FLUID INCLUSION RESEARCH

Proceedings of COFFI

Edwin Roedder, *Editor*

Volume 7

1974

Fluid Inclusion Research

Volume 7

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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. These jobs can be partitioned into as small units as desired; please contact either editor 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 fluid inclusions (aqueous, organic, silicate melt, sulfide melt, gas, etc.), causes and mechanisms of trapping (including immiscibility), physical, chemical, and isotopic data, and data on experimental studies of systems pertinent to the interpretation of the phase changes occurring in inclusions, as well as to the sources of such fluids and their interactions with rocks. These data are generally given without editorial value judgments except in the case of obviously contradictory or obscure statements. Extent of coverage varies in part as an inverse function of the availability of the original text to the average Western reader and in part as a direct function of the usefulness of the data. In addition to abstracts and citations, we publish English translations of inclusion papers from foreign languages, where available and not otherwise published in English, and notices of meetings and symposia.

Most of the translations from Russian sources in this volume are by the associate editor. Included among these are part of the 144 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., that could not be included in the previous volume. Part of the Russian abstracts were translated through the courtesy of Professor N. P. Ermakov, Dr. E. I. Dolomanova, Dr. N. I. Andrusenko, and Dr. T. M. Sushchevskaya, all at Moscow. Complete translations of full articles were provided by Dr. C. Barker (Univ. Tulsa), Dr. V. V. Mogarovskii (Dushanbe, Tadzhik S.S.R.), Dr. T. M. Sushchevskaya (Vernadsky Inst., Moscow), and Dr. A. Kozlowski (Inst. Geochem., Univ. Warsaw).

Although each abstract is duly credited, the editors wish to acknowledge, in particular, the help of Dr. M. Fleischer, of the U.S. Geological Survey, who provided translations of two 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 particularly are indebted to Professor Ermakov, Chairman Emeritus of COFFI, for copies of Russian books.

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
June 21, 1976 Andrzej Kozlowski, Associate Editor

Contents

Indices

Notices of Meetings and Symposia

The Fourth All-Union Conference on Thermobarometry met at Rostov-on-Don, September 24-30, 1973. Translations of most of the 236 extended abstracts for this meeting were published in volume 6; the balance are in this volume. 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 are in this volume.

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 are in this volume.

The International Symposium on Water-Rock Interaction was held at Prague, Č.S.S.R., September, 1974, and the Symposium on Metallization and Acid Magmatism was held at Karlovy Vary, Č.S.S.R., October, 1974; abstracts of pertinent papers are in this volume.

A meeting on Typomorphism of Ukrainian Quartz, with many papers on fluid inclusion studies, was held in 1974 in the Ukraine. The papers presented were published as a book (see Lazarenko, Ye.K., ed., 1974, this volume); individual papers involving inclusions were abstracted by A. Kozlowski and are entered here under their individual authorships.

A conference was held on September 30 to October 1, 1975, in L'vov, U.S.S.R., on "Carbon and Its Compounds in Endogenetic Processes of Mineral Formation." The abstract volume for this conference consists of 115 pages. A total of 47 papers were presented, and 150 members attended, mainly from the Soviet sector of COFFI. Many of the abstracts will be translated in <u>Fluid Inclusion Research: Proceedings of COFFI</u>, volume 8, 1975.

A conference was held in Alma Ata, U.S.S.R., on November 11-13, 1975, on "Methods and Techniques for the Study of Gas and Liquid Inclusions and Their Practical Use for Prospecting and Exploration." There were 22 papers and 114 attendees, mainly from the Central Asian republics and Kazakhstan.

The Fifth All-Union Conference on Thermobarometry will meet at Ufa, in the Urals, September 20-27, 1976; Professor N. P. Ermakov of Moscow University is the convenor.

The Fifth International Symposium on Fluid Inclusion Research will be held August 20, 23, and 24, 1976, at Sydney, Australia, in conjunction with the 25th International Geological Congress; E. Roedder is the convenor. Abstracts of many of the 22 papers to be presented will be published by the IGC, and all will be published in the next volume of COFFI.

Organization of COFFI

The Bureau of COFFI consists of six officers as follows: Chairman Emeritus - N. P. Ermakov, U.S.S.R.; Chairman - E. Roedder, U.S.A.; First Vice-Chairman - 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. The following series of Regional Representatives have also been established to provide foci for coordination and exchange of information on COFFI activities.

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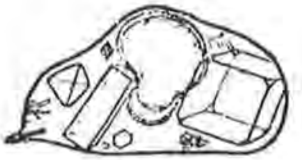
U.S.S.R.: Professor F. P. Mel'nikov, Department of Geology, Moscow State University, Moscow, B234, U.S.S.R.

Abbreviations

Note: The following abbreviations are used in part of these abstracts to save space, and will be used more generally in future volumes. The correct form of the word (noun, adjective, verb, plural, etc.) can be obtained from context.

alt.	altered
amorph.	amorphous
anal.	analysis
app.	apparatus
aq.	aqueous
assemb.	assemblage
assoc.	associated
avg.	average
calc.	calculated
char.	characterized
chem.	chemical
coef.	coefficient
comp.	composition
conc.	concentrated
conds.	conditions
cpd.	compound
d.	density
decrep.	decrepitated
dep.	deposit
det.	determined
devel.	developed
diam.	diameter
diff.	difference
dist.	distinguish
distrib.	distribution
dm.	daughter mineral
dxl.	daughter crystal
equil.	equilibrium
est.	estimated
exper.	experimental
extr.	extracted
F	degree of fill
form.	formation
G	gas
homog.	homogenization
hyd.	hydrothermal
ident.	identification
ign.	igneous
inc.	inclusion
invest.	investigated
iso.	isotopic
L	liquid
lab.	laboratory
mech.	mechanism
meta.	metamorphic
min.	mineral, mineralization
obs.	observation
org.	organic
P	pressure
peg.	pegmatite
P inc.	primary inclusion
ppt.	precipitate
prop.	property
PS	pseudosecondary
qual.	qualitative
quan.	quantitative
ref.	reference
sed.	sedimentary
sol.	solution
soly.	solubility
std.	standard
T	temperature (°C)
T_D	temperature of decrepitation
T_F	temperature of formation (i.e., trapping)
T_{Frz}	temperature of freezing
T_H	temperature of homogenization
T_M	temperature of melting
thdy.	thermodynamic
theor.	theoretical
therm.	thermometer
xl.	crystal
xline	crystalline
xlized	crystallized
(...)	part of author's abstract omitted.



Abstracts, Translated Abstracts, or Annotated Citations to World Literature, 1974

Note — This section also includes a few earlier items that were not available in time for inclusion in the previous volume.

ADRYANOVA, S.I., ZAREMBO, Yu. G., BARKHUDARYAN, N.B. and ELINSON, M.M., 1973, Physico-chemical conditions of formation and genesis of gold mineralization in Central Kyzylkum: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 56-57 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Central Scientific-Research Geological-Prospecting Inst. of Ministry of Geology of USSR and IGEM Acad. Sci. of USSR, Moscow.

1. (...) Genesis of the gold ore mineralization was accepted as hydrothermal, metamorphogenic or a more complex mode. Conditions of crystallization ranged from pneumatolytic-hydrothermal, critical, high- to low-temperature solutions, in the T range 600-60°C, with inversions occurring between individual stages. Ranges of these inversions (pulsations) were from 420°C-360°C to the lowest one at 220-200°C. Gold precipitated from moderate to low-temperature aqueous solutions bearing CO_2, at 300-200°C.

2. Investigations of quartz from various stages of mineral formation by the IR absorption method proved that the relative optical density of the absorption band at 3400 cm^{-1} regularly increases from pre-ore to post-ore varieties, that may reflect a change in the role of the OH^- group and other admixtures (in quartz) during mineral formation process.

Interaction of later portions of solutions and earlier mineral associations is marked by various intensities of absorption bands at 3400 and 2350 cm^{-1}, taken in different parts of the same plate, and sometimes by various shapes of the IR absorption curves.

3. (...) Solid phases (salts), water and gases (CO_2, O_2, H_2 N_2 and Ar) were found in the inclusions. The amount of CO_2 increases from pre-ore quartzes (30 cm^3/kg) to quartz of the ore stages (80-90 to 150-180 cm^3/kg) and then decreases in post-ore quartz (30 cm^3/kg). The intensity of bands at 3400 and 2850 cm^{-1} (OH^- and other admixtures and CO_2 absorp-

tion respectively) behave similarly.

These data support the metamorphic nature of pre-ore veins and hydrothermal genesis of ores clearly connects the ores with magmatism and can be used for research and evaluation of deposits of similar type. (Authors' abstract, abbreviated by A.K.)

ALEXANDER, E.C., Jr., 1974, ^{40}Ar-^{39}Ar studies of Precambrian cherts (abst.): Amer. Geophy. Union Trans., EOS, v. 55, no. 4, p. 466. Author at Dept. of Geol. and Geophy., Univ. of Minn., Minneapolis, MN 55455.

In an attempt to find old authigenic sedimentary minerals which might have trapped Ar from the primitative atmosphere a ^{40}Ar-^{39}Ar study has been conducted on chert samples from the Fig Tree, Bulawayan, Theespruit and Kromberg Formations of Africa and the Gunflint Formation in America. Only the Gunflint sample contained appreciable trapped argon. All of the cherts display complex ^{40}Ar-^{39}Ar release patterns which prevent the determination of plateau ages. The "total" age of Fig Tree chert, 2.98±0.03 b.y., is in excellent agreement with Allsopp *et al.*'s Rb/Sr age for Fig Tree shale. The "total" ages of the other samples are either geologically reasonable or too old. The lack of unreasonably young ages indicates that cherts do not lose Ar even in fairly complex histories and raises the possibility that younger, less disturbed Paleozoic cherts may prove to be dateable. (Author's abstract)

ALYEKHIN, Yu. V., 1973, Hydrodynamics of processes of filtration and filtration effect: *in* Contrib. to Physico-Chem. Petrology, V.A. Zharikov, et al., eds.: Moscow, "Nauka" Pub. House, v. 3, pp. 156-193 (in Russian; abstract courtesy of A. Kozlowski).

