotopic composition of sulfur in sulfides and in barite, and of solution composition in inclusions during formation of deposit are exemplified by the Zgidskoe deposit, where four (sic) types of ore-forming solutions were distinguished:

1. Cl-Na type: $Cl > HCO_3^-$; Na and (K) > Ca and (Mg)
2. Chloride-bicarbonate-sodium-calcium type: $Cl \cong HCO_3^-$; Na& (K)≅Ca& (Mg)
3. Bicarbonate: $HCO_3^- >> Cl$, 1) Na>Ca, 2) Ca> Na.

In quartz and barite of the investigated deposits CO_2

was determined; it was found to be relatively high, up to 3-12% (by weight? - A. K.) of the solution.

In quartz three-phase inclusions were found, bearing liquid CO_2, with T_H 24-30°C.

Isotopic composition of sulfide sulfur changes from δS^{34} = +7.0‰ to -2.0‰; this indicates a crustal source for the sulfur. The lightest sulfur occurs in sulfides of the third stage. A regular decrease in the absolute value of δS^{34} in sulfides from earliest to latest ones indicates oxidation in the process of ore formation, giving at the end barite with the highest value of δS^{34}. (Authors' abstract)

VALYASHKO, L.M., 1973: Investigations of inclusions of mineral-forming fluids and melts in France (1968-1972): Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 28-29 (in Russian; translation provided through the courtesy of A. Kozlowski). Author at Moscow University.

A review, mainly on the basis of papers from Bern symposium 1969.

VAN LOON, J.C., KESLER, S.E., and MOORE, C.M., 1973, Analysis of water-extractable chloride in rocks by use of a selective ion electrode, <u>in</u> Geochemical Exploration 1972, ed. M.J. Jones, (Proc. Fourth Internat. Geochem. Explor. Symp., London): England, Inst. Mining and Metallurgy, p. 429-434.

Analysis of water-extractable chloride from rocks (in large part stemming from fluid inclusions) has been proposed as a means of recognizing rocks associated with hydrothermal mineralization. This paper gives details on an appropriately sensitive, cheap and fast method. (ER)

VASILENKO, G.P., 1973, Stages and composition of entrapped solutions of cassiterite-sulfide deposits of Primorye: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 83-84 (in Russian; translation provided through the courtesy of A. Kozlowski). Author at Far-East Geological Institute of Far-East Scientific Center of Academy of Sciences of USSR, Vladivostok-DVGI DNC AN SSSR

The mineralization process was divided into 4 stages: quartz, arsenopyrite with cassiterite, chlorite and tourmaline; sulfide (galena, sphalerite - pyrrhotite); carbonate-sulfide (ankerite) and calcite with pyrite. It developed during a continuous decrease of temperature. In early quartz inclusions homogenize at 410-318°C, and for the sulfide stage the interval was 360-192°C. Water leachate proved that Sn-bearing solutions of the early stage are of the 4th Ca-Na-S-HCO_3^- type and late Sn-poor solutions are of the 5th Ca-Mg-HCO_3^--S type. (...) (Author's abstract, shortened by A.K.)

VASIL'KOVA, N.N. and KUKUSHKINA, O.A., 1973, Composition, properties and conditions of crystallization of fluorite in deposits related to granitoids: Geokhimiya, 1973, no. 5, p. 689-700, (in Russian; translated in Geochem. Internat. v. 10, no. 3, 1974, p. 530-539).

Homogenization data (125 to >360°C) are presented for 15 samples of fluorite from various deposits, along with trace element, thermoluminescence, and other parameters. (ER)

VASIL'YEV, V.I., OBOLENSKIY, A.A., BORISENKO, A.S., 1973, Temperatures of formation of mercury deposits: Akad. Nauk SSSR Doklady, v. 209, no. 2, p. 451-454. (in Russian; translated in Doklady Acad. Sci. USSR, v. 209, p. 103-106, 1974; abstract in Int. Geol. Rev., v. 15, no. 5, p. 619, 1973). Authors at Institute of Geology and Geophysics, Siberian Division, USSR Academy of Sciences, Novosibirsk.

Mineralo-thermometric studies of mercury, cinnabar, and the gangue minerals (quartz, ankerite, calcite, barite, etc.) from several mercury provinces, USSR (table 1) show that every one of the deposits was formed at <250°C. The bulk of cinnabar comes down at 150-170°C, rarely at 180°C. The temperature control, principal factor in deposition of the ore from concentrated solutions, is moderated by other variables, however, very much like the solubility of mercury sulfides under experimental conditions. The fact that Hg is generally high in natural mineralizing solutions is indicated by the development of massive metacolloidal ores, metasomatic deposition of the bulk of the cinnabar, high salinity of the solutions (in the inclusions), and other evidence. (Authors' abstract)

VENIDZE, G.M., TVALCHRELIDZE, T.A., MINDIASHVILI, T.N., and CHICHINADZE, M.K., 1973, Stages and temperature conditions of formation of copper-pyrrhotite mineralizations of Mt. Kakhetin (eastern Georgia): Program of the Fourth Regional Meeting on Thermobarogeochemistry of Mineral-Forming Processes, at Rostov-on-Don, 24-30 Sept., 1973: Rostov-on-Don, USSR (in Russian). (No abstract in Abstracts volume.)

VERES, G.I., KASAVCHENKO, G.V., and TRANKVILLITSKAYA, I.A., 1973, On evaluation of gold-bearing features of quartz from Muruntau by thermobarometric analysis: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 263 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at All-Union Correspondence Polytechnical Inst., Kyzyl-Kum Geological-Research Expedition.

Similar types of quartz give thermobarograms with typical curve configuration. Thus thermobarograms are typomorphic features of the minerals, useful for qualitative analysis. An atlas of thermobarograms of quartz from Muruntau was made for calibration and three genetic types were distinguished; individual features were ascertained for thermobarograms of gold-bearing quartz. Control thermobarographic analyses of 200 quartz samples were made and gold-bearing quartz was distinguished. (Authors' abstract, modified by A.K.)

VERTUSHKOV, G.N. AND SOKOLOV, Yu.A., 1973, Reconstruction of mineral-forming solutions of endogene deposits of quartz: Abstracts of papers from the Fourth Regional Conference on Themobarogeochemistry of Mineral-forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 185 (in Russian; translation through through the courtesy of A. Kozlowski). Authors at Sverdlovsk Geological Inst., Sverdlovsk.

(. . .) Investigations of fluid inclusions were made on samples taken from E. slope of Middle and S. Ural (area ca. 15,000 km^2). $H_2O + CO_2$ (95 to 98% of volatiles by vol.), Na, and K are the main components of fluid inclusions. Concentration of Na + K in inclusions in quartz from non-ore veins equals 0.1 - 20 mg per 100 g of quartz (10 - 380 g per liter of H_2O in fluid inclusions, average value 60 g per 1 i.e., 6%).[2] Weight ratio Na^+/K^+ is near equal to the aqueous index (Vertushkov et al. 1966, 1969, 1970) and does not depend on mineral composition of non-ore quartz veins and wall rocks. The ratio decreases with increasing temperature of mineral-forming process. (Authors' abstract, modified by A.K.)

VLADIMIRSKAYA, N.I., 1973, Genetic features of borosilicates, based on investigations of fluid inclusions: Vses. Mineral. Obshchest., Zap., v. 102, no. 4, p. 394-401, (in Russian). Chem. Abst., v. 79, no. 11, 128076c, 1973.

The borosilicate deposits of Central Asia are localized in the Carboniferous, Permian, and Triassic terrigenous, effusive-pyroclastic, and siliceous-carbonatic rocks intruded by the Upper Permian granitic rocks. The ore minerals include danburite, datolite, axinite, and tourmaline. Most (69%) of the 2-phase gas-liq. inclusions in danburite yield a homogenization temp. of 150-400° with some inclusions (24%) yielding 60-150° and the rest (7%) 400-600°. Decrepitation of these inclusions in borosilicates occurs in the range 250-500°. The formation of borosilicates commenced during the close of the skarn stage, with major B mineralization occurring during the post-skarn stage. (Author's abstract)

VOLYNETS, V.F. AND BANNIKOVA, L.A., 1973, Nitrogen in sulfides: Abstracts of papers from the Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 173 (in Russian; translation through the courtesy of A. Kozlowski). Authors at Vernadsky Inst. of Geochemistry and Analytical Chemistry, Acad. Sci. of USSR, Moscow.

(. . .) The amount of combined N in quartz ranges from 0.10 to 0.84 g per liter of solution in fluid inclusions, in fluorites - from 0.84 to 3.6 g/l, and in sulfides reaches 12 g/l. The essential form of the combined N in inclusions is NH_4^+, but the presence of amino acids was also ascertained. The latter are very interesting, because amino acid complexes with many metals are as stable as with carbonate and sulfide complexes, and in some cases they are more stable. The possible mechanisms resulting in occurrence of combined N in hydrothermal solutions will be discussed. (Authors' abstract, abbreviated by A. K.)

VOVK, P.K. and PAVLISHIN, V.I., 1971, Morphology and growth of albite in cavity (chamber) pegmatites: Mineral. Mineral. Kristallogr., Tr. Soveshch. 1969 (Pub. 1971), 100-102. Edited by Vertushkov, G. N., Sverdlovsk. Gorn. Inst.: Sverdlovsk, USSR (in Russian) Chem. Abst. v. 79, no. 12, 138474 v, 1973.

All morphol. varieties of albite, with the exception of perthitic albite, were formed approx. at the same time, in a narrow temp. interval (300-400°) with different compns. of mineral-forming solns. The compn. of the mineral-forming soln. detd. the morphol. differences of the crystals. (Authors' abstract)

VOYTKEVICH, G.V., 1973, On some questions of cosmic formation of minerals: Abstracts of papers from the Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30, Sept., 1973: Rostov, Rostov Univ. Press, p. 135-136 (in Russian; translation provided through the courtesy of A. Kozlowski). Author at Rostov Univ.

No data on fluid inclusions.

VOZNYAK, D.K., GRITSYK, V.V., KVASNITSA, V.N. and GALABURDA, Yu. A., 1973, Inclusions of petroleum in Marmarosh diamonds: Dopov. Akad. Nauk Ukr. RSR, Ser. B 1973, v. 35, no. 12, p. 1059-1062 (in Ukrainian). Authors at Inst. Geochem. Phys. Miner., Kiev, USSR. Chem. Abst. v. 80, 110749K, 1973.

Primary inclusions in "diamond" (quartz) crystals, from the left bank of the Perkalab River, were formed from hydrothermal solns. (petroleum brines). Petroleum-and gas-bearing deposits may occur in the region. Chem. compns. and pressure-temp. conditions of the inclusions in crystals from stratigraphic horizons of different regions should be studied. (Authors' abstract)

VOZNYAK, D.K. and KALYUZHNYI, Vl.A., 1973, Change of shape of inclusions in minerals of variable composition and its effect on the composition of parent solution isolated in vacuoles: Akad. Nauk SSSR, Doklady, v. 212, no. 5, p. 1192-1195 (in Russian; translated in Doklady Acad. Sci. USSR, v. 212, p. 140-143, 1974; abstract in Int. Geol. Rev., v. 16, no. 1, p. 117, 1974.) First author at Institute of Geological Sciences, Ukrainian Academy of Sciences, Kiev.

Applicability of Lemmleyn's generalizations (DAN 78, no. 4 et seq.) to inclusions in topaz is provided here by detailed studies of secondary and primary gas-liquid inclusions in tens of specimens (figs. 1-4). (Authors' abstract)

WANG, Yuan, 1973, Wall rock alteration of late Cenozoic mineral deposits in Taiwan: Mineralogical and physicochemical aspects: Acta Geologica Taiwanica, no. 16, p. 1-29 (in English).

Wall rock alterations of the representative mineral deposits of late Cenozoic time, namely, the Chinkuashih copper-gold, the Tatun sulphur-pyrite, and the Chimei copper-pyrite deposits in Taiwan, are closely studied in terms of mineralogy in order to establish spatial and paragenetic relations for the alteration haloes concerned.

The formation temperatures of the alteration haloes and the intimately associated deposits are estimated from T_H of liquid inclusions and other mineralogical data as follows: Chinkuashih, 210°-290°C; Tatun, around 100°C; Chimei, 150°-270°C. The pressure conditions for Tatun and Chimei deposits are inferred from geological data to be near surface condition and for Chinkuashih around 0.2-1.0 kb at most.

From the comparison of the mineralogical assemblages with the data of experimental mineralogy physicochemical conditions of the hydrothermal solution responsible for advanced argillic facies and the concurrent ore deposition at Chinkuashih may be as follows: pH 3.5-4.5; $-\log f_{O_2}$ 30-34 atm.; $-\log_{s_2}$ 6-8 atm., with sufficiently high activities of SiO_{2aq}, K^+ and SO_4^{2-}. Those for the Chimei deposits are somewhat different from the above, being characterized by near neutral to slightly alkaline condition with lower fugacities of O_2 and S_2, and sufficiently high activities of SiO_{2aq}, Na^+, and lower SO_4^{2-}. (Author's abstract, greatly abbreviated by ER.)

WATKINSON, D.H., 1973, Shortite in kimberlite from the Upper Canada Gold Mine, Ontario (abst.): Canadian Mineralogist, v. 12, pt. 2, p. 148. Author at Carleton University, Ottawa.

Shortite, $Na_2Ca_2(CO_3)_3$, occurs in the groundmass of micaceous, hypabyssal-facies, kimberlite dikes in the Upper Canada Gold Mine, Ontario. Electron microprobe analytical, optical and x-ray data are virtually identical to those of shortite from saline dolomitic marl of the Green River Formation, the only other known occurrence. Shortite grains range up to 2.2 mm across and constitute about 8 volume percent of the kimberlite groundmass. Shortite is associated with calcite, aggregates of serpentine and fresh olivine (Fo_{83-88}). Grains of the former three minerals have about equal dimensions and all poikilitically enclose small grains of phlogopite, magnetite, apatite and perovskite. Round megacrysts, as large as 2 cm, of olivine (Fo_{93-94}) are concentrated in central portions of the dikes by flow differentiation. Minor megacrysts of phlogopite, chromite, partially kelyphitized pyrope, and chrome-diopside are also present. The shortite, serpentine and associated minerals are interpreted to be primary, late-stage precipitates from kimberlitic magma at low temperature. This implies that a sodic, carbonatic, residual magma might be generated by fractionation of kimberlitic magma. (Author's abstract)

WATTS, B.J., 1973, Relationship between fluid-bearing and fluid-absent invariant points and a petrogenetic grid for a greenschist facies assemblage in the system $CaO-MgO-Al_2O_3-SiO_2-CO_2-H_2O$: Contr. Mineral. and Petrol.v.40, 1973, p. 225-238. Author at N.S.W. Geological Survey, Sydney, Australia.

In the 6-component system $CaO-MgO-Al_2O_3-SiO_2-CO_2-H_2O$ with 9 solid phases (quartz, plagioclase, epidote, tremolite, talc, chlorite, magnesite, calcite, dolomite) and a fluid phase, all 17 possible fluid-absent reactions have been set up and balanced. Using molar entropy and volume data for the solid phases, these reactions are arranged in P-T space about the 8 possible fluid-absent invariant points after the method of Schreinemakers. Field observations in Ordovician greenschist facies basic volcanics at Sofala N.S.W. indicate that neither talc + epidote nor magnesite + calcite are stable under the conditions of metamorphism. Assuming these conditions to apply to the theoretical study here, the fluid-absent invariant points are arranged in a relative fashion with fluid-absent reactions subdividing P-T space into smaller areas.

A scheme which permits a fluid of composition $0 \leq X_{H_2O}+X_{CO_2} \leq 1$ (i.e. a fluid containing CO_2 and H_2O together with other components), is modeled by treating H_2O as a mobile component independent of CO_2, and by allowing $U_{H_2O}-U_{CO_2}$ values that lie off the $U_{H_2O}-U_{CO_2}$ locus of binary H_2O-CO_2. Taking into account that neither talc + epidote nor magnesite + calcite is to be permitted, the fluid scheme is used to set up and balance all 39 possible fluid-bearing reactions. These are then arranged about 20 valid fluid-bearing invariant points in $U_{H_2O}-U_{CO_2}$ space after the method of Korzhinskii and Schreinemakers.

A characteristic solid phase assemblage is defined for each P-T area using chemographic relations inherent from the fluid-absent boundary reactions. The fluid-bearing invariant points that have a solid assemblage compatible with the characteristic assemblage in a particular P-T area are stable within the P-T regime of that area. When these stable fluid-bearing invariant points are arranged in a relative fashion in $U_{H_2O}-U_{CO_2}$ space, they outline a fluid grid which can be used to study the possible effects of local variation in X_{fluid} over the particular P-T regime.(Author's abstract)

WEIBLEN, P.W. and ROEDDER, Edwin, 1973, Petrology of melt inclusions in Apollo samples 15598 and 62295, and of clasts in 67915 and several lunar soils: Proc. of Fourth Lunar Sci. Conf. (Suppl. 4), Geochimica et Cosmochimica Acta, v. 1, pp. 681-703. First author at Dept. of Geology and Geophysics, Univ. Minn., Minneapolis, Minn.

Electron microprobe analyses (188) of silicate melt inclusions and their host and associated phases (olivine including fayalite, pyroxene, plagioclase, hyalophane, ilmenite, ulvospinel, spinel, chromite, taenite, kamacite and schreibersite) are presented from Apollo 15 and 16 samples.

Inclusions in mare basalt and highlands rocks, ranging from those in early olivine and intermediate plagioclase, to late stage interstitial inclusions, show an evolutionary change in composition. Postulated crystallization sequences are consistent with textures, trends on variation diagrams, and preliminary petrologic mixing calculations. For mare basalts the sequence is olivine, ilmenite, and plagioclase, followed by pyroxene. The sequence for a very high aluminum basalt, 62295, is spinel, olivine, and a minor undetermined titanium bearing phase followed by plagioclase, leaving a residual melt of 40% normative quartz, 27% feldspar, 27% pyroxene, and 6% ilmenite. Late-stage melts in mare basalts but not in 62295 split into immiscible high-iron and high-silica liquids. (Authors' abstract, abbreviated by ER.)

WHITE, D.E., 1973a, Evidence for diverse origins of hydrothermal ore fluids (abst): Geol. Soc. Amer. Abstracts with Programs, v. 5, no. 7, p. 861. Author at U.S. Geological Survey, Menlo Park, California 94025.

Chemical, isotope, and physical data from fluid inclusions, ore and gangue minerals, and active geothermal systems indicate the general characteristics and probable origin of the dominant ore-transporting water of many systems, including: (1) 3 active Hg systems (metamorphic and "evolved-connate"); (2) 5 epithermal Au-Ag districts and 3 similar active systems (dominantly meteoric but perhaps as much as 5% "magmatic" water); (3) 8 ore districts and 2 active systems with abundant base metals± Ag (diverse origins--ocean, "evolved-connate", meteoric, and "magmatic", with high salinity, $>\sim 3\%$, as the principle common factor); (4) 5 porphyry Cu-Mo deposits (generally with early dominance of "magmatic" water but increasing meteoric involvement during ore and post-ore stages). Meteoric water may dominate the late stages of mineralization of most deposits of the above groups.

Other individual constituents, including metals, Cl, S, and CO_2, may have similar or different origins than the dominant water. Igneous intrusions may frequently provide the energy and perhaps the S for ore generation; magmatic origin of metals and H_2O are commonly assumed without critical evaluation of other possible origins. (Author's abstract)

WHITE, D.E. 1973b, Characteristics of geothermal resources: in Paul Kruger and Carel Otte, eds., Geothermal Energy Resources, Production, Stimulation, Stanford University Press, Stanford, Calif., p. 69-94.

A good review of the geology, physics, chemistry and circulation patterns of the major geothermal areas of the world. (E.R.)

WHITE, D.E., 1973c, Geochemistry applied to the discovery, evaluation, and exploitation of geothermal energy resources, Reports of U. N. Symposium on the Devel. and Util. of Geothermal Resources, Geothermics Istituto Internazionale per le Richerche Geotermiche, Pisa, Italy. Author at U.S. Geol. Survey, Menlo Park, CA.

An extensive discussion, in particular of thermal, chemical, and isotopic data on geothermal systems (ER).

WHITE, D.E., BARNES, Ivan, and O'NEIL, J.R., 1973, Thermal and mineral waters of nonmeteoric origin, California Coast Ranges: Geological Society of America Bulletin, v. 84, p. 547-560, 1973. Authors at U.S. Geological Survey, 345 Middlefield Road, Menlo Park, California 94025.

Recent isotope studies show that the waters involved in a variety of geologic processes are dominantly the local meteoric water of each area. In most active geothermal systems, the D/H ratio of the hot water is nearly identical with the local cold meteoric water, but the O^{18}/O^{16} ratio has been shifted to a more positive value because of subsurface exchange with rocks.

The numerous thermal springs of the Wilbur Springs mercury district, although rich in CO_2, are otherwise similar in Cl content and isotopic composition to analyzed California oil-field waters. Some of the springs discharge near the tops of ridges. These relations cannot be explained by normal meteoric recharge.

Water of isotopic composition similar to that of Wilbur Springs occurs in the Sulphur Bank mercury district 15 mi west of Wilbur Springs, but the Sulphur Bank water is higher in B and NH_3 and much lower in Cl than are the Wilbur and most oil-field waters.

The Wilbur Springs and Sulphur Bank waters are enriched by ∿40‰ in δD and ∿13‰ in δO^{18} relative to local meteoric waters of each area, and thus require processes that differ, at least in part, from most previously studied geothermal systems. The D enrichment, chemical composition, and ridge-top discharge are best explained by large proportions of nonmeteoric water. Wilbur Springs and Sulphur Bank may be dominated, respectively, by waters of connate and metamorphic origin, derived from reaction of ancient ocean waters and marine sediments, and now being forced out by pressures that are higher than hydrostatic. Present data indicate that the most saline of each of these types is more restricted in range of δD than are present-day meteoric waters of the same areas; complete flushing by existing or ancient meteoric waters is unlikely.