A theor. anal. was made of phenomena observed during filtration of sols. of electrolytes through porous layers. In general case of transport of polycomponent liquid when work against viscosity is made, it cannot be expressed only as mechanical work $\Delta V \cdot \Delta P$. Occurrence during filtration through porous layer, of electrokinetic phenomena, expressed as electrochemical transport and origin of electroosmotic reverse pressure, proves that there the mechanical work against viscosity does not change solely into heat, i.e., in such system $SdT \neq VdP$. Suggestions on differential work of component of filtrating stream against viscosity are presented. During processes of transport in an electric field (electrochemical transport), in the field of a concentration gradient (diffusion), in the field of a temperature gradient (thermodiffusion) in the field of a hydraulic pressure gradient (filtration) - work against viscosity is the general feature. Mobilities of individual components during filtration vary and orders of mobilities are characterized by value of work against viscosity. As filtration is the transport process connected with viscous movement of solvent, the most hydrated ions migrate first with solvent. Only ions causing a decrease of viscosity migrate with higher speed, for these ions the energy of breaking the junction ion - water is lower than that of breaking the junction water-water. This explains well the idea of acid-alkaline filtration effect of Korzhinskii. (Author's abstract).

ALEKHIN, Yu. V., PASHKOV, Yu. N., and DISTLER, V., 1970, Study of the greisen process by using gaseous-liquid inclusions: Geol. Rudnykh Mestorozhdenii, v. 12, no. 3, p. 33-40 (in Russian; translation in Intern. Geol. Rev., v. 14, p. 639-644, 1972; abstract translated in

Econ. Geol., v. 69, 1974, p. 722-723).

Abstracted in Fluid Inclusion Research — Proceedings of COFFI, v. 3, 1970, p. 6. (ER).

ALLCOCK, J.B., 1974, Gaspé Copper: A Devonian skarn-porphyry copper complex (abst.): Econ. Geology, v. 69 , p. 1175-1176. Author at Department of Geology and Geophysics, Yale University, New Haven, Connecticut.

The changing physico-chemical environment was followed in terms of P_{H_2O}, P_{CO_2}, f_{S_2}, and T. (ER).

ALLMENDINGER, R.J., 1974, Source of ore-forming fluids at the Hansonburg Mining District, Central New Mexico (abst.): Econ. Geol., v. 69 p. 1176. Author at New Mexico Bureau of Mines and Mineral Resources, Socorro, New Mexico.

The Hansonburg mining district contains open-space fillings and replacements of fluorite, barite, quartz, and galena in fractured Pennsylvanian limestones. Normal faulting associated with mid-Tertiary rifting of the Rio Grande trough has exposed over 800 feet of limestones and arkoses in the north-south trending, westward facing scarps of the Sierra Oscura. This Pennsylvanian sequence rests unconformably on Precambrian granites and metasediments. Mineralization appears to be Oligocene or Miocene in age. Fluid inclusions indicate that most of the mineralization took place from a 2 to 3 molal NaCl solution at temperature between 140° and 200°C. Present-day heat flow is inadequate to provide for these temperatures, even in deep, adjacent basins; nor is there any evidence for a large igneous body in the district. Mid-Tertiary dikes and sills in the area probably contributed to high heat flow. Early sulfides precipitated during a period of increasing tempatures, while later fluorite mineralization occurred as temperatures decreased. Barite deposition overlapped between the sulfide and fluorite stages. Organic material identified in some inclusions was probably derived from nearby petroliferous limestones; these organics may have played a role in the precipitation of early sulfides. Sulfur isotopes indicate that nearly all of the sulfide and sulfate sulfur was probably derived from Permian evaporites found in the local stratigraphic column. Chemical analyses of various country rocks suggest that they may have been the source of the hydrothermal mineral-forming constituents. Estimates of Oligocene-Miocene hydrologic flow patterns and a reinterpretation of lead isotopes are compatible with such a sedimentary-hydrothermal origin of the deposits. (Author's abstract).

ANDERSON, A.T., Jr., 1974a, Evidence for a picritic, volatile-rich magma beneath Mt. Shasta, California: Journal of Petrology, v. 15, Part 2, p. 243-267. Author at the University of Chicago, Chicago, Illinois, 60637.

Large, magnesium-rich olivines are plentiful in several Holocene cinder cones within 20 km of Mt. Shasta summit. Glasses (formerly silicate melts) included in the olivines are high alumina basalts (tholeiites and olivine tholeiites). In the most magnesian olivines the glass inclusions have large vapor bubbles. Surrounding some of the glass inclusions are broad Fe-rich zones and ghost outlines. These facts indicate crystallization of major proportions of olivine from the initial trapped melts. The initial melts contained an inferred 24 percent of MgO and were rich in volatiles. The inferred entrapment temperature of the initial melt is 1410°C. The initial liquid is a possible mantle derived parent of Mt. Shasta basalts and andesites and of some hidden alpine peridotite. (Author's abstract)

ANDERSON, A.T., 1974b, Chlorine, sulfur, and water in magmas and oceans: Geological Society of America Bull., v. 85, p. 1485-1492. Author at the University of Chicago, Chicago, Illinois.

The concentrations of chlorine, sulfur, and water in basaltic and andesitic glasses trapped in large crystals are commonly 5 to 20 times as high as those found in vesicular glasses and bulk lavas. Chlorine and sulfur concentrations in trapped glasses range from 100 to 2,200 ppm and from 50 to 2,800 ppm, respectively. Vesicular glasses contain 100 to 600 ppm chlorine and 50 to 400 ppm sulfur. The chlorine-rich trapped glasses tend to have high water contents, from 1 to 7 percent by weight. In general, the basaltic trapped glasses have as high or higher concentration of chlorine, sulfur, and water as do the andesitic glasses. For individual eruptions, water-rich magmas (Mount Shasta, California) lose an appreciable fraction of their chlorine prior to extrusion, whereas water-poor magmas (Kilauea, Hawaii) lose little if any chlorine, even after extrusion. Apparently, water acts as a carrier gas and distills chlorine out of magmas as it boils away.

The behavior of sulfur is complex and appears to reflect pre-eruption saturation with respect to a sulfide melt and strong loss of sulfur as SO_2 during eruption (the pre-eruption fugacity of SO_2 is about 60 atm for Kilauean fractionated basalt).

The potential chlorine, sulfur, and water contents of andesitic magmas have been estimated by assuming derivation from basaltic precursors and extrapolating the volatile contents of related basalts along lines of constant ratios to K_2O to 1 percent K_2O. The potential volatile concentrations are: 0.08 to 0.66 percent Cl, 0.10 to 0.67 percent S, and about 5 to 15 percent H_2O. Assuming that the estimated rate of production of continental crust in Cenozoic island arcs has been constant throughout earth history, the total amounts of Cl, H_2O, and continental crust produced are within factors of 0.3 to 4 times the presently existing masses of these substances in the surface reservoir of sea water, sediment, and crust. The amount of sulfur produced is larger than that in the reservoir. Sulfur probably is less efficiently transferred into the surface reservoir than are chlorine and water. The data can be reconciled with models of recycling of volatiles through the mantle, but the near coincidence of residence times for chlorine, water, and crust in the surface reservoir with the age of the earth is not explained. Also, the equality between the Cl/H_2O ratio of oceanic tholeiite, Kilauean basalt, and H_2O-rich Mount Shasta basalts with the same ratio for the surface reservoir is consistent with the idea of igneous derivation and permanent storage of Cl and H_2O in the surface reservoir. (Author's abstract).

ANDERSON, G. M., SYLVESTER, G., and REEVE, E. J., 1974, Nepheline pegmatites in the Bancroft area, Ontario, Canada (abst.): Internat. Mineral. Assoc. Ninth Gen. Meeting, West Berlin and Regensburg, W. Germany, Collected Abstracts: West Berlin, German Mineralog. Soc., p. 9 (in English). Authors at Toronto, Canada.

A narrow, discontinuous belt of syenite and nepheline syenite gneisses extends for over 160 km in northern Ontario, through the town of Bancroft. Within the nepheline-bearing gneisses there occur several large (50-100 m) pegmatite bodies consisting almost entirely of albite-oligoclase, nepheline and biotite. Two pegmatites and their adjacent gneisses in the York River area have been diamond-drilled and studied in detail.

The gneisses and unzoned pegmatites have rather simple mineralogy with no unusual trace element concentrations and no rare mineral occurrences. Plagioclase is generally unzoned, shows two generations, and ranges from about An_1 to An_{30}. Nepheline compositions cluster around $Ne_{77}Ks_{21}Qz_2$. Microcline is minor and ranges from about Or_{70} to Or_{95}.

The bulk compositions of the pegmatites are $Ne_{67}Ks_{11}Qz_{22}$ and $Ne_{50}Ks_{10}Qz_{40}$ (CIPW norms) and gneiss compositions are similar but highly variable. These compositions cannot be derived by differentiation of known igneous rock compositions, nor can they represent partial melting of the host gneisses unless unrealistically large degrees of melting are postulated.

Many of the compositional and textural features of these rocks can be explained by the hypothesis that post-metamorphic ion-exchange reactions between quartz-poor feldspathic gneisses and NaCl-rich brines have taken place. The reaction:

$$Or + NaCl = Ab + KCl$$

depleted the rocks in Or content (thus the strange pegmatite compositions) and the reaction:

$$An + 2NaCl = Ne + CaCl_2$$

produced nepheline. These reactions result in a second generation of plagioclase higher in Ab. In the presence of quartz the reaction:

$$An + 2NaCl + 4SiO_2 = 2Ab + CaCl_2$$

enriches the rock in Ab and depletes it of quartz. The occurrence of sodalite sporadically throughout the belt shows that NaCl was present. (Authors' abstract.)

ANDRUSENKO, N.I., and SHCHEPOT'YEV, 1974, Temperature conditions and stages of formation of subvolcanic gold-silver deposits of Central Kamchatka: Geokhimiya, 1974, no. 2, p. 179-186 (in Russian; translated in Geochemistry International, v. 11, no. 1, p. 130-137). Authors at Central Scientific Research Institute for Rare and Precious Metal Mining and Prospecting, Moscow.

A multistage character of the mineral formation process has been established at the deposits studied. The thermometry and chemistry of gaseous-liquid inclusions have shown a pulsating mineralization in the sequence: a) copper-molybdenum mineralization from highly concentrated, essentially chloride solutions within the temperature range of 340-70°C; b) gold-silver mineralization from alkaline chloride-sulfate-bicarbonate solutions with carbon dioxide in the ranges of 400-300° (early gold), 320-240 (main gold concentrations), 260-115 (late occurrences); c) mercury mineralization at temperatures 260-105°C. Episodes of solution boiling from CO_2 degassing stimulated ore formation. (Authors' abstract)

ANONYMOUS, 1974a, Resolutions of the 4th Regional Meeting on Thermobarochemistry of Mineral-Forming Solutions: Vysshikh Uchebnykh Zavedenii, Geologiya i Razvedka, 1974, no. 7, p. 212-214. (In Russian)

A review of what was and should be done. (ER)

ANONYMOUS, 1974b, Research group on the equilibrium between fluids and minerals: Nancy, C.R.P.G., C.o. no. 1, 54500 Vandoeuvre-les-Nancy, Franie, 27 pp. (in French).