Many springs in the region are chemically intermediate between the high- and low-chloride types and commonly mix near the surface in different proportions with local meteoric water. Many of these springs are associated with mercury deposits and Alpine serpentinites. (Authors' abstract)

WHITE, D.E., and O'NEIL, J.R., 1973, [Stable isotope studies at the Steamboat Springs geothermal system, Nevada]: Geol. Sur. Research 1973, U.S. Geol. Sur. Prof. Paper 850, p. 154.

Stable isotope evidence demonstrates that the Steamboat Springs geothermal system of Nevada is the present-day active equivalent of the fossil geothermal systems of epithermal Au-Ag deposits, as White has been contending for nearly 30 yr, based on similarities in ore-metal concentrations, gangue minerals, and hydrothermal alteration. New isotope data on the vein minerals of drill cores from Steamboat Springs, combined with results by others on epithermal deposits, such as Bodie, Calif., and Tonopah, Goldfield, and the Comstock Lode of Nevada, provide striking new evidence for great dominance of meteoric water in the ore fluids and for other similarities. (Authors' abstract.)

WHITE, S., 1973a, Dislocations and bubbles in vein quartz: Nature Physical Sci., v. 243, May 7, 1973, p. 11-14.

In an attempt to recognize differences between two epochs of quartz veins at Ballarat, Victoria (one associated with gold and one always barren), the author used high voltage electron microscopy of ion-thinned foils from petrographic thin sections. Several variaties of bubbles were found decorating dislocation and subgrain boundaries. Most appear to be <0.1 μm in diameter. Extensive conclusions are reached as to the geological significance of movement of such dislocations and their inclusions, and in particular raises doubts as to the accuracy of bubble geothermometry when applied to deformed quartzes. (Editor's note: geothermometry is normally performed on inclusions whose volume is approximately 10^6 times larger than the microbubbles described here.) (ER) (See next item also.)

WHITE, S., 1973b, Syntectonic recrystallization and texture development in quartz: Nature, v. 244, no. 5414, 1973, p. 276-278.

An electron microscope study of deformed quartz, of significance to any investigations of the mechanisms of trapping of fluid inclusions in such veins. (ER) (See previous item also.)

WHITNEY, James A., 1973a, Synthetic modelling of vapor generation in a quartz monzonite magma (abst): Amer. Geophys. Union Trans. (EOS), v. 54, no. 11, p. 1222.

WHITNEY, James A., 1973b, Effect of H_2O content on crystallization of a granitic composition (abst): Amer. Geophys. Union, Trans. (EOS), v. 54, no. 4, p. 481.

WILCOX, W.R., and KUO, V.H.S., 1973, Gas bubble nucleation during crystallization: Journal of Crystal Growth, v. 19, p. 221-228, 1973. Authors at Chemical Engineering and Materials Science Departments, University of Southern California, Los Angeles, California 90007.

Literature on gas bubble incorporation in growing crystals is reviewed. A theory for nucleation in dilute multicomponent gas solutions was derived. Combined with solute segregation equations, theories result for various forms of crystal growth. The tendency to form gas bubbles increases with increasing growth rate, decreasing stirring, increasing ambient gas pressure, and decreasing height of liquid over crystal. The liquid surface temperature is also an important variable. Homogeneous nucleation of bubbles was found to be possible for melt growth. Bubble formation in solution growth is most likely by heterogeneous nucleation on the crystal surface. (Authors' abstract)

WILLEY, L.M., RAPP, J.B., and BARNES, Ivan, 1973, Geochemistry of thermal waters in Long Valley, California (abst.): Amer. Geophys. Union, Trans. (EOS), v. 54, no. 11, p. 1212.

WYLLIE, P.J., 1973, Carbonatitic Volcanism: Experimental Studies on the Kimberlite-Carbonatite Relationship, in International School of Earth Sciences, 2nd Course: Volcanism on Earth and in the Solar System: Erice-Trapani - Sicily, International Center for Scientific Culture

(Course notes). Author at Department of Geophysical Sciences, Univ. of Chicago.

The eruption of sodium carbonatite lava flows from Oldoinyo Lengai in Tanzania is the most dramatic evidence of the existence of carbonatite magmas in association with highly alkalic volcanic rocks. The occurrence of diapiric carbonatites in the Benfontein layered kimberlite sill complex confirms the association of carbonatite magmas with material from mantle sources. Primary carbon dioxide or carbonate in the mantle is also indicated by CO_2-rich fluid inclusions in olivines of ultramafic nodules, and by crystalline carbonate inclusions in garnets from kimerlites. Carbonatite magmas could be (1) immiscible fractions from carbonated kimberlitic magmas, (2) residual derived by fractional crystallization of kimberlitic magma, or (3) primary from the mantle. Experimental studies in various silicate-carbonate systems demonstrate the feasibility of all three processes under appropriate conditions. Liquid immiscibility between silicate liquids and Na_2CO_3-rich melts on the join albite-Na_2CO_3-H_2O has been traced into the more complex system with anorthite as an additional component. The carbonate liquid becomes enriched in $CaCO_3$ and the silicate liquid in feldspathoidal components. Melting relationships in the system CaO-MgO-SiO_2-CO_2-H_2O illustrate some aspects of mantle kimberlite-carbonate relationships. Calcite can be precipitated from melts at temperatures below 550°C at 30 kbars in this system. Residual carbonate liquids can be derived by fractional cyrstallization of nepheline-normative silicate liquids, but not from plagioclase-mormative silicate liquids. Melting relationships of the carbonates in the join $CaCO_3$-$MgCO_3$ show that at pressures greater than about 30 kbars (100 km depth), most carbonate compositions melt at temperatures lower than the solidus curves for mantle peridotites. Addition of components such as forsterite, enstatite and diopside to the carbonate liquids should elucidate the role of CO_2 in mantle as fluid, carbonate liquid, or crystalline carbonate; the relationship between kimberlites and carbonatites; and the processes leading to the generation and eruption of carbonatitic lavas. (Author's abstract)

YAKOVLEV, Ya.V., 1973, Formation temperature of tin deposits of Yakutia (on data of inclusion homogenization in minerals): Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept. 1973: Rostov, Rostov Univ. Press p.78-80.(In Russian; translation provided through the courtesy of N.P. Ermakov). Author at Institute of Geology, Yakut Branch, Siberian Department, Academy of Sciences of the USSR, Yakutsk, USSR.

Formation temperatures of tin deposits, mineral associations, and mineralogy has been studied by us for 12 deposits, characterizing the main mineral types and ore formations of Eastern Yakutia.

The prevailing majority of inclusions is two-phase and regardless of phase quantity it homogenized into the liquid phase. In some cassiterite-quartz deposits a part of the inclusions contain transparent cubic crystals, however, of halite. In these deposits and in similar ones sometimes inclusions occur, homogenizing at high temperatures into a gas-phase, that we prefer to relate with a "local" boiling-up of a solution, caused by sharp pressure differentials in the ore depositing zone (see Table). (Author's abstract.)

Mineral (number of inclusions)	Homogenization temperature, °C	Typical mineral associations	Notes
1	2	3	4
Cassiterite-Quartz Formation			
1. Stanniferous Greisens			
Quartz (100)	505,450-400 375-350 310-180	Quartz, light micas, topaz, cassiterite	Greisen deposit
Quartz (24)	405-300	Quartz, fluorite, epidote	Greisen zones in the exocontact
Fluorite (26)	370-310, 205		
Quartz (20)	360-150	Quartz, potash feldspar, muscovite	Pegmatoid veins, nests
Quartz (1)	400	Quartz, fluorite, wolframite, cassiterite	Veins in the endocontact
Fluorite (11)	445 320		
Cassiterite (43)	400-350	Quartz, tourmaline, light micas, cassiterite	Veins, veinlets
Quartz (25)	360-170	Amblygonite, quartz	Veins, nests in the greisens
Amblygonite (20)	330-310		
Apatite (10)	200-130	Potash feldspar, quartz, apatite	
2. Quartz Type			
Quartz (21)	380-270 230-155	Potash feldspar, quartz, muscovite, molybdenite	Pegmatoid nests
Quartz (370)	400-280 265-180 160-110	Quartz, tourmaline, muscovite, cassiterite, wolframite, arsenopyrite	Veins, veinlets in the endocontact
Tourmaline (2)	365, 340		
Muscovite (10)	360-290		
Cassiterite (50)	390-310		
Wolframite (6)	325-310		
Quartz (29)	440-280 230-185	Quartz, muscovite, tourmaline, arsenopyrite, cassiterite	Close-to-vein greisens
Tourmaline (1)	370		
Muscovite (1)	365		
Cassiterite (5)	370-320		
Quartz (77)	390-290 240-225 155-120	Quartz, tourmaline, cassiterite, wolframite, arsenopyrite	Veinlets in the exocontact
Calcite (10)	200-120	Calcite	
Cassiterite-Sulphide Formation			
1. Sulphide-Tourmaline Type			
Quartz (130)	490-400 370-320 300-270 200-145	Quartz, tourmaline fluorite, siderite, cassiterite, wolframite	Veins
Fluorite (80)	320-250		
Siderite (15)	225-180		
Cassiterite (5)	345-330		
2. Sulphide-Chlorite Type			
Quartz (40)	440-250	Quartz, chlorite, tourmaline, cassiterite, arsenopyrite	Veins
Fluorite (30)	350-240		
Cassiterite (48)	375-210		
Quartz (5)	370-280	Pyrrotite, sphalerite, chlorite, fluorite, quartz	Veins
Fluorite (15)	320-200		
Calcite	150-130	Calcite, pyrite	
Deposits of Transitional Type			
Quartz (73)	450-150	Quartz, adularia, tourmaline, fluorite, cassiterite, arsenopyrite, scheelite	Veinlets
Fluorite (15)	265-160		

YAKOVLEVA, M.Ye., and POTAPOVA, L.I., 1972, Inclusion of bituminous substances in obsidian: Acad. Sci. USSR, Fersman Mineralogical Museum, Trudy. v. 21, p. 205-209 (in Russian; translation provided through the courtesy of A. Kozlowski).

Obsidians were divided into five types, based on the presence of water in channels and inclusions: 1) water-free, 2) obsidian bearing only high-temp. water, 3) obsidian bearing only low-temp. water, 4) perlite bearing high- and low-temp. water, 5) perlite bearing only low-temp. water. Volcanic glasses contain also CO_2, H_2, N_2, He, Ne, Ar, Kr, Xe, filling vacuoles. Vacuoles in Armenian and Georgian obsidians make up 10-12% of the rock volume. The authors investigated obsidians from the Dzhraber and Paravani deposits. Vacuoles have dimensions $\leq$ 0.1 mm, and are filled partly or completely by anisotropic, colourless or light-brown bituminous substance having bluish luminescence in UV light. Obsidian from Dzhraber bears 0.23 to 0.38% water, and has ignition loss av. 0.28 wt. %. Water comes off at 730 and 930°C. Concentration of bituminous substance by extraction with chloroform was determined as 0.009 to 0.001 wt. %. During weathering of obsidians the bitumens form very thin films on the rock surface. Elemental composition of bitumen is as follows: C 53.32%, H 7.70%, N+O+S 38.98%, refractive index at 20°C is 1.499 to 1.510. IR analysis proves that the bitumen consists of oxygenated derivatives of hydrocarbons as acids and neutral carbonyl compounds, hydrocarbons with groups CH_2 and CH_3, and probably naphthens and aromatic structures; solid parafines are lacking.

The authors believe that these bituminous substances were formed during cooling of the magma, from its gaseous exhalations, and was partly brought in later by high-temp. hydrothermal solutions.

YEGOROV, V.M. and IKORNIKOVA, N. Yu., 1973, Partial molar volumes of aqueous chloride solutions at high temperatures and pressures: VSES. Mineral. Obshchest., Zap., v. 102, no. 3, p. 272-282 (in Russian).

YODER, H.S., Jr., 1973, Contemporaneous basaltic and rhyolitic magmas: Amer. Mineral., v. 58, p. 153-171.

The author concludes on the basis of laboratory studies that the common terrestrial assemblage of basalt and rhyolite is not the result of silicate liquid immiscibility, but the result of fractional melting. (ER)

YUDIN, I.M., 1973, Thermometric investigations of altered rocks and sedimentary-metamorphic finely dispersed sulfides in a series of wall-rocks of a gold ore deposit (W. Uzbekistan): Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 57-58 (in Russian; translation provided through the courtesy of A. Kozlowski). Author at Central-Scientific-Research Geologic-Prospecting Institute, Ministry of Geology of USSR, Moscow.

1. Decrepitophonic analysis of 83 samples (at the Mineralthermometric Laboratory of Moscow State University, F. P. Mel'nikov) of altered rocks of the deposit showed the following: parent metasedimentary rocks were characterized by very low background values of a relatively narrow range (0-5 impulses at 480-560°C). As a result of contact metamorphism (5-40 imp., 400-580°C) and successive overlapping of different age hydrothermal metasomatities (30-220 imp., 280-700°C) both the general amount of impulses and the width of the

interval of their occurrence increase. These characteristics are especially large on decrepitations of quartz-metasomatites with microcline zones (140-220 imp., 280-700°C), immediately connected with veinlets of gold-bearing quartz.

2. On the basis of thermographic investigations of 35 samples of finely dispersed sulfides (pyrite, marcasite, pyrrhotite), performed on the author's material in the laboratory of mineralogy and geochemistry of VZPI using the method of G. I. Veres (1969), it was found that the quantitative characteristics of their thermobarograms are quite different from the same minerals from hydrothermal veinlets cutting the ore stock. (Author's abstract, shortened by A.K.).

ZAKHARCHENKO, A.I., 1971, On time and physico-chemical conditions of mobilization, transport and precipitation of tungsten and tin in postmagmatic processes (exemplified by intragranitic chamber pegmatites), pp. 287-306, in Mineralogy and geochemistry of tungsten deposits (Materials of 2nd All-Union Symposium on Mineralogy, Geochemistry and Genesis of Tungsten Deposits of USSR): Leningrad, Leningrad Univ. Publishing House, 344 pp. (In Russian; abstract through the courtesy of A. Kozlowski). Author at All-Union Scientific-Research Geological Institute, Leningrad. See Translation Section.

ZAKHARCHENKO, A.I., 1973, Pegmatite-forming melt - solutions, on the basis of their inclusions in minerals of granite-chamber pegmatites: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 192-194 (in Russian; translation provided through the courtesy of A. Kozlowski). Author at VSEGEI, Leningrad.

In well-developed full-zoned, typical chamber pegmatites, formed in situ under quiet conditions, in zones following from external to internal monomineral ones, and especially to mineralized voids, one may obeerve a more or less regular change of primary inclusions (often with deviations) from melt to solution-melts and at the end - to solutions, with continuous changes of chemical composition and other features.

1. In wall-rocks (granites) and external zones of pegmatites clear primary melt inclusions can be observed, consisting of crystallized aggregate of minerals (feldspars, quartz, micas, etc.) plus an essentially "dry" gas phase = 10-20 vol.% in granites and 30-40% in pegmatites. Melting of these inclusions begins at 700-720°C in granites and in 680-650°C in pegmatites; complete melting takes place at 800-850°C.

2. In the internal zones of pegmatites (especially in monomineralic zones and in early minerals of voids) in inclusions a strong increase in the role of alkalies in the inclusions may be found, as well as rare halogens (especially F), and among volatiles - CO_2; an aqueous solution phase also appears. The T of melting of mineral aggregates (in the inclusions) decreases to 600-560-540°C. On this background the most important change of inclusion filling was observed. In these inclusions the melt component strongly decreases (80-70% to 50-30-10% and less) and the role of crystals of free growth (such as feldspars, especially quartz, often micas, fluorite, sylvite, halite, etc.) (i.e., daughter crystals; Ed.) becomes more and more important, achieving a volume of 50-60 and even 70%. These crystals are formed from fluids. Thus melts change to fluids, initially of very high concentration. Such a change

can be observed in early topaz, beryl, etc., but usually not in quartz and feldspars, where the major part of the dissolved material in the inclusions is used for growth on the walls of the inclusions.

3. In examining the minerals of the cavities a continuous change of phase state of the fluids was observed: from very concentrated solutions to dilute ones with liquid phase prevailing. K-feldspathization, albitization and greisenization develop at 650-400-350°C, and mobilization plus redeposition of heavy metals (occurs) only in the hydrothermal stage.

4. Thus, pegmatites crystallize essentially from remnant, easily melting melts, enriched fluids, and in the period of transition from melts into fluids. Essential commercially useful minerals (rare metal ores, rock crystal, fluorite, etc.) are developed during the hydrothermal stage. In vein pegmatites (rare metal, mica-bearing, etc.) due to tectonic discontinuities it is almost impossible to study the alteration of mineral-forming medium from melts to fluids. There inclusions of boiling fluids and overlapping hydrothermal fluids prevail. (Author's abstract, abbreviated by A.K.)

ZAKRUTKIN, V.V., TRUFANOV, V.N., AND DUDAKOV, V.K., 1973, Gaseous-liquid inclusions as indicators of the primary nature of basic metamorphites: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 226-227 (in Russian; translation through the courtesy of A. Kozlowski). Authors at Rostov Univ.

(...) Para-rocks of charnockite series bear major amounts of low-temp. (T 40-100°C) inclusions, but they are practically absent in ortho-rocks of this series. Histograms of vacuum decrepitometry of para-rocks, in addition to the above maxima, have two other peaks: 350-450 and a weaker one at 580-650°C. The latter is caused undoubtedly by trapping of metamorphic intergranular solutions during crystal growth under P-T conditions of amphibolitic (up to 450°C) and hornblende-granulite facies (up to 650°), as is distinctly supported by adequate mineral parageneses. On the other hand, the low-temp. maximum is caused by inclusions that formed probably before metamorphism, at the time of sedimentation. Complete lack of low-temp. inclusions in the ortho-rocks testifies to this sedimentary origin (as well as thermometric data, specific composition and morphology).

The thorough hermeticity of a certain number of primary inclusions preserved genetic information under conditions of regional metamorphism of granulitic facies and is probably the cause of a positive correlation between the nature of ortho-and para-charnockites, and the kind of decrepigraph obtained during analysis.

Low-temp. peaks usually are very distinct and reflect on histograms from 45 to 66% of the gases released during heating of a parametamorphite sample. Investigation of large number of rocks from the charnockite series revealed that this method permits correct distinguishing of the primary nature of rocks under question with a high probability. (Authors' abstract; abbreviations by A.K.)

ZATSIKHA, B.V., KUROVETS, M.I., LYUBINETSKAYA, A.V. AND TEPLOV, V.P., 1973, Thermodynamic and geochemical peculiarities of Hg deposit formation at Vyshkovskoe ore field (Transcarpathian internal anticline): Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov,

Rostov Univ. Press, p. 100 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Ivano-Frankovskivy Inst. of Geological Sciences,-IFING-, Ivano-Frankovsk; Transcarpath Geol. Exped.

The end of Pb-Zn stage and beginning of Hg stage are characterized by heterogenization of solutions of H_2O-CO_2-low salt concentration type. The solutions also contain N_2,H_2 and CH_3. At the N end of the ore field heterogenization took place at 150-170°C and 200 atm; at the S end - at 275-250 and 300 atm. Solutions of ore-bearing zones contain higher amounts of CO_2 than those of ore-free zones (pH 6, 5-6.7 up to 7.0-7.1 respectively and 8.0-9.0 after CO_2 separation). During pH change from weakly acid-neutral to weakly alkaline at the beginning marcasite I and metacinnabarite crystallized (250-200°C); later- cinnabar in 2 generations with marcasite II and III and calcite (150-100°C).

Inclusions of heterogenous type can be observed in all types of "marmarosh diamonds." (i.e., transparent colorless quartz crystals from Carpathian flysch). (Authors' abstract)

ZAYTSEV, A.I., NENASHEV, N.I., and SHILIN, A.I., 1973, Age of the gold-bearing quartz veins in the Allakh-Yun area, Southern Verkhoyansk Ridge Region: Akad. Nauk SSSR, Izv., Ser. Geol., No. 4, p. 74-83 (in Russian).

Includes decrepitation data (100-550°C) on many samples and homogenization data (122-370°C) on three of the same samples (ER).

ZIMA, N.S. & RESHETNIKOVA, O.M., 1973, Investigation of gas-liquid inclusions in epigenetic minerals of ores of Krivoy Rog (exemplified by apatite and quartz): Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 103 (in Russian; translation through the courtesy of A. Kozlowski). Authors at MEKHANOBRECHMET Institute.

The ores are mainly of the martite type. "Poikilitic" and "spherolitic" quartz and apatite were investigated. In spherolitic quartz the inclusions are mainly 2-phase, gas-liquid, 0.000n to 0.015 mm in diameter with 8-10 vol. % of gas and 90-92 vol. % of liquid. In poikilitic quartz they contain 85% liquid. In apatite, the inclusions are 0.0005-0.008 mm.

For both minerals T_d = 200-220°C and T_h = 160-180°C. (Authors' abstract, abbreviated by A.K.)

ZIMMERMANN, J.-L., 1973, Mass spectrometric study of the composition of fluids in cordierites from Southern Norway (abst): Reun. Annu. Sci. Terre, (Programme Resumes), 1973, p. 418 (in French). Author at Centre de Recherches Petrographiques et Geochimiques - Case Officielle n° 1 - 54500 - Vandoeuvre-Les-Nancy.

Eight analyses show that the gases evolved at 420°C consist mainly of water and lesser organic compounds. The maximum amounts of other gases are H_2 (2.2%), CH_4 (1.4%) and CO_2 (14%). (ER)

ZLENKO, B.F., and MAMONTOV, B.V., 1973, Test of application of decrepitation for evaluation of primary and secondary geochemical anomalies in skarn deposits: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 267-268 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Inst. of Mineralogy, Geochemistry and Crystallochemistry of Rare Elements, Kanimansuryan Geol. - Prospecting Expedition of Geological Office of Ministry Board of Tadzhikistan SSR.