This is the first of an annual summary of research on fluid-inc-related topics at CRPG, Nancy, somewhat similar in format to the Geophysical Laboratory Yearbook. It includes sections on basic and ultrabasic rocks by Vincent Vehl; the Lynn Lake, Manitoba, nickel dep. by Arthur Barabas; an exper. study of $MgO-SiO_2-H_2O-HCl$ by Chinh Nguyen Trung; U deps. at Bois-Noirs Limouzat (Forez) (Michel Cuney), and the Carswell circular structure in Saskatchewan (Maurice Pagel), and soly. of UO_2 in aq. sols. at high T and P (Alain Lemoine); the Sierrita porph. Cu dep. (Michel Denis; see separate entry, this volume); productive and barren porph. Cu deps. in Iran (Hachem Etminan); alt. of acid rocks (Bernard Charoy); the Chaixmeca heating and cooling stage (B. Poty et al.); the Chaixmeca crushing stage (B. Poty, et al.); a short summary of the NATO-sponsored conference on Fluids in Metamorphism; and a bibliography of publications by the staff. (ER)

ANTHONIOZ, P.M., and VIANA CORREA, Alberto, 1974, Fluid inclusions in chromite. Podiformed chromites of the Precambrian age in northeast Portugal: Acad. Sci. (Paris) C.R., Ser. D, v. 278, no. 26, p. 3271-3273 (in French). Authors at Lab. Petrol. Univ. Nancy, Nancy, France. C.A. v. 2, no. 82, 1975, 19376S.

Liq. inclusions were esp. numerous in the massive chromitite facies, occasionally very dense, sometimes scattered, and rarer in the other facies, such as chromite. The liq. inclusions were rectilinear aligned, of max. 0.2 mm length, oriented on the cubic mesh of chromite. The reticular alignments were established as a no. of small discs 0.001 to 0.025 mm oriented perpendicular to the direction of the alignment. Sometimes, small channels connected the centers of 2 adjacent discs, possibly corresponding to inclusion retractions from initially bigger size. This type of alignment, chronologically the most ancient, could correspond to the stretching along the most feeble d. of primary inclusions, at probable elevated pressures. The alignment, either reticular or curved, had large inclusions, either isolated or forming a very dense mesh, neg. cubic or octahedral, xenomorphic crystals. This mesh of fissures, shown by the presence of liq. inclusions, had developed before the bursting of the nodules. They were mono- or biphased, and in the latter case, the vapor bubbles were 20 to 40% of the vol. of the inclusion. (Authors' abstract)

ANTHONY, T.R., and CLINE, H.E., 1974, Thermomigration of liquid droplets in salt, <u>in</u> Fourth symposium on salt, v. 1, p. 313-321, A.H. Coogan, ed.: Cleveland, Ohio, Northern Ohio Geological Society. Authors at General Electric Research and Development Center, Schnectady, New York.

The salt mine burial of fission waste products resulting from the reprocessing of spent fuel elements is now planned as a permanent means of disposal of these highly radioactive wastes. Although salt mine burial is apparently the best method of disposal, the vigorous self-heating of these waste products leads to some potential problems. Natural salt formations regularly contain small brine inclusions which will migrate up the thermal gradients generated by the self-heating of the waste products. The resulting inflow of water into the nuclear waste crypts is undesirable because water vapor may accelerate waste container corrosion and /or lead to fission product contamination of currently unused sections of the salt mine. In addition, contaminated vapor-liquid biphase droplets generated on the walls of the nuclear waste crypt are capable of dispersing fission products throughout the salt formation since these unusual inclusions migrate down thermal gradients, in contrast to the normal thermomigration of simple gas or liquid droplets up thermal gradients in salt. By considering viscous gas flow, vapor diffusion, liquid diffusion, evaporation and condensation, and liquid currents driven by surface tension gradients, the odd thermomigration behavior of the vapor-liquid droplets observed in the present investigation is explained. It is concluded that a modest dispersal of radioactive wastes may occur in the salt formation. However, because of droplet trapping by the grain boundaries in the salt, the escape of radioactivity to the outside environment is unlikely even on a geological time scale. (Authors' abstract)

ANUFRYEV, Yu.N., MOSKALYUK, A.A., POKROVSKII, P.V. & PURTOV, V.K., 1974 Mineral-forming solutions of hydrothermal deposits of Ural (abst.): Internat. Assoc. on the Genesis of Ore Deposits, Fourth Symposium, Varna, Sept, 1974, Abstracts of Papers: Sofia, IAGOD, p. 241-242. First author at All-Union Scientific-Research Inst. of Synthesis of Mineral Raw Materials, Alexandrov.

(...) Ore-bearing forms. have various connections with magmatism, but genetically all are characterized by precip. of mins. in fractures in assoc. with quartz veins. G/L incs. in quartz of various forms. were investigated by the water leachate method; T, P, amount of CO_2, concs., and densities were determined in individual incs. Comp. in % equivalents as follows:

Ore forms. and quartz types		No. of samples	K	Na	NH_4	Ca	Mg	Cl	F	HCO_3	SO_4
Rock-crystal	1	70	5	60	1	32	2	68	2	22	8
bearing	2	23	7	61	1	30	1	60	3	27	10
Gold-ore	1	16	3	30	1	58	8	32	4	52	12
	2	4	4	34	2	53	7	38	9	42	11
Wolframite	1	11	10	43	1	29	17	35	10	43	12
Scheelite	1	4	6	25	1	43	25	17	1	70	12
Barren	1	33	11	33	2	50	3	27	2	55	16

Note: quartz types: 1 - vein, 2 - rock crystals.

Sols. vary in comp. depending on their evolution, but there are regular differences between sols. of various formations. In quartz of rock-crystal-bearing form. sols. are Cl-Na type; gold-ore form. - HCO_3-Ca; wolframite form. -HCO_3-Cl-Na with increased Mg & F; scheelite form. - strictly HCO_3-Ca with high Mg. Salt concs. range from 1-2 to 30-40 wt%; the highest are during growth of the latest parts of quartz crystals in rock-crystal forms. Sols. have here high concs. of CO_2 (occurrence of incs. of CO_2). Amount of CO_2 in water incls. in quartz of rock-crystal forms. $\leq$ 16 mole %, but in wolframite form. - only 12 mole %. Density of water sols. - 0.6 to 1.0. Growth of crystals in deps. of rock-crystal forms. was accompanied by T decrease from 500-470°C to $\leq$200°C. In Au deps. rock crystal grew at 260-140°C. P. decreases during mineral-forming process caused separation of immiscible CO_2 phase. Ore-bearing quartz of Ural grew from homogeneous sols. unsaturated with CO_2. (...). (Authors' abstract, shortened by A.K.).

ANUFRIYEV, Yu. N., SOKOLOV, Yu. A. and STUPAKOV, G.P., 1973, Aqueous index in quartz from Ural rock crystal deposits: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes

24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 174-175 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at All-Union Scientific-Research Institute for the Synthesis of Mineral Raw Materials, Alexandrov, Sverdlovsk Geological Inst., Sverdlovsk.

(...) The H_2O/CO_2 ratio (aqueous index) in quartz from rock-crystal-bearing and rock-crystal-free veins was determined by the method of Vertushkov and Sokolov. Samples were taken from 3 rock crystal deposits from Ural. Results (Table) of determination of average amounts are expressed in cm^3 of aqueous vapor V_{H_2O} and of gas V_{CO_2} in 100g of quartz sample. Data on determination of general amount of vapor and gas V_G agree with values obtained by loss on ignition.

1. At all 3 deposits there is a consistent, regular decrease of values of aqueous index in the series: quartz of rock-crystal-free veins-quartz of rock-crystal-bearing veins — quartz surrounding the voids and rock crystals.

2. At the third deposit the aqueous indices for vein quartz of rock-crystal-bearing and rock-crystal-free veins are lower than in the other deposits. The difference may be explained by the higher degree of metamorphism of quartz at the third deposit.

These regularities ought to be taken into account during prospecting for rock crystal in the Urals. Authors' abstract abbreviated by A.K.)

Type of quartz	Sample Size	Ignition loss, %	V_G	V_{H_2O}	V_{CO_2}	V_{H_2O}/V_{CO_2}
First deposit						
Rock-xl-free	21	0.11	92.0	72.5	19.5	3.7
Rock-xl-bearing	25	0.09	66.3	48.1	18.2	2.5
Surrounding voids	5	0.06	47.0	32.4	14.6	2.2
Second deposit						
Rock-xl-free	19	0.05	32.1	25.4	6.7	3.7
Rock-xl-bearing	28	0.06	35.8	28.0	7.8	3.6
Surrounding voids	5	0.01	3.5	2.0	1.5	1.3
Third deposit						
Rock-xl-free	31	0.05	42.5	31.5	11.8	2.7
Rock-xl-bearing	28	0.05	39.0	25.8	13.2	1.9
Surrounding voids	8	0.03	26.7	15.9	10.8	1.5

APLONOV, V.S. and GORYAINOV, I.V., 1973, Temperature conditions of formation of the Noril'sk differentiated intrusions (exemplified by the Talnakh intrusion): Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 215 (in Russian; translation through the courtesy of A. Kozlowski). Authors at Scientific-Research Inst. of Geol. of the Arctic, Leningrad.

Melt inclusions in rock-forming minerals of the Noril'sk differentiated intrusions have T_H = 1100-1260°C (Ye.N. Bulgakova and others). In olivines and pyroxenes secondary gas-liquid inclusions were found (T_H = 150-660°C).

On all decrepitation curves peaks occur distinctly at 710-750°C; for pyroxenes of taxitic and trotolitic abbro-dolerites T_D 330°C and 430°C are typical. Most of the decrepigraphs have peaks caused by "overlapped" processes at 290, 330 and 430°C.

High-temp. maxima agree in all varieties of rocks. Sufficiently abrupt decrepitation peaks prove the uniformity of decrepitating inclusions. In taxitic and picritic gabbro-dolerites T_D is sharp at 430-450°C; in olivine gabbro-dolerites this maximum of decrepitation is most distinct at 330°C. (Authors' abstract).

ARKHIPCHUK, R.Z., 1974, Physico-chemical conditions of forming of fluorite deposits of Central Asia (abst.): Internat. Assoc. on the Genesis of Ore Deposits, Fourth Symposium, Varna, Sept., 1974, Abstracts of Papers: Sofia, IAGOD, p. 457-458 (in Russian; translation courtesy A. Kozlowski). Author at Buryatian Geol. Office, Ulan-Ude, USSR.