The authors took samples for decrepitation studies from a 100 x 200 m net of boreholes in the Chorukh-Dayron ore district. Analyses were made in Lab. of Inst. of Geol. of Acad. Sci. of Tadzh. SSR. Comparison of decrepitation data with polyelement geochemical anomalies proves that T maxima agree with maxima of concentration of ore elements in rocks not altered by hypergene processes. Individual geochemical anomalies were found in the Paleozoic bedrock without higher decrepitation activity. Petrographic and mineralogical studies of these plots prove that these anomalies are secondary ones, caused by exogene processes. Wall rocks (carbonate rocks and granitoids not altered by postmagmatic processes) are practically free of decrepitation effects. Maximum T up to 600°C were noted in the mineralized areas, decreasing away from the area of T max. Individual zones with 400°C maxima match zones of post-ore metasomatites without commercial mineralization. This indicates uneven heating of wall rocks by postmagmatic solutions and shows that data on decrepitation may be used for evaluation of geochemical anomalies at skarn ore fields, even though literature data indicate that skarn ore deposits have formed in a uniform T field, generated by intrusive massifs.

Thus, use of decrepitometric mapping with geochemical methods of prospecting at skarn deposits, in addition to providing interesting scientific data on temp. of formation of various metasomatites, has great practical value.(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 older items may be included when particularly significant. 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.

ELINSON, M.M., and ALIDODOV, B.A., 1973, Composition of gases of inclusions in minerals and some physico-chemical conditions of mineral formation in the Chorukh-Dairon ore field: Izvest. Akad. Nauk S.S.S.R., Ser. Geol., 1973, no. 7, p. 103-111. (In Russian).

Study of gas phases of inclusions in minerals is of interest in itself and also helps to solve some problems of the formation of deposits.

Despite the small volume of study devoted to the deposits of Chorukh-Dairon, interesting data have been obtained on the problem of the composition of mineral-forming solutions and the conditions of mineral formation.

The Chorukh-Darion ore field is located in the northeastern part of Mogol-Tau Mountain and consists predominantly of igneous rocks from Upper Carboniferous to Upper Permian-Lower Triassic age, among which granodiorites, monzonites, and effusives of andesite-dacite composition are dominant.

With respect to structure, the ore field is located at the node of the junction of five large fractures of northeast strike. Endogenic mineralization is controlled by smaller tectonic disturbances, formed in areas of the greatest compression of the ore zones. Mineralization is generally restricted to areas of the development of skarn zones and is superposed on them.

In the ore-bearing zones of the ore field, according to the scheme of Kristel'nyi (1963), there are eight consecutively formed paragenetic associations of hypogene minerals: garnet-pyroxene-scapolite, calcite-scheelite-garnet, amphibole-epidote-albite, quartz-scapolite-tourmaline, scheelite-sulfides-albite, scheelite-sulfides-quartz, fluorite-barite, and calcite, which were formed in 5 stages: (1) garnet-pyroxene-scapolite, (2) scheelite-garnet, (3) scheelite-albite-hydrous silicates, (4) fluorite-barite, and (5) calcite.

Studies were made of gas-liquid inclusions in minerals of early stages of mineralization, with the purpose of explaining some thermodynamic and chemical conditions of formation of the deposits.

The gas composition of the inclusions was studied in samples of minerals selected from different mineral associations in mine works and cores. Nearly all the minerals were studied preliminarily under the microscope in transparent polished plates. For them, temperatures of homogenization and decrepitation were obtained.

The composition of the aqueous part of gas-liquid inclusions was studied by the method of aqueous extraction in the laboratory of V.I.M.Sa. under the supervision of D.N. Khitarov. For two samples of scheelite (nos. 210 and 44), determinations were made of the amount of water extracted from gas-liquid inclusions by means of an electrochemical method[1]. There were studied monomineralic samples of scapolite (sample 97) of the 1st stage of skarn mineralization; scheelite (sample 210) of the second

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[1] The method was developed by E.B. Matskevich

stage; scheelite (samples 44 and 225) and quartz (samples 131, 139, 145, and 203) of the third stage; barite (sample 70) of the fourth stage; and calcite (nos. 40, 55, 132) of the final carbonate stage.

These monomineralic samples were selected from areas of samples that had undergone little or no hydrothermal alteration after formation. The total composition of the gaseous part of the gas-liquid inclusions were studied by a previously described method (Elinson, 1956, 1968). Microscopic study showed that in the samples studied most of the gas occurred in the primary and pseudosecondary inclusions, and it can be considered that the data obtained characterize the medium from which the studied mineral crystallized.

Study of the gas was accomplished by pulverizing a monomineralic fraction of the sample of weight 50 g. in an evacuated vessel in a vibratory mill. The composition of the gas was determined in an improved semimicro gas analyzer and a special apparatus for separate determination of the acid gases. Each type of sample was studied for control in parallel by another method (Elinson, 1968), with the use of the universal gas chromatograph UKh-2. The deviations in the parallel determinations did not exceed 50% of the magnitudes obtained.

The results of the analyses of gas composition of the inclusions are given in Table 1. From them it is seen that in the samples of minerals from the Chorukh-Darion ore field, there are present CO_2, O_2, H_2, and N_2 in different amounts, and gases such as H_2S, CH_4, CO, Ar, and He are absent within the limits of sensitivity of the apparatus.

CO_2 gas was found in nearly all the minerals in amounts of 2.0-37.0 cm^3/kg. The largest amount of it was found in quartz - 37.0 cm^3/kg.

Hydrogen dominates among the other gases. The largest amount of it was found in quartz occurring in effusives - up to 142.0 cm^3/kg. No notable regularity was found in the distribution of nitrogen.

It must be noted that of all the minerals studied quartz is the most saturated by gas.

The high content of gases in quartzes is apparently explained by the long-lasting conditions of its formation. In most cases, quartz of drusy form is found in cavities and nests. In the opinion of Dolgov (1961), this form originates in consequence of fluctuations of thermodynamic parameters, when because of sharp decrease of pressure, there occurs separation of dissolved gases into the free state, and the density of the solution decreases markedly. One can assume that the quartz we studied was formed from pneumatolytic-hydrothermal solutions under conditions of intense decrease of pressure and increase of gas separation from solution.

The ratio H_2:CO_2 remains relatively constant during the entire process of mineral formation, except for the stage of the formation of quartz, which may indicate the formation of mineral products during pulsations of a single source solution. The mode of formation of quartz, apparently, contributes additional intake into the solution of relatively large amounts of hydrogen, as the result of which, during the sharp drop of pressure, hydrogen escapes into the free phase more intensively than

the other gases.
Oxygen and nitrogen occur in equal degrees in products of the early and late stages, with nitrogen dominant. It is probable here that there occurred mixing of vadose gases with the post-magmatic solutions. The presence of nitrogen, besides other factors, can also be explained as the result of the interaction of mineral-forming solutions with deep-lying horizons of rocks of organogenic origin, which occur in the region of the deposits. The presence of O_2 in the minerals of the early stages can be explained by the decomposition of skarn minerals with the liberation of O_2 (Ovchinnikov, 1948).

The gas saturation in general decreases in the sequence of mineral formation. If one traces it by minerals occurring in a single type of country rock, then the total gas saturation decreases from the early scheelite to the later minerals, except for quartz, which is always more saturated with gases than the other minerals, and except for late calcite, which contains more CO_2 and H_2 than the early scheelite (Table 2).

The change of mineralization and qualitative composition of the aqueous extracts of gas-liquid inclusions can be followed by data on aqueous extracts (Table 3).

The solutions contained in the gas-liquid inclusions are characterized for the samples:
scheelite (no. 210) mainly by the presence of Na^+, Cl^-, and F^- at a sum of cations + anions ∿ 180.8 mg/kg;
quartz (A-145), by Na^+, K^+, Cl^-, HCO_3^- at a sum of cations + anions ∿ 528 mg/kg;
barite (A-70), by Na^+, Ca^{++}, Cl^- at a sum of cations + anions ∿ 250 mg/kg;
calcite (A-50), by Ca^{++}, HCO_3^-, Fe^{++}, Cl^-, at a sum of cations + anions ∿ 193 mg/kg.

Determination of the total amount of water[2/] of the inclusions was made only for scheelite samples no. 210(1.8 g.kg) and no. 44 (0.65 g/kg). If one provisionally determines the average concentration of solution in the primary inclusions according to the total sum of the cations and anions, we obtain on the basis of Table 3 10% for sample 210.

The average temperature of homogenization and the corrections to this for pressures of 600 and 250 atm. (Kalyuzhnyi, 1960) are given in Table 4. (The pressures are taken approximately from the calculations given in Table 6.)

From the scheelite samples there were selected transparent polished plates, which were studied under the microscope and were photographed. On the basis of the forms and locations of the inclusions - in zones of growth of the crystal or along fractures - the presence was shown of primary, pseudo-secondary, and secondary inclusions. The sizes of the inclusions and the volumes of the phases were measured.

For estimating the primary and secondary inclusions there were calcu-

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[2/] According to the data of microscopic studies, in scheelite sample no. 210 there is contained in the primary inclusions 66% liquid, and in the secondary ones 33% (Table 6), agreeing with the ratios of the phases for this inclusion. (sic.)

lated the average percentage amount of both of these occurring in a single area of the plate of the mineral under the microscope (from photographs). The volume of the inclusions was calculated, depending on the forms and sizes of inclusions in these phases. The volumes of the inclusions, depending on their forms, were calculated as spherical, ellipsoidal, or tubular. The ratios of gaseous to liquid phases were calculated for the primary inclusions. For several plates of different orientation, there was calculated the average and maximum number of inclusions in the field of the grain.

In Table 5 are given the results of this study and the calculation of the volume of inclusions in the studied volume of samples, from measurements of the area of the fields of the grains for scheelite samples nos. 210 and 225-44. The transition from measured individual volumes to volume in one kg. of sample was made according to the formula proposed by B. Alidodov:

$$Vr = \frac{Q}{\sqrt{S}\cdot S} \left(\frac{V'r\sqrt{n}}{N} n\right) \text{ cm}^3/\text{kg},$$

where Q is the volume of 1 kg of sample, cm^3/kg; S is the area of the field of the grain; in cm^2(at d=0.3mm); V'r- the volume of the gas phase in the inclusion at its maximum amount, in cm^3 (in the volume of sample = $\sqrt{S}\cdot S$); n_1 is the average probable amount of inclusions in the studied volume of sample ($n_1 = \sqrt{n}\cdot n$); n is the average probable amount of inclusions in the area of the field of the grain; N is the maximum probable amount in the same area.

On the basis of the experimental data obtained, attempts were made by two means of determining the pressure of mineral formation for the samples of earlier and later scheelite, nos. 210 and 225-44.

By the first method, the pressure in the inclusions was determined at room temperature: (a) by the ratio of liquid and gas phases in the inclusions upon their opening; or (b) by the ratios of the volumes of the extracted gases (Table 1) in the volume of the inclusion filled by the gas phase (Table 5). The ratios mentioned above characterize the average pressure in all inclusions at room temperature.

In calculating the pressure, we considered that in the primary inclusions there was 66% of the total volume as liquid extracted from scheelite sample no. 210 and 90% from sample no. 225. It is interesting to note that the calculation of the volume of inclusion filled by liquid in scheelite sample no. 210 agrees well with the determination of the amount of water obtained experimentally, which indicates the correctness of the microscopic study and the calculation made on that basis.