Fluorite ores in Central Asia province (USSR, Mongolian People's Republic, and People's Republic of China) pptd. in following assocs.: quartz; fluorite + adularia; quartz + fluorite; pyrite + marcasite; quartz + fluorite + hydromicas; calcite + ankerite. Ores formed from homogeneous sols. under conditions: T = 260-60°C, P = 400-50 atm, pH = 5.0-8.5 (USSR); T = 210-70°C, pH = 5.3-8.3 (Mongolia); T = 190-80°C, pH = 5.1-7.8 (China). Commercial assocs. ppted. at 180-120°C. Octahedral fluorite xlized from sols. of pH = 5.0-5.8, and cubic at pH = 6.2-6.7. Late mineral assoc. formed from weakly alkaline sols. Chem. anal. of water leachates showed Na, K, Ca, Mg, Mn^{2+}, Ba, Fe^{3+}. HCO_3, F, Cl, $HSiO_3^{2-}$, SO_4. Components of gas: H_2(3.15 - 6.79 vol. %), C_nH_{2n+2} (6.0-38.09 vol. %), N_2+ rare gases (61.91 - 95.45 vol. %). (Author's abstract, shortened by A.K.)

ARKHIPCHUK, R.Z., and ROSIKHINA, A.I., 1969, Conditions of formation of fluorspar mineralization in the western Transbaikal region according to the paleothermometry: Geol. Rudnykh Mestorozhdenii, v. 11, no. 5, p. 110-113 (in Russian; abstract translated in Econ. Geol., v. 69, 1974, p. 579).

A full translation of this paper will be found in *Fluid Inclusion Research — Proceedings of COFFI*, v. 3, p. 85-88. (ER)

BAKUMENKO, I.T., POPOVA, N.M., and SHUGUROVA, N.A., 1973, On crystallization conditions of lavas of parasitic breaks [craters] of Klyuchevskaya Sopka volcano: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 207-208 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Inst. of Geol. and Geophysics Siberian Branch, Acad. Sci. of USSR, Novosibirsk.

Melt inclusions in phenocrysts and xenocrysts from basalts of the Apakhonchich 1946 lava flow and from basaltic extrusions and flows of the "Piypa Break", are connected with periodic excentric activity of Klyuchevskaya Sopka volcano at Kamchatka. (...) In addition to phenocrysts of olivine, clinopyroxene and plagioclase, the authors found nodules of hyperbasite composition and deep origin, and xenoliths of subsuperficial vein quartz in the lava. Homogenization of inclusions was possible only in phenocrysts of clinopyroxene and xenocrysts of quartz. T_H of primary, pseudosecondary, and secondary inclusions in clinopyroxene phenocrysts were 1325 - 1050°C. In xenoliths of quartz clearly secondary melt inclusions were found (T_H = 1060 - 1070°C). Most intensive trapping of inclusions by clinopyroxene was at 1225 - 1170°C, probably connected with intensification of movement of magma from a transitional magmatic chamber toward surface, closed by excentric extrusion (...). T of lava (pyrometric measurements of S.I. Naboko) was 1160 - 1140°C and is probably somewhat low because it is only a surface measure. Additional low-temperature inclusions were trapped under superficial conditions of the moving lava flow.

(...) In the gas phase of individual melt inclusions (H_2O not determined) in clinopyroxene "N_2 + rare gases" prevailed (97.2 %) in only one case, and other components were absent. In other analyses, the amounts of CO_2 and "N_2 + R.G." either are comparable or CO_2 significantly prevails (up to 93.7 %). Commonly the "acid gases" ($H_2S + SO_2 + SO_3 + HF + HCl$)+$NH_3$ are present (2.3 - 8.7 %) as well as CO (0.2 - 15 %). No relationship was found between T and gas composition. Such large differences in gas composition may be explained only by sharp instability of the crystallization regime and repeated inflow of fresh material.

The above results are comparable with data obtained by the authors on I.T. Kirsanov's material from extrusions and flows of "Piypa Break". Melt inclusions were found in phenocrysts of olivine, clinopyroxene and plagioclase. T_H for inclusions in clinopyroxene was 1290 - 1060°C, with 1 result at 1360°C and the majority of inclusions homogenizing at 1260 - 1160°C. Mechanism of trapping was similar to that described for Apakhonchich flow. Gas analysis data differ somewhat: CO is absent and CO_2 prevails (95.5-70 %) in all analyses, and "acid gases + NH_3" (11.5 - 3.7 %) as well as "N_2 + R.G." (22-0 %) occur in lesser amounts. Absence or scarcity of N_2 is probably caused by the fact that immediately before extrusion of parasitic break, an eruption of the main crater took place. (Authors' abstract, abbreviated by A.K.)

BALDI, P., and FERRARA, G.C., 1974, Hydrochemical features of Northern Latium (Central Italy), with particular reference to the Stigliano thermal springs (abst.): Internat. Symp. on Water-Rock Interaction, Czechoslovakia, Sept. 9-17, 1974, Abstracts: Prague, Geological Survey, p. 10-11 (in English). Authors at ENEL - C.R.G., 56 100 Pisa, Italy.

BALITSKIY, V.S., KASHAEV, N.I., RADYANSKIY, V.M. and NOSOV, S.F., 1973, Investigations of inclusion composition in beryl and emerald and interaction between hypothetical beryl-forming solutions and wall-rocks: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 142-144 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at All-Union Scientific-Research Institute for the Synthesis of Mineral Raw Materials, Aleksandrov.

Composition, phase ratios and T_H of gas-liquid inclusions in emeralds and beryls of various genesis were investigated, and experiments on interaction of beryl-forming solutions with wall-rocks were made. Using 25g samples, F^-, Cl^-, HCO_3^- and SO_4^{2-} were determined by chemical methods, and Mg^{2+}, Ca^{2+}, $Fe^{2+,3+}$ Mn^{2+}, Cr^{3+}, Cu^{2+} by the atomic absorption method, and Li^+, Na^+, K^+, by the flame photometry method. Mineral-forming solutions had bicarbonate-chloride-sodium-potassium compositions with minor amounts of fluoride.

Inclusions in beryl at room temp. are two- and three-phase (G=15%, L_{H_2O}=75%, L_{CO_2}=10%), and in emerald mainly two-phase (G and L_{H_2O}); T_H=210-320°C, P_H=420 atm.

On the base of analyses of water leachates the hypothetical beryl-forming solutions were reconstructed. Action of these solutions on wall-rocks of beryl-bearing bodies (dunites, harzburgites and amphibolites, was investigated. The strongest changes are caused by these solutions in dunites and harzburgites; amphibolites are very passive. In nature, beryl-bearing micaceous rocks also develop by alteration of ultrabasic rocks and almost never were found in amphibolites. (Authors' abstract).

Results of analyses of water leachates of gas-liquid inclusions

Component	Emerald			Beryl			Beryl-2		
	g/l	g.eqv./l	% eqv.	g/l	g.eqv./l	% eqv.	g/l	g.eqv./l	% eqv.
Li	0.037	0.005	2.53	0.04	0.006	3.87	0.09	0.013	5.08
Na	2.92	0.127	64.14	1.94	0.084	54.20	3.37	0.147	57.42
K	1.89	0.048	24.24	1.92	0.049	31.61	2.82	0.072	28.12
Mg	0.04	0.003	1.51	0.02	0.002	1.29	0.11	0.009	3.52
Ca	0.085	0.004	2.02	0.04	0.002	1.29	0.10	0.005	1.95
$Fe^{2+,3+}$	0.20	0.011	5.56	0.23	0.012	7.74	0.18	0.010	3.91
Mn	not found			not found			not found		
Cu	traces			not found			traces		
Cr	not found			not found			not found		
Σcation	5.172	0.198	100.0	4.19	0.155	100.0	6.67	0.256	100.0
HCO_3^-	9.16	0.150	73.89	7.97	0.131	92.25	10.4	0.171	62.64
Cl^-	1.33	0.037	18.23	0.4	0.011	7.75	1.88	0.053	19.41
F^-	0.3	0.016	7.88	traces			0.53	0.028	10.26
SO_4^{2-}	traces			traces			1.03	0.021	7.69
Σanion	10.79	0.203	100.0	8.37	0.142	100.0	13.84	0.273	100.0
Total concentration	15.962			12.56			20.51		

BARATOV, R.B., AFINOGENOVA, L.N., and SAL'NIKOVA, R.N., 1974, Certain differences of magmatism and ore mineralization of geosynclinal and active zones of Central Tadzhikistan and Pamir: Geol. Rudn. Mest., v. 16, no. 4, p. 57-62 (in Russian). Authors at Geol. Inst. of Acad. Sci. Tadzhikistan SSR and Geol. Management Bureau of Tadzhikistan SSR, Dushanbe.

T_H in fluorites of Varzobskiy massif are 50-280°C, of Tokuzbulak deposit - 95-205°C. (A.K.)

BARKER, Colin, 1972, Aquathermal pressuring - role of temperature in development of abnormal-pressure zones: Amer. Assoc. Pet. Geol. Bull., v. 56, no. 10, p. 2068-2071. Author at Department of Chemistry, University of Tulsa.

B. shows that zones of abnormal subsurface pressures, both above and below hydrostatic, can form if the zones become hydrologically isolated. (They behave essentially like large fluid inclusions). (ER)

BARKER, C. and SOMMER, M.A., 1974, Potential method of geobarometry using quartz: Nature, v. 250, no. 5465, p. 402-404.

The amount of water given off on heating synthetic quartz (grown at known pressure) over the range 25° to 1850°C was compared with that found for Arkansas and Brazilian quartz. (ER).

BARKER, Colin and WAGENHOFER, Paul, 1974a, Composition of the gases in primary and secondary fluid inclusions in hydrothermal ore deposits (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 6, no. 7, p. 1020-1021. First author at Department of Chemistry, University of Tulsa, Tulsa, Oklahoma 74104.

The presence of fluid inclusions in hydrothermal minerals provides a unique opportunity to sample the ore-forming fluid together with its associated gases. A technique has been developed for analyzing the gases in fluid inclusions by mass spectometrically monitoring the gases released as temperature is increased. Gases from primary and secondary inclusions are evolved over different temperature intervals and can be distinguished. Water and CO_2 from contaminating clays and carbonates can also be recognized. Quartz and fluorite from the Pasto Bueno base metal deposit N. Peru, have been studied. Water accounts for approximately 90 percent of the volatiles, the balance being mainly CO_2 with lesser amounts of CO, N_2, CH_4, H_2, C_2H_6 and C_3H_8. Secondary inclusions were more abundant than primaries in all samples analyzed and in general the secondaries were richer in CH_4 but poorer in CO_2. At Pasto Bueno crystallization occurred over the temperature interval from >450° to 150°C. CO_2/H_2O ratios varied very little over this whole range with values generally close to 0.1. This is higher than the values found for Mississippi Valley type deposits. CH_4/H_2O ratios increased at times of tungsten deposition possibly due to the addition of ground water.