Thus, the ratio of liquid to gas phase, $\frac{Vg}{V_L}$, in the primary inclusions of sample 210 equals 0.3, and the volume of liquid in the primary inclusions with respect to the volume of liquid contained in all inclusions is 66% (Table 5). Calculation of the volume of the gas in the primary inclusions in 1 kg sample, according to the formula given above, gave the magnitude 0.375 cm^3. Taking the ratio $\frac{V_G}{V_L} = 0.3$ for primary inclusions, there will be in this sample

$$V_L = \frac{V_g \times 100}{0.3 \times 66} = \frac{0.375 \times 100}{0.3 \times 66} 1.8 \text{ cm}^3/\text{kg.}$$ (sic.) The same magnitude of volume was also obtained experimentally by determination of the total amount of water from sample 210 (1.8g/kg). The average pressure of mineral

formation was determined by obtaining the average pressure in the inclusions at room temperature to the temperature of mineral formation; calculating the water vapor pressure at this temperature according to the formula:

$$P_{av} = p_{av} (1 + \alpha_t) Z + P_{vapor},$$

where P_{av} = the average pressure of mineral formation(atmos.); Z = coefficient of compression of the gas at P_{av}, calculated according to the formula of Ryzhenko and Volkov (1971), p_{av} = average pressure at room temperature in the inclusions; t = temperature of mineral formation, °C (table 5); P_{vapor} = water vapor pressure at temperature t_M (Kaye and Laby, 1949). The results of determination of pressure are given in Table 6.

The second means of determining pressure is based on microscopic study in the inclusions of the ratios of volumes of liquid CO_2 and aqueous solutions at room temperature, which permits one to judge the concentration of CO_2 in the homogeneous mineral-forming solution at the temperature of mineral formation, because a regular interconnection exists between the concentration of CO_2, the temperature of the solution, and the pressure. Taking the concentrations of CO_2 and salts in the solution and the temperature of mineral formation, one can find from the corresponding curves the desired pressure. The results of the determination of pressure are given in Table 6.

As seen, the magnitudes of pressure obtained in different ways are similar and are, respectively, 560-580 and 650 atm.

Conclusions

Summarizing all the studies made, one can express the following remarks on the condition of formation of the Chorukh-Dairon ore field.

The pressure at which the highest temperature scheelite crystallized averaged ∿550-650 atm., and the average temperature was ∿315°C. The composition of the residual solution of gas-liquid inclusions was mainly of NaCl type and contained fluorine. Further, at t=250°C quartz crystallized. In the composition of the solution, besides the ions Na^+ and Cl^-, K^+ and HCO_3^- appeared in notable amounts. The separation of barite occurred at an average t=170° and pressure below 215 atm. In the solution besides Na^+ and Cl^-, Ca^{++} was also present.

During the formation of calcite the composition of the solution changed sharply; the main cation was Ca^{++} or Ca^{++} and Fe^{++}, and the anions HCO_3^-, F^-, and Cl^-. The gas phase of the solution consisted of H_2, CO_2, N_2. The composition of the gas changed, apparently, as the result of the entry from the country rocks of new gases - nitrogen and oxygen.

Considering that for all the samples studied from the early stages of mineral formation, excepting quartz, the ratio of hydrogen and CO_2 gas fall within the same limits, one can assume that the solution came from a single hearth. The absolute gas saturation of the solution in the process of mineral formation decreased, apparently, because of lowering of temperature and pressure.

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Table 2 (p. 105)

Change of gas saturation of minerals in dependence on the sequence of their formation

No. of Sample	Sequence of formation of mineral	Country rock	Temperature of homogenization, °C	Volume of gas, cm^3/kg
210	Scheelite	Granodiorites	270	55.1
70	Barite	"	150	44.0
55	Calcite	"	115	20.0
47	Scapolite	Monzonites	-	44.6
225	Scheelite	"	210	30.0
40	Calcite	"	115	36.0

Table 1 (p. 104) Results of analyses of gases extracted from samples of minerals of the Chorukh-Dairon ore field

No. of sample	Mineral	Country rock	Depth from surface, m.	Deposit	%				cm^3/kg					
					CO_2	O_2	H_2	N_2	V_{total}	CO_2	O_2	H_2	N_2	H_2/CO_2
97	Scapolite	Monzonites	0.0	Chorukh-Dairon	15.3	7.6	30.0	47.1	44.6	6.8	3.4	13.4	21.0	1.96
210	Scheelite	Granodiorites	203.0	"	10.0	2.5	23.2	64.3	55.1	5.5	1.4	12.8	35.4	2.32
44	"	"	175.0	"	30.3	-	69.7	-	7.26	2.2	-	5.06	-	2.3
225	"	Monzonites	0.0	"	13.3	-	-	86.7	30.0	4.0	-	-	26.0	-
203	Quartz, dark grey	Granodiorites	250.0	Shurale	22.9	0.7	71.6	4.7	163.6	37.52	1.0	117.21	7.87	3.1
133	Quartz, light grey	Effusives	361.0	S. Yungikan	7.8	2.2	83.8	6.2	156.6	12.2	3.5	131.2	9.7	10.7
131	Quartz, dark grey	Effusives	780.0	" "	7.4	5.2	87.4	-	162.8	12.1	8.4	142.3	-	11.8
145	Quartz, gray drusy	"	921.0	" "	19.3	9.1	71.6	-	191.2	37.0	17.4	136.8	-	3.7
70	Barite	Granodiorites	250.0	Shurale-I	17.7	-	35.0	47.3	44.0	7.8	-	15.4	20.8	1.9
40	Calcite	Monzonites	200.0	Chorukh-Dairon	16.5	4.3	27.5	51.1	36.4	6.0	1.8	10.0	18.6	1.67
132	"	Effusives	1005	S. Michigan	18.4	-	43.6	38.0	44.5	8.2	-	19.4	16.9	2.37

Table 3 (p. 106). Results of analysis of aqueous extracts of inclusions

Mineral	Content	Na^+	K^+	Ca^{++}	Mg^{++}	HCO_3^-	Cl^-	F^-	SO_4^{--}	SiO_2	Total Sum Cations+anions	Main cations and anions
Barite A-70	Mg-equiv/100g	0.529	0.006	0.297	not detd	not detd	0.779	0.010	not detd	not detd		
	Mg/kg	121.7	2.34	59.5	-	-	276.2	1.9	-	-	487.3	Na^+, Ca^{++}, Cl^-
Quartz A145	Mg-equiv/100g	0.589	0.198	not detd	not detd	0.131	0.580	not detd	not detd	29.45		
	Mg/kg	142.0	77.2	-	-	79.9	205.5	-	-		582.2	Na^+, K^+, Cl^-, HCO_3^-
Calcite A119	Mg-equiv/100g	0.003	not detd	0.390	not detd	0.113	0.011	0.328	0.023	-		
	Mg/kg	0.69	-	78.0	-	69.0	3.90	62.40	11.01	-	250.7	Ca^{++}, F^-, HCO_3^-

Table 3 (p. 106). Results of analysis of aqueous extracts of inclusions (Cont.)

Mineral	Content	Na^+	K^+	Ca^{++}	Mg^{++}	HCO_3^-	Cl^-	F^-	SO_4^{--}	SiO_2	Total Sum Cations+anions	Main cations and anions
Calcite A50	Mg-equiv/100g	0.049	0.004	0.334	not detd	0.112	0.093	0.106	0.011	not detd		
	Mg/kg	11.3	1.56	66.80	–	68.3	33.00	20.17	5.28	–	193.5	Ca^{++}, HCO_3^-, F^-, Cl^-
Scheelite No. 210	Mg-equiv.100g	0.129	0.031	0.075	0.030	0.018	0.191	0.084	0.05	0.178		
	Mg/kg	29.6	12.1	15.0	3.6	10.9	67.8	16.0	24.0	–	180.8	Na^+, F^-, Cl^-

Table 5 (p. 108). Results of microscopic study of gas-liquid inclusions in samples of scheelite

No. of sample	Type of inclusion	Phase Composition	Vol. of inclusions $10^{-8}cm^3$ in field of grain 0.0311sq.mm. spherical		Ellipsoidal		Tubular		Total		Total vol.* of primary inclusions cm^3/kg		Vol. of primary* inclusions %		$\frac{Vg}{Vl}$ primary	n	N
			G	L	G	L	G	L	G	L	G	L	G	L			
210	Primary	G	0.55	–	0.8	–	–	–	1.35								
		G+L	1.8	8.1	0.25	0.81	2.02	8.7	4.07	17.6	0.375	1.25	95	66	0.3	9	35
								Σ	5.42	17.6							
	Secondary	G+L	–	–	–	–	0.26	4.55	0.26	4.51							
										–	–	–	–	–	–	–	–
		L	–	0.28	–	2.93	–	1.27	–	4.4							
								Σ		8.9							
225	Primary	G+L	–	–	0.037	0.3	0.016	0.017	0.053	0.407	–	–	90	88	0.1		
	Secondary	G+L	0.002	0.022	0.0035	0.031	–	–	0.0055	0.053							

* The volume of inclusions per kg of sample was calculated according to the formula proposed by B. Aliododov

Table 6 (p.110). Results of determination of pressure of mineral formation in the Chorukh-Dairon deposits

No. of sample	Method of determining pressure	Starting data	Calculated formula or graphical determination	$P_{av.}$, atm.	Notes
Scheelite (210)	From ratio V_g/V_L before and after extraction from inclusion	$(V_G/V_L)_{inclusion}=0.3$; $(V_G/V_L)_{extd}=45$; $Z=1.5$; $t_m=315°C$; $P_{vapor}=88$ atm.	$P_{av}(V_G/V_L)_{extn}:(V_G/V_L)_{incl}\cdot Z\cdot$ $t+273/273 + P_{vapor}$ $P_{av.}=45/0.3\ x1.5x2.2+88$	∿580	Z, after Ryzhenko & Volkov (1974); P_{vapor} from Kaye & Laby (1949); other values from Tables 1, 3, 4
the same	From the ratio $V_G/V_{inclusion}$	$V_G=54.6\ cm^3/kg$ $V_{inclusion}=0.375cm^3/kg$	$P_{av}=V_G/V_{incl}\ x\ t+273/273\ x\ Z +$ P_{vapor} $P_{av}=54.6/0.375\ x\ 2.2\ x\ 1.5 + 88$	∿560	ditto
	From microscopic determination of the concentration of CO_2, taking in account the concentration of the liquid solution and the temperature	Concentration of CO_2-19% Concentration of NaCl+ $CaCl_2$ in the solution 7%, $t_m=315°C$	Graphic determination from experimental data (Takenouchi and Kennedy, 1965)	∿650	
Later scheelite (44-225)	From the ratio V_G/V_L before and after extraction	$(V_G/V_L)_{inclusion}=0.1$; $(V_G/V_L)_{incl.}=12.5$ $Z=1.1$, $t_m=230°C$, $P_{vapor}=$ 15 at.	$P_{av}=(V_G/V_L)_{extraction}:(V_G/V_L)_{incl}$ $\frac{x\ Z\ x\ t + 273}{373} + P_{vapor}$	∿215	

Table 4 (p. 107). Results of determination of temperatures of homogenization for samples of minerals from the Chorukh-Dairon deposits

No. of samples	Name of mineral	temperature homogenization, °C	Δt, °C	t miner., °C
17 (? illegible)	Scapolite	260-450	45	315
210	Scheelite	av.270	20	230
44	Scheelite	210	20	230
225	Scheelite	210	-	-
133	Quartz	230	-	-
70	Barite	130-150	-	-
74	Barite	130-150	-	-
49	Calcite	115	-	-
55	Calcite	115	-	-
132	Calcite	115	-	-

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KORMUSHIN, V.A., SHARIPOV, R.K. and LIPOVA, E.M., 1973, Chemical analysis of liquid phase inclusions in quartz: Akad. Nauk Kazakh. S.S.R., Izvest., Ser. Geol., 1973, no. 3, p. 88-90 (In Russian; translation courtesy M. Fleischer).

Study of gas-liquid inclusions in quartz is of considerable interest because of the extremely important role of the latter in explaining the genesis of different deposits (1). In the present report is given the application by us of the method of chemical microanalysis of liquid phase inclusions in quartz. In aqueous extracts there were determined the ions K^+, Na^+, Ca^{2+}, Mg^{2+}, Fe^{3+}, Fe^{2+}, Cl^-, F^-, HCO_3^-, SO_4^{2-}, and BO_3^{3-}.

Preparation of Aqueous Extracts

The original sample of quartz in pieces of size up to 20-30 mm. was crushed to 5-7 mm. and pure grains of the mineral were selected visually, which were later crushed to the fraction -1.0+0.25 mm. Under the binoculars 110-120g. of the mineral was selected. To free it from accessory iron and hydrous oxides of iron, to the quartz was added 80-100 ml. HCl (1:1) and boiled 1.5-2 hours. After cooling, the sample was washed again with distilled water until it gave a negative reaction for chloride with $AgNO_3$, and then with doubly distilled water. The sample was dried at 110° for 2-3 hours. After cooling, a weight of 100 g. was taken.

To extract the mineral salts in the gas-liquid inclusions, the sample was ground to 1-2 microns in an agate mortar under a layer of bidistillate. Complete opening of the inclusions was controlled by scanning the ground sample under the microscope in immersion. Afterwards the ground sample was transferred into a beaker* with 200-300 ml. and filtered (blue ribbon) on a Buchner funnel under vacuum, created by a water-jet pump. In transferring the sample from the beaker to the filter and washing, 400 ml. of bidistillate was used.

Chemical analysis of aqueous extracts

The difficulty of the chemical analysis of the liquid phase of the inclusions is due to the low concentration of the ions leached in the aqueous extract. For this reason, the total volume of aqueous extract is concentrated down to 50 ml. The determination of the ions was carried out on volumes of 1-10 ml by flame photometry, micro-titration, photocolorimetric, and microturbidimetric methods.

The determination of K^+ and Na^+ was made by the flame photometry method (2) with propane-butane flame. The analytical lines used were 7665A. for K, 5890A for Na. To measure the intensities of the leached K and Na, 8 ml. of filtrate was taken.

The determination of Ca^{+2} and Mg^{+2} was made by a volumetric method, which is based on the formation by the divalent metal of a stable inner-complex compound with Trilon B (3). The determination is interfered with by Al, di- and tri-valent Fe at concentrations higher than 2 mg/ml, and also by Cu higher than 3 mg/ml.

For the determination of the total Ca and Mg, 10 ml of filtrate was placed in a conical 50 ml flask, 10 ml of ammoniacal buffer solution was added to pH 10, a pinch of ET-00 indicator with NaCl was added, and it

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* One must use only quartz or polyethylene vessels.

was titrated with 0.05M Trilon blue to a blue color.

To determine Ca, there was added to 10 mm. of filtrate 2 ml of 10% KOH solution (pH 12), 0.2-0.3g. of murexide in powder form and it was titrated by 0.05M Trilon B to the change in color from rose-red to violet.

Determination of Fe^{+3} and Fe^{+2}. The volumetric method for determining iron was based on the ability of Trilon B to form with trivalent iron a stable complex at pH 1.0-1.5 (4). 1 ml. of filtrate was placed in a 50 ml. conical flask, diluted to 10-20 ml. with bidistillate and some drops of HCl (1:10) to a pH of 1.2-1.4. After the solution was heated to 60-70°, 1 ml. of a 10% solution of sulfosalicylic acid was added and the solution was titrated with 0.05M Trilon B to the disappearance of the rose color.

To determine divalent iron, the solution in which ferric oxide was titrated, is again heated to 60-70°, 100 mg. of ammonium persulfate was added to oxidize divalent iron, and the solution was titrated with the same solution of Trilon B to the disappearance of the rose color.

Determination of Cl^-. The volumetric method for determining chloride ion was based on its precipitation with silver nitrate (5).

To 1 ml. of the neutral solution of the filtrate (for an acid solution, one must add a pinch of MgO), add 1-2 ml. ethyl alcohol, a drop of 7% solution of $K_2Cr_2O_4$, and titrate with 0.01 N $AgNO_3$ to the transition of the yellowish color to pale brown.

Determination of F^-! The colorimetric method of determination of fluorine is based on the weakening of the blue color of the complex compound of thorium with arsenazo in the presence of fluoride-ion (6).

5 ml. of filtrate was placed in a calibrated 50 ml. flask, diluted with 20 ml. bidistillate, 5 drops of a saturated solution of α-dinitrophenol and 1 drop of HCl (1:1) added, and it was neutralized by a solution of NH_4OH(1:10) to a distinct yellow color. Afterward there was added 6 ml. of a solution prepared by mixing 50 ml. of thorium nitrate (30 microg Th/ml) acidified with 0.5 ml concd. HCl, with 10 ml. 0.05% solution of arsenazo. Bidistillate was added to the mark; it was measured on the following day with 20 ml. with an orange light filter.

Determination of CHO_3^-. The volumetric method of determination of bicarbonate ion is based on titration of the solution with HCl in the presence of methyl orange indicator, coloring the solution yellow (5).

To 1 ml. of filtrate was added 1 drop of 0.1% solution of methyl orange and it was titrated with a white background with 0.01 N HCl with constant stirring to the change of color to pale rose.

Determination of Sulfate. The microturbidimetric method of determination of sulfate ion is based on the change of intensity of the color transmitted through the solution studied on introduction of barium ion (7).

Into the cavity of the microturbidometer was poured 0.4 ml filtrate, the logarithmic scale of the microphotometer was set at zero, 0.1 ml. of a 2% solution of $BaCl_2$ was added, and after 5 minutes the reading on the apparatus was recorded.

Determination of BO_3^{-3}. The colorimetric method of determination of boron is based on the formation of a complex compound of boric acid with carmine that is colored violet or blue (8). The determination is interfered with by oxidants (nitrates, chromates) and by the fluoride ion, which forms complex compounds with boron. At a ratio F:B = 1:1, the results of determination of B are lowered by 25-30% and at a ratio 3:2 by 50.

1 ml. of filtrate was placed in a dish, a pinch of soda was added and it was evaporated to dryness. After cooling, the residue was transferred with concentrated H_2SO_4 (5-7 ml) into a 25 ml flask; there was added 15 ml. of a 0.005% solution of carmine in concentrated H_2SO_4; it was filled to the mark with concentrated H_2SO_4 and mixed. After 2-3 hours it was measured visually colorimetrically.

The method described was first tested on a synthetically prepared solution, containing the ions K^+, Na^+, Ca^{+2}, Mg^{+2}, Fe^{+3}, Fe^{+2}, Cl^-, F^-, HCO_3^-, SO_4^{-2}, and BO_3^{-3} in amounts corresponding to their possible concentrations in the aqueous extracts of inclusions from minerals (9). The results are given in Table 1. The significant error in the determination of individual components lies within the permissible limits for slightly mineralized solutions (10).

Results of the analyses of liquid phase inclusions in quartz are given in Table 2. The data obtained show only the quantitative ratios of the ions in the studied mineral-forming solutions. However, they permit one, in conjunction with the cryometric method (11), to estimate also the actual concentrations of the ions in the inclusions.

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Table 1 (page 89)

Results of Chemical Analysis of a Synthetic Solution of Mixtures of Ions

Ion	Concentration of ion in mixture, mg/ml.	Taken, mg.	Found, mg. (average of 3 analyses	Relative error, %
K^+	0.050	0.400	0.456	14
Na^+	0.100	0.800	0.856	7
Ca^{2+*}	0.050	0.500	0.550	10
Mg^{2+}	0.050	0.500	0.420	16
Fe^{3+}	1.000	1.000	0.909	9
Fe^{2+}	1.000	1.000	0.909	9
Cl^-	0.147	0.147	0.161	8
F^-	0.042	0.210	0.240	14
CHO_3^-	0.133	0.133	0.158	17
SO_4^{2-}	0.024	0.0096	0.0104	8
BO_3^{3-}	0.050	0.050	0.040	20

*Calcium was determined in a pure solution

Table 2 (Page 90)

Chemical Analysis of Liquid Phase Inclusions from Quartz, mg/100 g. sample

	DEPOSIT		
Ion	Southern Kazakhstan, Boguty	Central Kazakhstan, Koktasdzhal	Central Kazakhstan, Karoaba
K^+	2.05	0.95	0.58
Na^+	2.82	3.95	1.87
Ca^{2+}	1.92	1.54	0.10
Mg^{2+}	0.26	0.62	0.09
Fe^{3+}	not found	not found	not found
Fe^{2+}	"	"	"
Cl^-	4.50	10.90	6.79
F^-	0.15	0.67	0.46
HCO_3^-	10.70	4.08	1.22
SO_4^{2-}	1.90	2.60	5.22
FO_3^{3-}	not found	not found	not found

Order of the Workers Red Banner
Institute named for K.I. Satpaev,
Academy of Sciences, Kazakh SSR,
Alma-Ata.

Translated by Michael Fleischer,
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ZAKHARCHENKO, A.I., 1971, On time and physico-chemical conditions of mobilization, transport and precipitation of tungsten and tin in postmagmatic processes (exemplified by intragranitic chamber pegmatities), pp. 287-306, in Mineralogy and geochemistry of tungsten deposits (Materials of 2nd All-Union Symposium on Mineralogy, Geochemistry and Genesis of Tungsten Deposits of USSR): Leningrad, Leningrad Univ. Publishing House, 344 pp. (In Russian; abstract through the courtesy of A. Kozlowski). Author at All-Union Scientific-Research Geological Institute, Leningrad.

The geological setting of intragranitic chamber pegmatities was described in the massifs of Central Kazakhstan, Transbaykalia and Volhyn.

Short descriptions of the petrochemical characteristics of the massifs are given, as well as the geological and tectonic features. Very detailed descriptions are given of the structural and mineralogical features (see Figure 2).