Isotopic data are consistent with this concept. The presence of increased amounts of methane and higher hydrocarbons in primary fluid inclusions may be a generally-applicable indicator of meteoric water influx. (Authors' abstract)

BARKER, Colin, and WAGENHOFER, Paul, 1974b, Volatile content of the fluid inclusions in hydrothermal minerals from ore deposits (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 6, no. 2, p. 95 (note-volume incorrectly titled "v. 5"). First author at Dept of Chem., Univ. of Tulsa, Tulsa, Okla.

The presence of fluid inclusions in the hydrothermal minerals from ore deposits provides a unique opportunity to sample the volatiles associated with the ore-forming fluids. Primary inclusions form at the same time as the mineral and trap a representative sample of the solution depositing the crystal. Secondary inclusions, however, form later by rehealing of cracks. Techniques have been developed for distinguishing between the gases obtained from these two generations of inclusions, by heating mineral samples in vacuum at a steady rate (2.5 or 5.0°C/min) and monitoring the evolved gases with a mass spectrometer. Secondary inclusions rupture first and their gas content can be distinguished from the gases evolved from the primaries which rupture at higher temperatures. Gases produced by the thermal breakdown of contaminating clays and carbonates also can be identified using the procedure. The gas release-versus-temperature curves were used in selecting the temperature intervals over which the evolved gas was collected for quantitative mass spectrometric analysis. Quartz and fluorite from ore deposits in England and Peru have been analyzed. In all cases water accounts for >95% of the volatiles, the balance being mainly CO_2 with less amounts of CH_4, CO, H_2 and N_2. The volume of water released can be used to calculate the volume of the fluid inclusions ruptured. This, together with the volume of CO_2, permits an estimate of the partial pressure of carbon dioxide at the time of mineralization. The values obtained are consistent with those deduced from mineral equilibria. (Authors' abstract).

BARLIER, Jacques, RAGOT, Jean-Paul, and TOURAY, Jean-Claude, 1974, The evolution of the Terres Noires from the French Alps, from a study of clay mineralogy and reflectivity of organic particles: B.R.G.M., Bull., Ser. 2, Sect. II, no. 6, p. 533-548 (in French).

Maps of the geographic distribution of various clay minerals and of the reflectivity of solid organic particles (see also Touray and Barlier, 1974, in this volume) are used to produce a map of the geographic distribution of temperature maxima for the formation. (ER)(See also paper by Touray and Barlier, 1974, this volume)

BARLIER, Jacques, and TOURAY, Jean-Claude, 1974, The application of three methods of geothermometry to a study of the thermal history of the "Black Earths" (Terres Noires), (Die-Nyons-Digne-Barcelonnette quaddrilatéral, France): Réunion Annuelle des Sciences de la Terre, 2ème, Pont-à-Mousson, April 1974, p. 27 (in French). First author at Laboratoire de Géochimie des Roches Sédimentaires, Université de Paris-Sud, 91405 - Orsay, France.(See preceding paper)

BARNES, Ivan, 1974, Metamorphic fluids of flysch deposits (abst.): Internat. Symp. on Water-Rock Interaction, Czechoslovakia, Sept. 9-17, 1974, Abstracts: Prague, Geological Survey, p. 59 (in English). Author at U.S. Geol. Surv., Menlo Park, Cal., USA.

BARNES, Ivan, and MILLER, T.P., 1974, Geothermal Studies in Alaska (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 6, no. 7, p. 645-646. First author at U.S. Geological Survey, Menlo Park, California 94025.

Samples were collected from hot springs in Alaska as part of a geochemical reconnaissance of areas of potential geothermal resources. Most of the waters are of local meteoric origin and show slight enrichments in O^{18} relative to nearby cold springs, presumably due to reaction (exchange) with the rocks through which the water flows. The moderately high chloride and sodium concentrations (up to 3,000 milligrams/liter) in hot springs of southeastern Alaska and the Seward Peninsula are best explained by leaching of solutes from the rocks rather than from the mixing of a more concentrated brine of a different deuterium concentration with locally derived meteoric water.

The chloride and bicarbonate rich waters of the Copper River Basin near Gulkana are definitely of nonmeteoric origin and are derived most likely from de-watering and metamorphism of marine sediments buried under fluvioglacial sediments. (Authors' abstract)

BARSUKOV, V.L., 1974, Main features of geochemistry of tin: Moscow, "Nauka" Pub. House (150 pp., in Russian; abstract courtesy A. Kozlowski).

T and P of tin-bearing hyd. sols. (p. 81-91) as well as their chem. comp. (p. 91-107), CO_2 conc. and pH (p. 107-112), are evaluated on the basis of fluid incs; the author probably uses mainly reference data.

BARSUKOV, V.L., GLADYSHEV, G.D., KOZYREV, V.N., LAVEROV, N.P., and MALYSHEV, B.I., 1972, Conditions of forming of deposits of uranium in volcanic depressions: Moscow, "Atomizdat" (312 pp; in Russian; abstract courtesy A. Kozlowski).

Parent magmatic rocks: quartz porphyries and felsite porphyries, bear phenocrysts of quartz and feldspars with melt incs. having T_H = 1030 - 1320°C (p. 22-23). Quartz, feldspars and hematite from veins gave T_D = 300 - 330°C, T_H = 295 - 340°C (p. 36-37). Veins of albite, quartz, fluorite, apatite, calcite and pyrite xlized at ∿200°C (T_H; T_D = 180-220°C); T_H in calcite 228-240°C, in fluorite 185-210°C. Late calcite bears one-phase incs., T xliz <80°C (p. 41-43). Pitchblende I gave T_D 130-150°C, and paragenetic with it calcite II - T_D = 120-150 and T_H = 107-137°C, and fluorite II - T_D = 130°C, T_H = 110-135°C (p. 70-72). The second paragenetic assoc. (pitchblende I, pitchblende II and molybdenite, galena, sphalerite) gave T_D and T_H 100-120°C (p. 78-79). Secondary GL incs. in quartz of wall rocks homog. in intervals: 90-115, 140-165, 205-240 and 295-320°C (p. 87-88). Water leachates prove following comp. of sols: pitchblende I H_2O, %: 1.10-4.30; ions, g/1, Na 0.02-1.3; K 0.01-0.04; Ca 2.4-10.9; Mg 0.0-0.7; Cl 0.0-07; SO_4 3.0-22.5; HCO_3 0.12-21.4; Li 0.000-0.014; F 0.0-0.3; total salts 8.01-40.8; CO_2 0.22-0.44 molar; also results of analysis of water leachates from calcite II and galena are given, (p. 227-233).

BASS, M.N., 1974, Secondary minerals in basalt, DSDP Leg 34 (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 6, no. 7, p. 646. Author at Department of Terrestrial Magnetism, 5241 Broad Branch Road, N.W., Washington, D.C. 20015.

Deuteric hydrous phases occur rarely in coarse rocks; only mica was definitely identified (Hole 321). Well-crystallized diagenetic(?) smectite replaces almost all Fe- and H_2O-rich, chemically labile interstitial glass. (Author's abstract, abbreviated)

BASSETT, W.A., and KINSLAND, G.L., 1973, Trip H-Mineral collecting at Penfield Quarry, in P.C. Hewitt, ed., Guidebook to Field Trips, 45th Annual Meeting, New York State Geological Association, pp. H1-H9. Authors at Department of Geological Sciences, University of Rochester, Rochester, N.Y.

A brief description of the minerals (including sphalerite and celestite) to be found in vugs in the Lockport Dolomite, and a discussion of their possible relationship to Mississippi Valley-type mineralization. (ER)

BAUMAN, L., STEMPROK, M., TISCHENDORF, G., and ZOUBEK, V., 1974, Metallogeny of tin and tungsten in the Krušné Hory-Erzgebirge: Pre-Symposium Excursion Guide: Prague, Geological Survey, 66 pp (in English).

An excellent summary of the complex geology of this tin-tungsten district, prepared in connection with the Symposium - Metallization associated with acid magmatism, Karlovy Vary, ČSSR, Oct, 1974. (ER)

BAYBULATOV, E.V., GROSHEV, A.K., SOLOMOVICH, L.I. and TURYAEV, R.T., 1973, Vertical temperature zonation as a criterion for search of hidden rare-metal ore mineralization (exemplified by a certain tin-tungsten deposit): Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 329-331 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Inst. of Geology of Acad. Sci. of Kirgiz SSR.

Ore mineralization (at this deposit) is exposed at the surface at two points, corresponding to low and high levels in the deposit, and for 500 m horizontally. The lower outcrop is connected with a group of greisenized granites of the third phase of the Upper Carboniferous - Permian intrusive complex. The group disappears in wall-rocks under the mineralized upper outcrop (occurring 400-500 m higher). The slope between the two outcrops is covered by Tertiary and Quarternary deposits.

Ore bodies of lower outcrop consist of vein-greisen forms with some distinguished facies: a/ quartz-tourmaline, T - 340-385°C; b/ quartz-feldspar, T - 330-350°C; c/ quartz, T - 260-300°C; d/ quartz-fluorite, T - 270-330°C; and vein quartz, T - 195-205. Rare metal ores in greisens consists of wolframite, scheelite, molybdenite, bismuthite, and cassiterite; sulfides are scarce.

Ore mineralization of the upper outcrop occurs in clayey-sandstone rocks of Upper Carboniferous age altered into hornfelses under action of leucocratic granites. Zones of greisenization were observed, among them rocks of the following facies: quartz-tourmaline (295-320°C), quartz-fluorite (260-270°C), quartz (225-250°C) and vein quartz with hematite (160-170°C). Very scarce scheelite is the sole rare-metal mineral.

Greisens of the upper outcrop are overlapped by sulfide mineralization, forming a zonal sequence in the exposed section. From the top downward the composition of mineralization changes in agreement with an increase of temperature of origin: hematite, galena, sphalerite, chalcopyrite, arsenopyrite, pyrrhotite.

On the basis of geological-structural, mineralogical-geochemical and thermometric data, the common genesis of vein greisens and ore mineralization at the lower and upper outcrops was accepted. The indicated gradient of mineral origin (30-50°C) depends on the distance from the mass of the granites. Main rare-metal mineralization occurs at the external greisen zone in vertical interval 0-25 m from the upper contact of granites, and this is taken into account during prospecting. (Authors' abstract).

BAZAROV, L.Sh., 1974, Primary crystalline inclusions and photoelastic effect in tourmaline, in Mineralogy of endogenetic deposits, Yu. A. Dolgov and V. S. Sobolev, eds.: Novosibirsk, Acad. Sci. USSR, Sib. Branch, Inst. Geol. and Geophys., p. 131-136 (in Russian; abstract courtesy A. Kozlowski).

The phenomenon of photoelastic effect in tourmalines, connected with primary crystalline inclusions, was described. Temperatures of disappearance of photoelastic effects were found to be 510°C, vs T_H of primary fluid inclusions = 550-510°C. The solid inclusions are probably beryl crystals.

BAZAROV, L.Sh., GORDEEVA, V.I., and AKIMTSEV, V.A., 1974, Temperature conditions of beryl crystallization in apogranite, in Mineralogy of endogenetic deposits, Yu. A. Dolgov and V. S. Sobolev, eds.: Novosibirsk, Acad. Sci. USSR, Sib. Branch, Inst. Geol. and Geophys., p. 65-74 (in Russian; abstract courtesy A. Kozlowski).

Beryl crystal aggregates from gneisses (0.2-5 cm) and quartz-topaz-beryl veins were studied. Four genetic types of inclusions were found:

(1) Primary solid crystalline (beryl, mica and xenoliths of rock).

(2) Primary solution-melt. The inclusions occupy up to 10-20% by volume of milky zones in beryl. Uniform phase relations are: gas (10-20 vol. %) + liquid CO_2 (15-40 vol. %) + aqueous-salt solution (20-45 vol. %) + nine solid phases (20-65 vol. %). Homogenization: gas + liquid CO_2 at 26-28°C in liquid; aqueous solution + liquid CO_2 at 260 to 390°C, by elimination of CO_2; liquid phase + solid phases at 520 to 740°C in liquid phase (complete homogenization). There are no easily soluble chlorides. Pressure at 720°C - 4500±500 atm, fluid density 1.75 $g \cdot cm^{-3}$.

(3) Pseudo secondary solution-melt. Similar to the primary type, T_H520 to 710°C. Another type was also round: gas (up to 15%) + liquid

CO_2 (up to 35%) + aqueous solution (up to 60%) + isotropic solid phase with regular meniscus (probably silicate glass). T_H range the same as above. Rapid cooling of homogenized inclusions forms glass with contraction bubbles.

(4) Secondary gas-liquid, with various phase relations and T_H 110-370°C.

The primary inclusions indicate the conditions of origin of the greisens.

BAZAROV, L.Sh., KLYAKHIN, V.A., and SENINA, V.A., 1974, Solution-melt primary inclusions in emeralds of Ural, in Mineralogy of endogenetic deposits, Yu. A. Dolgov and V. S. Sobolev, eds.: Novosibirsk, Acad. Sci. USSR, Sib. Branch, Inst. Geol. and Geophys., p. 96-108 (in Russian; translation courtesy A. Kozlowski).

Investigated beryls were found in pegmatites of Izumrudnye Kopii at Ural. Special care was paid to the problem of primary origin and necking-down. Over 3000 temp. measurements were made, of which only 200 were used as suitable for genetic interpretation (sic). The criteria for primary origin are presented. Four genetic types of inclusions were found:

(1) Primary solid (phlogopite, actinolite, etc.)

(2) Primary solution-melt: gas + liquid CO_2 + solution + phlogopite + plagioclase? + two unknown minerals in the following volume percents: 5-10, 5-20, 20-50, and 20-50 (all crystals). Course of homogenization: gas + liquid CO_2 in liquid at 28-30°C, liquid CO_2 + water solution in water solution at 230-410°C, water solution + crystal phases in liquid (melt) at 470-680°C. Homogenizations of primary inclusions in central parts of crystals were not reached; probably T_h of those inclusions is $\sim$750°C. P at about 700°C - 3500 atm ± 500 atm, depth of pegmatite formation about 12 km. Denisty of fluid at 670°C - 1.75 to 1.85 g/cm^{-3}. Melt is highly viscous at T_H.

(3) Pseudosecondary inclusions, similar to primary ones with T_H 490 to 650°C.

(4) Secondary gas-liquid inclusions are very numerous, T_H 310 to 150°C, in liquid phase.

In colorless clear late beryl primary inclusions (10-30% gas + water solution) homogenized at 280-180°C in liquid phase. No soluble salts were found.

BEANE, R.E., 1974a, Biotite stability in the porphyry copper environment: Economic Geology, v. 69, p. 241-256.

Hydrothermal biotites from the potassic alteration zone of North American porphyry copper deposits are compositionally different from igneous biotites in typical granitic-granodioritic host rocks. Whereas such igneous biotites generally have molecular ratios of Mg/Fe <1.0, alteration biotites appear to be characterized by Mg/Fe >1.5 and $Fe^{+3}/Fe^{+2}<0.3$. Evaluation of mixing parameters for the Mg^{+2}-Fe^{+2}-Fe^{+3} substitution in biotite provides a geothermometer for the potassic zone which is based on the composition of biotite coexisting with magnetite and K-feldspar. Temperatures determined for potassic alteration at Santa Rita, New Mexico, and Ray and Safford, Arizona, lie in the range 350° to 410°C; Bingham, Utah, and Galore Creek, British Columbia, which contain significant amounts of bornite, are characterized by slightly higher temperatures (450° to 550°C). Such temperatures are in general agreement with those determined from stable isotope and fluid inclusion studies. Conclusions regarding a magmatic or meteoric source for a hydrothermal fluid based upon hydrogen and oxygen isotope contents of biotite and quartz may be greatly influenced by the characteristically low Fe^{+3}/Fe^{+2} ratio of alteration biotite and its effect on exchange properties of hydrogen in the hydroxyl position.

Calculated equilibrium relations among biotite, magnetite, K-feldspar, chalcopyrite, and pyrite, which commonly occur together in the potassic zone, provide provisional chemical characteristics of a coexisting aqueous phase at a temperature of 350°C. Such a solution is maintained in the liquid phase region in spite of low pressures (<250 atm) by large concentrations (≈6 molal) of NaCl. The calculated $f_{O_2} = 10^{-27}$ is such that aqueous sulfur occurs chiefly as sulfate, at $f_{S_2} \approx 10^{-7}$. Examination of calculated fluid compositions as a function of pH suggests that the hydrothermal solution is only slightly acidic, but contains on the order of 1,000 ppm dissolved copper and sulfur. Dissolved iron, on the other hand, appears to attain less than 1 ppm if only chloride complexing is considered. This fluid composition is compatible with the low total sulfide and copper contents characteristic of rocks from the potassic zone. (Author's abstract).

BEANE, R.E., 1974b, Barite-fluorite-galena deposits in South-Central New Mexico: A product of shallow intrusions, groundwater and epicontinental sediments (abst.): Econ. Geol., v. 69, p. 1176. Author at Geoscience Department, New Mexico Institute of Mining and Technology, Socorro, New Mexico.

During the Oligocene, south-central New Mexico underwent extensive near-surface intrusion of monzonitic dikes and sills, many of which are now accompanied by small magnetite replacement deposits. Previous work on such occurrences points toward groundwater transport of iron derived from Permian redbeds in the adjacent geologic column. Barite also appears in a similar spatial relationship to these intrusives. Local intraformational waters associated with modern evaporites in southcentral New Mexico exhibit comparatively high halide and sulfate contents as a result of circulation through evaporite-carbonate units in the middle-Permian Yeso Formation. Such brines undoubtedly provide a present-day analogue to groundwaters which occurred in this region during the middle-Tertiary. The shallow intrusives provided sufficient heat to elevate the temperatures of these saline waters to 150°-200°C. Certain clastic units in the lower-Permian Bursum and Abo Formations consist of arkosic detritus derived from Precambrian granitic rocks; these units contain significant amounts of lead and barium which substitute in potassic feldspar. Chemical interaction between circulating basin brines and Permian arkosic material resulted in local generation of hydrothermal fluids containing all of the components necessary to form the widespread barite-fluorite-galena occurrences in south-central New Mexico. This mineralization, which occurs as limestone replacements and fracture fillings, was localized by structures associated with contemporaneous rifting of the Rio Grande graben. Fluid inclusion and stable isotope data indicate a common genetic link among numerous deposits. Differences in detail exhibited by individual deposits is chiefly a result of variability in both the thermal histories of the brines, and the sediments with which they came in contact. (Author's abstract)

BEDINGER, M.S., SNIEGOCKI, R.T., PEARSON, F.J., Jr., and REED, J.E., 1974, The thermal springs of Hot Springs National Park, Arkansas (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 6, no. 7, p. 648-649. First author at U.S. Geological Survey, Little Rock, Arkansas 72201.

The geochemical data, flow measurements, geologic structure, and digital models of flow and head support the concept that virtually all water that flows from the hot-springs artesian-flow system is from infiltration of precipitation on several square miles of outcrop within about 10 miles (16 kilometers) of the hot springs. (Authors' abstract, abbreviated).

BELEVTSEV, Ya. N., and KOVAL, V.B., 1973, Inclusions in quartz of ferriferous quartzites from the Krivoi Rog: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 235-236 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Inst. of Geochemistry and Physics of Minerals Acad. Sci. of Ukrainian SSR, Kiev.

Studies of T_H and composition of inclusions were made in quartz from a regional section from lamellar and crosscutting veinlets in ferriferous quartzites of various levels of the K_2-complex of the Krivoi Rog Fe-ore region.

For N. Krivoi Rog, pseudosecondary G-L inclusions with T_H 316-370°C (0.006-0.01 mm long), sometimes bearing liquid CO_2, are characteristic. Not far from veins of aplite-like granites (Zholtaya River region), as well as in crosscutting quartz veins from Annovskiy Quarry, a major amount of halite-bearing inclusions was found, T_H (partial) 136-163°C, T_H (full) 325-372°C; halite occupies 15-25 vol. % of vacuole. In zones of metasomatic development of quartz and biotite the following inclusions were found: L_{H_2O} (55%) plus NaCl (15%) plus L_{CO_2} (25%) plus G (5%), proving high pressures of fluid during the mineral-forming process. Two-phase G-L inclusions (0.005-0.007 mm) occurring alone or in groups (T_H 267-230°C) are later than above.

Quartz from Central Krivoi Rog is enriched in one-phase liquid CO_2 inclusions and two-phase inclusions L_{CO_2} plus G (T_H = 26 to 30°C), with dimensions 0.003÷0.008 mm. Among two-phase inclusions the groups of pseudosecondary (T_H 360 to 252°C) and secondary ones (T_H 247 to 218°C) are most important. No similar T and inclusion types were ascertained for regions of S. Krivoi Rog.