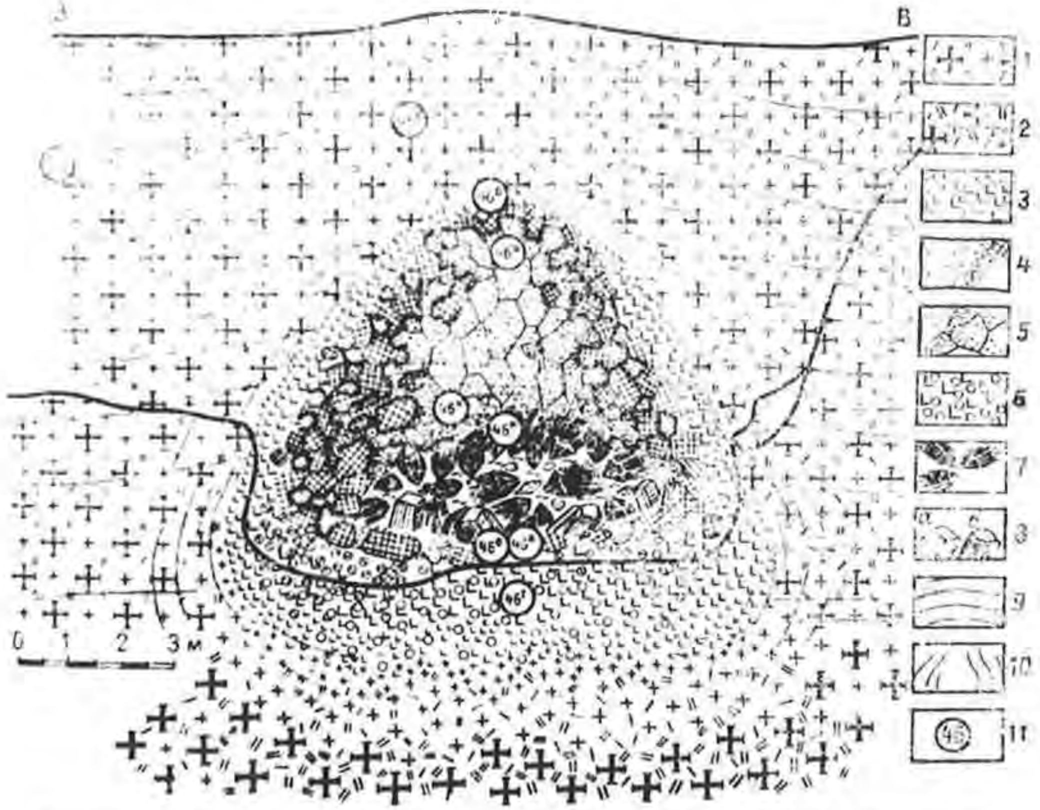

Figure 2. Cross-section of pegmatite body from Korostenskyi intrusion, Ukraine, Volhyn showing cavity mineralized by quartz, feldspars, topaz, cassiterite and molybdenite.

A zone of dissolution and albitization occurs below the cavity. 1-biotite-hornblende granite, 2-altered melanocratic granite, 3-graphic intergrowth pegmatite, 4-block pegmatite, 5-quartz core, 6-zone of dissolution and albitization, 7-quartz crystals, 8-feldspar and topaz (a and b respectively) crystals (at the bottom of cavity cassiterite and molybdenite crystals occur),9-10-contraction fractures, 11-places of sampling for water leachate analysis.

As one may see in large crystals of quartz (e.g. from Volhyn pegmatites), such quartz consists of an internal zone of honeycomb quartz formed at temp. over 600°C, followed by crystallization of "ice-like" quartz, morion and late weakly smoky and colorless quartz (Figure 3). Cassiterite and wolframite crystallized together with

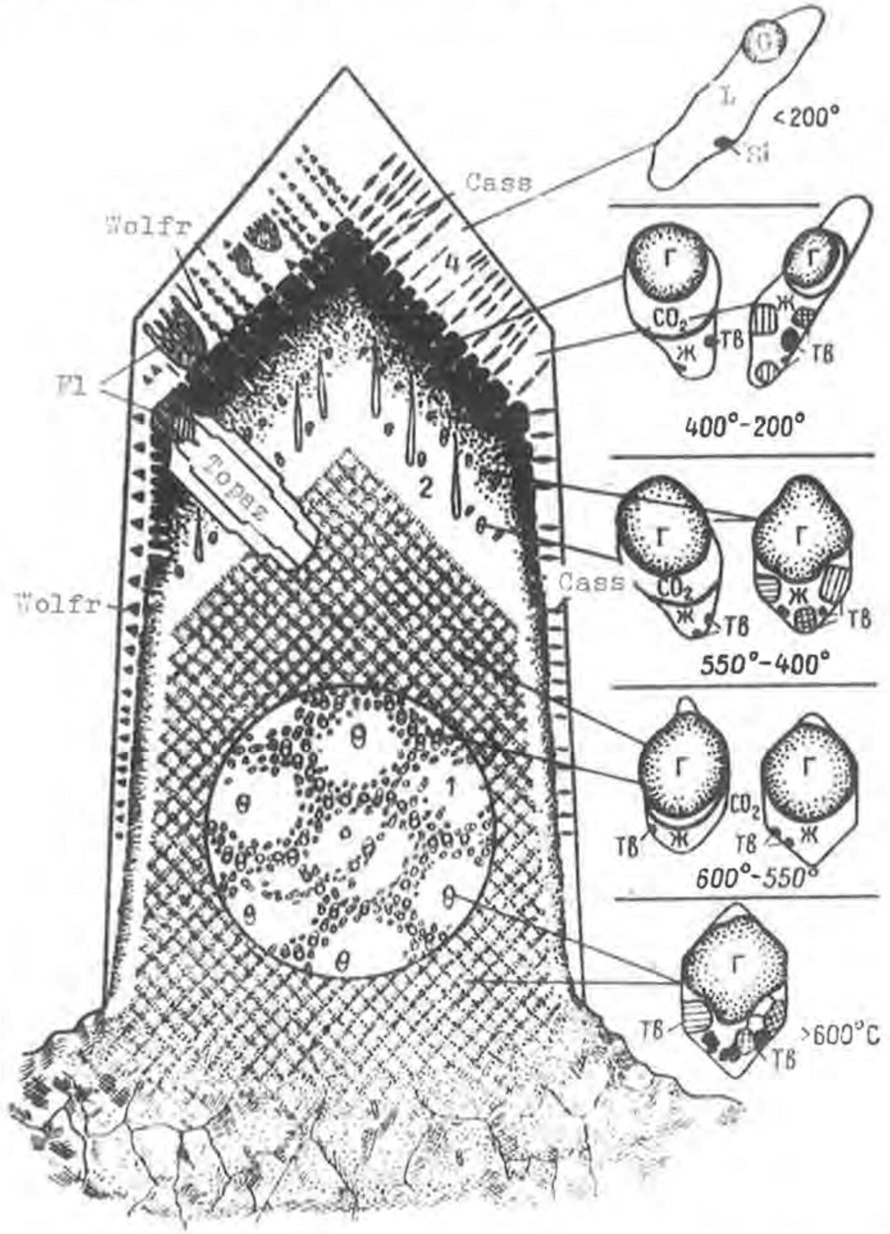

Figure 3. Polyzonal quartz crystal from cavity of Volhyn pegmatites. 1-inner zone of honeycomb (reticulate, cracked) quartz, formed at T over 600°C and inverted. In circle- details of reticulate quartz structure: fractures bear secondary gaseous inclusions (T_h 600-550°C) of low density among which the primary inclusions of solutions occur, with T_h over 600°C; 2-zone of ice-like quartz with gaseous inclusions, 3-morion zone with transitional inclusions from gaseous to liquid type (T_h 500-350°C), 4-zone of smoky and colorless quartz with liquid inclusions (T_h below 350°), Cass.-cassiterite and Wolfr. - wolframite, precipitated together with quartz (450-400 to 200°C), Fl - fluorite precipitated together with topaz and quartz (together and later than cassiterite and wolframite).

the late morion and essentially with the weakly smoky and colorless quartz. The main mass of topaz crystallized before the ore minerals and fluorite formed together and after the ore minerals. Cassiterite and wolframite form solid, acicular or prismatic, pyramidal and icicle-like inclusions in quartz (illustrated with photos).

In quartz grains (especially dark) of wall-rocks (granites and aplites) and pegmatite graphic zones melt inclusions occur (10-40% gas phase, increasing toward the center of pegmatite, and solidified, partly recrystallized melt) without a liquid aqueous phase. Such inclusions begin to melt at 700°C, become completely liquid at 800-900°C, with almost complete disappearance of gas phase, and become a very mobile melt. In internal pegmatite zones melt inclusions enriched in gases, alkalies, F and Li occur. During melt solidification, it boils. Zones with this type of inclusions are enriched in dispersed rare metals, (RM), proving that the metals accumulate in easily melting remnant melts.

In internal zones of pegmatites polyphase inclusions, rich in gases, and homogenizing in gas, are very common. Later increase in the role of aqueous liquid solutions occurs, occasionally very rich in salts (polyphase inclusions with numerous daughter minerals). Homogenization yields a superdense gaseous phase close to a liquid ("fluids" after Ermakov). Gaseous inclusions in healed honeycomb fractures are secondary ones and formed from gases of the boiling superdense fluids.

In morion, late beryl and topaz, transitional inclusions from gaseous (or "fluid") to liquid ones, also highly saline (30-50%) occur as primary inclusions. They homogenize at 500-400°C in the liquid phase. This stage is accompanied by albitization and greisenization processes in the pegmatite under the chamber cavity and precipitation of the first RM minerals.

Later stages of evolution of mineral-forming medium give liquid solutions with a gradual decrease of salt concentration. Temperatures drop from 450 to 200°C. In addition, processes of mineral solution under the pegmatite cavity, and metasomatic alteration of rocks occurring there, accompanied the main stage of cassiterite, wolframite, and molybdenite precipitation, mainly at temp. range 400-250°C. Late quartz, fluorite and pyrite crystallized at 200-100°C (two-phase incl.-gas-liquid).

Thus, the main zones of the pegmatite form at $T = 600\text{-}650°C$. Rare metals did not distill from the residual magma together with the first portions of primary gas solutions. After formation of water solutions, i.e., during hydrothermal process, the extensive processes of mobilization, transport, and precipitation as RM minerals were widely developed. The dominance of water solution begins at 500-400°C. The main gases are H_2 and N_2 and in later stages - CO_2 (particularly at the time of formation of the RM minerals. CO, O_2, Ar, and He also are found, and in some samples hydrocarbons were found. The differences in gas composition from various massifs can be expected from the geological data. The importance of H_2 during the early stages explains the immobility of RM, probably as hydride compounds (sic.) and the mobilization at later stages presumably under the action of halogenide complexes in water solutions.

The following daughter minerals in the inclusions occur: halite, sylvite, elpasolite, cryolite, topaz, fluorite, and OH-chlorides and fluorides of Fe, Mg, Ca, albite, hematite, carbonates, rutile,sulfides (pyrite?), sulfates(?), etc.

Solutions in inclusions (water leachate method) are of Na-K-Cl type. Cl at later stages is replaced by HCO_3^-, and F was removed from the low solubility liquid phase of inclusions by crystallization of daughter minerals (fluorides).

The boundary of mobilization, transport and precipitation of RM is very distinct at the point of chloride-type solution change to form hydrocarbonate solutions at temp. interval 270-240 to 200°C

Indices

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AUTHOR INDEX

Note : Only first authors are listed. See general note above.

SUBJECT INDEX

Notes: See page 194. 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 known to the Editor 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 (such as Homogenization, Quartz) are omitted. Some entries with broad and diffuse applicability (e.g. "Geobarometry, methods and comparisons" or "Homogenization of inclusions, factors affecting") have only a few of the most appropriate page references.

DEPOSIT INDEX

Notes: See page 194. 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.

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Edwin Roedder, *Editor*

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