Inclusions of L_{CO_2} plus G are the most common group in crosscutting and lamellar quartz (T_H 26 to 31°C)[2]. In addition to inclusions L_{H_2O} plus G, only individual inclusions homogenize in gas (T_H 394 to 409°C). (Authors' abstract).

BELEVTSEV, Ya.N., and MEL'NIK, Yu.P., 1974, Genetic problems of Precambrian iron ore-bearing formations: Geol. Rudn. Mest., v. 16, no. 5, p. 66-76 (in Russian; abstract courtesy A. Kozlowski). Authors at Inst. of Geochemistry and Physics of Minerals of Acad. Sci. Ukrainian SSR, Kiev.

The authors discuss T_D data by Gusel'nikov (quartz of pyroxene-bearing ferriferous quartzites of Kursk Magnetic Anomaly - T_D = 425°C, less metamorphosed hematite-magnetite jaspilites - T_D = 600-800°; Gusel'nikov, V.N., 1972, Genetic problems of iron ore formations of KMA, "Nauka", Moscow) and present new T_H data, ranging from 348 to 434°C in quartz layers of jaspilites and from 205 to 580°C in quartz veinlets cutting jaspilites.

BELEVTSEV, Ya.N., SAKHATSKY, I.I., MAKIVCHUK, O.T., and OBRIZANOV, V.N., 1973, On Precambrian sodium metasomatites: Geol. Zhurnal (Kiev), v. 2, p. 120-125 (in Russian; abstract courtesy T. M. Sushchevskaya).

Precambrian U- and Au-bearing Na-metasomatites, confined to large deep zones of fracturing, were studied. U and Au are localized in the inner parts of metasomatic albitites. The main rock-forming minerals of albitites are: albite, aegirine, alkaline amphiboles, quartz, microcline, carbonate, and sphene. U mins. include oxides, silicates, and titanates. Ore mins. include pyrite, gold, Fe hydrooxides, and hematite. T_H of G/L inc. provided the T limits of formation of albite, quartz, and carbonates:

Mineral	Number of measurements	Generation	T_H°C
Albite (from plagioclase and microcline of original rocks)	126	I	210-280
Albite (fine tabular in blastocataclase zones)	64	II	150-180
Albite (from crosscutting veinlets)	10		127-140
Quartz (fine-grained mosaic aggregates)	52		140-170
Quartz (from crosscutting veinlets)	10		120-140
Carbonate (large separate grains, group of grains with polysynthetic twinning)	30	I	200-220
Carbonate (from crosscutting veinlets)	34	II	107-140

Taking into account close association of U-minerals and gold (II) with carbonate (I), the authors concluded that most Au and U minerals formed in the T range -200-220°C. This correlates well with experimental data on transport and deposition of these metals under hydrothermal conditions.

BENEŠOVA, Z., DURIŠOVA, Jana and MRNIA, F., 1974, Variscan and Alpine mineralization in Krusne Hory (Czechoslovakia) (abst.): Internat. Assoc. on the Genesis of Ore Deposits, Fourth Symposium, Varna, Sept., 1974, Abstracts of Papers: Sofia, IAGOD, p. 243-245 (in Russian; translation courtesy A. Kozlowski). Authors at Central Geol. Inst., Praha, CSSR.

(...) Variscan mineralization in E part of Krusne Hory consists of Sn-W form. (Cinovec, Horni Krupka, Preiselbert) (...). Alpine metallogenesis has given deps. of polymetallic ores (Roztoki) and fluorite (Jilove). (...).

1. Sn-W form., investigation of cassiterite and quartz. a) Preiselberk deposit — quartz veins with cassiterite at the contact of extrusive quartz porphyry with granite and gneiss. Cassiterite formed at 440-370°C (mainly 410-390°C) from fluid in state close to critical. Conc. of salts (cryometric) in ore-forming sols. did not exceed 8% NaCl equiv. Quartz crystallized at 500-270°C, including some individual, separated stages: concs. vary from 3 (in gaseous incs.) to 40% of NaCl equiv. (in incs. bearing solid phases), and CO_2 was verified cryometrically. Na/K ratio (water leachates) varies with T_H interval. b) Lukaš - cassiterite-wolframite vein. Incs. in quartz have conc. sols.; T_H of P. incs. 500-300°C. The lower the T_H the lower the conc. of sols. c) Barbora vein, Preiselberk dep.- Quartz from quartz-molybdenite veins contains two-phase and polyphase incs., T_H 430-340°C.

2. Sn-W dep. Cinovec. Pre-cassiterite quartz studied: two-phase incls. with <10 vol. % gas, T_H $\sim$200°C, and two-phase incs. with $\sim$50 vol. % gas, T_H (in liquid) $\sim$360°C.

3. Fluorite deps.: T_H - Jílové 125-115°C, Vrhoslav 160-110°C, Moldava 165-110°C, Hradište 120-95°C, Blahun'ov 120°C, Horni Krupka 150-

135°C. Sol. concs., in % NaCl equiv.: Vrhoslav and Moldava 13-22, Hradište 16-nearly nil, Na/K ratio 14.0-14.8 (water leachates).

The data establish a) small changes of T of origin of typomorphic minerals (cassiterite, fluorite) at deps. of the same type; b) presence of 2 types of fluorite mineralization at Krušne Hory area (...); c) possibility of T comparison of quartz at various deposits of the same formation (...); d) (...) usually most conc. sols. were the highest T ones; e) Na/K ratio in incs. can be used for evaluation of range of T of mineral form., especially when incs. suitable for T_H are lacking. (Authors' abstract, shortened by A.K.)

BENIDZE, G.M., TVAL CHRELIDZE, T.A., MINDYASHVILE, T.N., and CHICHINADZE, M.K., 1973, Stages and temperature conditions of formation of copper-pyrrhotite and polymetallic ore mineralization of Gornaya Kakhetia (E. Georgia): Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 326-328 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Main Geological Office, Caucasian Inst. of Mineral Raw Materials, Tbilisi.

Investigated mineralizations are of vein type, formed by filling of open fractures. Ore formation was a single process, with some breaks (alteration stages of mineralization). Following stages were distinguished: I pre-ore-quartz with albite and sericite, sometimes with ilmenite and sphene; II quartz-pyritic with subordinate chalcopyrite and sometimes marcasite; III copper-pyrrhotitic with paragenetic associations: a) quartz-chlorite-pyrrhotite-chalcopyrite with cubanite, valerite and mackinawite and sometimes with pentlandite; b) quartz-calcite-pyrrhotite-sphalerite with chalcopyrite, cobaltite, linnaeite, sericite and siderite; IV polymetallic with paragenetic associations: a) quartz-pyrite-sphalerite with chalcopyrite and b) calcite-sphalerite-galenite with siderite; post-ore V chlorite-carbonate with quartz and sericite.

Together with above in some ore mineralized outcrops of Gornaya (=Mountainous) Kakhetia, the Au-Bi-Te-As mineralization occurs in association with pyrite, siderite and hydromica, which by analogy with rare metal mineralizations of W regions of S slope of Great Caucasus one may presume the late ore formed in connection with Tertiary magmatism.

Junction of products of various stages of mineralization caused the forming of "mixed" ore mineralizations.

These stages of mineralization were verified by mineral-thermometric studies made by decrepitation on pyrite, pyrrhotite, chalcopyrite, sphalerite, galena, quartz and calcite. The last two minerals were also studied by the homogenization method. Stages of crystallization were distinguished very distinctly. Sulfides were characterized by relatively narrow ranges of T_D (mass decrepitation).

T range of forming of studied mineralizations is relatively wide: 460-120°C. Uneven abrupt decrease of T was ascertained in accordance with stages of ore forming. Minerals of pre-ore stage originated at high-temp. conditions (460-400°C).

II stage (T_D of quartz II and pyrite I) - 390-360°C, T_H of fluid inclusions in quartz - 390-380°C. Stage IIIa - 340-280°C, IIIb - 300-220°C. Stage IV - 280-240°C, post-ore stage V - 180-120°C. (Authors' abstract, modified by A.K.)

BENKA, Jozef, 1973, Mineralogy and geochemistry of siderite from the

Milynky and Vlachovo deposits: Geol. Pr., Spravy, v. 61, p. 89-99 (in Slovakian).

Decrepitation of siderite occurred at 310-380°C. (ER).

BENNETT, R.E., Jr., 1974, Fluid inclusion study of sphalerite from the northern Arkansas zinc-lead district; M.S. thesis, University of Michigan, 157 pp.

Samples from 29 mines were studied. T_H was 80 to 140°C. No compressed gas and no oil was found. The salinity ranged from 19 to >23%, and the density at T_H ranged from 1.07 to 1.15 g/cm^3. The origin is assumed to be heated connate brines. (ER).

BERZINA, A.P., and SOTNIKOV, V.I., 1973, Certain specific features of composition and state of mineral-forming solutions of the Kal'makyr deposit: Geol. Rudn. Mest., v. 15, no. 4, p. 44-50 (In Russian; abstract courtesy A. Kozlowski). Authors at Inst. of Geology and Geophysics of Siberian Branch of Acad. Sci. of USSR, Novosibirsk.

Kal'makyr Cu-Mo dep. is connected with granodiorite porphyries, the quartz of which bears incs. with T_H = 840-860°C (P?) in gas and 380-390°C (S). Sericitized granodiorite porphyries contain new-formed quartz bearing 3 types of incs.:

1. Essentially gaseous (G (60-80%) + halite (5-7%) + ore mineral), T_H (in G) = 550-800°C, NaCl conc. 37-47%, P at T_H 1000 atm; 2. Two-phase incs. homog. in gas at 370-400, in L at 330-350, and at 375°C with critical phenomena; 3. Incs. with halite and sylvite, T_H = 400°C, NaCl conc. 34%, P = 200 atm; some incs. had comp. NaCl 33.8, KCl 32.5, H_2O 33.7%. Incs. in sericite had T_H = 330-350°C. At 400°C boiling of sol. occurred.

In quartz-muscovite-alunite-molybdenite veins in quartz incs. gave T_H = 380-410°C with homo. in G or 330-380°C in L, (these incs. have molybdenite inside vacuole). Critical phenomena occur at 395 and 380°C.

Silicified granodiorite-porphyries bear quartz with incs. (G + L + halite and G + L + halite + sylvite) homog. at 440-470°C, P = 1100 atm, NaCl conc. 51%,or at 360°C, NaCl 23% + KCl 41% + H_2O 36%, and with essentially gaseous incs., T_H 380-500°C. Some quartz xls in nests bear incs.: NaCl 26% + KCl 43% + H_2O 31%, homog. in G at 580°C. Minute S incs. have T_H 220-290°C, similar to those in quartz-sulfide veins.

For quartz of silicified and sericitized syenite-diorites the following T_H are typical: 800°C (in G), 510-540°C (in G) 410-510°C (in L), 375°C (in L: incs. bearing halite, hematite and cubic ore dm.).

In quartz-pyrite-chalcopyrite veins the sequence of T_H from the side to center is: 720-510-375°C.

BEST, M.G., 1974, Mantle-derived amphibole within inclusions in alkalic-basaltic lavas: Jour. Geophys. Research, v. 79, p. 2107- 2113
Author at Department of Geology, Brigham Young University, Provo, Utah 84601.

Amphibole in mantle-derived inclusions in alkali-basaltic rocks occurs in four textural modes: veins and interstitial grains in chromian-spinel peridotite, poikilitic grains in igneous textured inclusions, and megacrysts. Over 90 available chemical analyses demonstrate that compositions vary widely, from Fe-Ti-rich kaersutite to richterite-pargasite solid solutions containing high concentrations of Na, Cr, and Mg. No particular composition occurs more frequently than any other. Amphiboles in the uppermost mantle are produced by precipitation of hydrous fluids that migrated upward from deeper hotter regions of the mantle where they originated by partial melting in the low-velocity zone and possibly by other but poorly understood processes of "dewatering" the mantle. These fluids are conceived to have a wide range of composition, depending upon the degree of initial partial melting and the amount of mantle peridotite through which they traveled and scavenged incompatible elements. Further diversification could occur in the zone of precipitation in the uppermost mantle owing to complex reactions with the chromian spinel peridotite wall rock. Vein and poikilitic amphiboles crystallize from fluids of probable nephelinitic to basanitic composition arrested during ascent into cooler parts of the uppermost mantle. Relatively larger masses in the same composition range crystallize as varied assemblages of pyroxenes, olivine, and Cr-poor spinel enclosed by late-formed amphibole. Fractionation in these masses provides another mechanism for producing diverse compositions in potential amphibole-forming fluids. Megacrysts represent fragmented veins and regions without anhydrous crystal accumulation in possible cumulate bodies. In contrast to vein and poikilitic occurrences, interstitial amphiboles appear to be in chemical equilibrium with their surrounding host assemblages of anhydrous phases. But, again, chemical compositions vary, correlating somewhat with the particular host phase assemblage and suggesting interaction between wall rocks and small volumes of hydrous, perhaps even aqueous, fluid. Certain textural relations suggest that reactions such as spinel + diopside + aqueous fluid → amphibole may have operated. In a dynamic (flowing) mantle, superposition of plastic deformation, recrystallization, partial melting, and invasion by potential amphibole-forming fluids will make the history of a mantle-derived peridotite sample very complex. These factors, combined with the variety of variables influencing the compositions and manner of crystallization of amphibole, make the meaning of statements on "primary" amphibole in the uppermost mantle difficult to evaluate. (Author's abstract.)

BETTETINI, E., 1974, The application of macro- and micro-cinematography in the studies of the crystals' and gems' inclusions, particularly the fluid inclusions - color-sound film (abst.): Internat. Mineral. Assoc. Ninth Gen. Meeting, West Berlin and Regensburg, W. Germany, Collected Abstracts: West Berlin, German Mineralog. Soc., p. 24 (in English). Author at Nice, France.

See next item.

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BETTETINI, E., and Turco, Guy, 1974, The utilization of macro- and micro-cinematography applied to the study of inclusions, particularly of fluids, in crystals and gems: Soc. franc. de Min. et Crist., Bull., v. 97, no. 6, p. XII (in French).

An abstract covering the showing of a film of the same title. See Bettetini, 1973, Fluid Inclusion Research — Proc. of COFFI, v. 6, p. 20, 1973. (ER).

BEUS, A.A., and MINEEV, D.A., 1974, On geology and geochemistry of emerald-bearing zone Muzo-Cosques, E. Cordilleras (Colombia): Geol. Rudn. Mest., v. 16, no. 4, p. 18-30 (in Russian). Authors at All-Union Correspondence Polytechnical Inst., Moscow, and Inst. of Mineralogy, Geochemistry and Crystallochemistry of Rare Elements, Moscow.

Emerald-bearing quartz from Tecuendama gave T_H = 280-380°C; p. 28.(A.K.)

BIBBY, D.M., FESQ, H.W., and SELLSCHOP, J.P.F., 1974, Oxygen in natural diamonds: Evidence for the presence of oxygen-containing volatiles: South African Jour. of Sci., v. 70, p. 377-378. Authors at NIM-WITS Activation Analysis Research Group, University of the Witwatersrand, Johannesburg, 2001.

The authors found oxygen in all 94 samples examined, using a sensitive neutron activation technique. Even "pure" samples (without inclusions visible at 50X) had 30-40 ppm O_2. (ER).

BIGNELL, R.D., TOOMS, J.S., and CRONAN, D.S., 1974, Red Sea metalliferous brine precipitates (abst.): Geol. Assoc. Canada — Min. Assoc. Canada Program, 1974 meeting, p. 10.

BINZER, K. and KARUP-MØLLER, S., 1974, Ferri-sepiolite in hydrothermal calcite-quartz-chalcedony veins on Nûgssuaq in West Greenland: Medd. om Grønland, v. 201, no. 5, Grøn. Geol. Undersøgelse Bull., no. 114, p. 1-16 (in English).

Ferri-sepiolite has been found in low temperature fracture veins in volcanic rocks. The veins are composed of an early calcite-quartz generation and a late generation of calcite, quartz, chalcedony and minor amounts of ferri-sepiolite. The late generation developed simultaneously with deformation of the early minerals. Fluid inclusion studies on the associated calcite give a temperature of formation of the early generation of 65°-80°C. Secondary inclusions in calcite which may have formed simultaneously with the late generation homogenize at temperatures between 40° and 50°C. The mineral veins probably formed from circulating meteoric waters. Optical and other physical properties of the ferri-sepiolite together with X-ray crystallographic and chemical data of the mineral are compared with the similar properties of ferri-sepiolite from East Greenland. (Authors' abstract).

BISCHOFF, J.L., and DICKSON, F.W., 1974, Seawater-basalt interaction and sea floor metal deposits (abst.): Internat. Symp. on Water-Rock Interaction, Czechoslovakia, Sept. 9-17, 1974, Abstracts: Prague, Geological Survey, p. 28 (in English). First author at Dept. of Geol. Sci., Univ. of S. Cal., Los Angeles, Calif. 90007, USA.

Preliminary experiments of seawater-basalt interaction have been carried out in hydrothermal vessels designed for on-line fluid sampling. At 200°C and 500 bars, seawater became considerably modified after 3500 hours. Ca increases three-fold, accompanied by a 100-fold increase in SiO_2, and 10,000-fold increases in Fe and Mn and other heavy metals. In contrast, Mg, SO_4 and alkalinity are almost quantitatively removed. Na, K and Cl remain relatively unchanged. The observed changes can be modeled by dissolution of anhydrous silicates from the basalt and precipitation of secondary anhydrite, calcite, and hydrated magnesium silicates from the seawater. The results suggest that such basalt-seawater interaction on the sea floor presents a possible mechanism for generation of heavy metal deposits associated with active ocean ridges, and perhaps plays a role in the regulation of the composition of seawater. (Authors' abstract.)

BLATTNER, Peter, and BIRD, G.W., 1974a, Quartz-feldspar-calcite-H_2O oxygen isotope geothermometers: new experimental results for 600°C and geothermal data for 250°C (abst.): Internat. Mineral. Assoc. Ninth Gen.

Meeting, West Berlin and Regensburg, W. Germany, Collected Abstracts: West Berlin, German Mineralog. Soc., p. 103 (in English). Authors at Lower Hutt, New Zealand.

In the experiments at 600°C quartz and alkali feldspar were equilibrated with a common solution and analyzed as pairs. Identical quartz-feldspar oxygen isotope fractionations were obtained for quartz and silica gel starting materials, and for water and 1M KCl solution. For silica gel starting material identical quartz-feldspar fractionations were obtained for fluids of widely differing $\sigma\ 0^{18}$ (reversal runs).

The geothermal data from Broadlands no. 7 drillhole are important for quartz and feldspar, which to date have not been equilibrated in the laboratory at low temperatures. The possibility of equilibrium among the geothermal phases, including quartz, is real and is critically discussed.

Significantly improved mineral-pair calibration curves are proposed and are compared with geological data. (From the authors' abstract)

BLATTNER, P. and BIRD, G.W., 1974b, Oxygen isotope fractionation between quartz and K-feldspar at 600°C: Earth Plan. Sci. Letters, v. 23, p. 21-27. See preceeding item.

BLEČIĆ, Novak, 1974a, Basic terms concerning inclusions of ore solutions: Univ. of Beograd, Fac. of Mining, Geol., and Metallurgy, Trans., v. 17, p. 109-115 (in Serbian (?) with English summary).

A brief definition of terms, with diagrams (ER).

BLEČIĆ, Novak, 1974b, An historical survey of the study and exploitation of gas-fluid inclusions (ore-melt inclusions): Univ. of Beograd, Fac. of Mining, Geol., and Metallurgy, Trans., v. 17, p. 117-126 (in Serbian with English summary).

A review with 12 references. (ER).

BLECIC, Novak, 1974c, Technique and theory of the homogenization method: Tehnika, v. 29, no. 7-8, p. 9-13 (in Serbian with brief English abstract).

A review (22 references) and discussion of the use of the Soviet microscope heating stage described by A.R. Groshenko (<u>Fluid Inclusion Research – Proceedings of COFFI</u>, v. 2, 1969, p. 4-7.).

BLOUNT, C.W., 1974, Evaluation of thermodynamic quantities for $BaSO_4$ from barite solubility measurements: Geol. Soc. Amer. Abstracts with Programs, v. 6, no. 7, p. 659-660. Author at Department of Geology, University of Georgia, Athens, Georgia 30602.

BOBOKHOV, A.S., PAVLOV, A.V. and KHAYRETDINOV, I.A., 1974, Distinguishing of acid porphyry-like rocks of S. Ural on the basis of composition of melt inclusions in rock-forming quartz (abst.): Internat. Assoc. on the Genesis of Ore Deposits, Fourth Symposium, Varna, Sept., 1974, Abstracts of Papers: Sofia, IAGOD, p. 246-247 (in Russian; translation courtesy A. Kozlowski). Authors at Bashkirian Division of Acad. Sci. of USSR, Geol. Inst.

Most Paleozoic volcanic forms. of S. Ural have had their primary chem. comp. changed during metamorphic processes. The original chem. comp. may be obtained by analysis of melt incs. in rock-forming quartz (laser microanalyser LMA-1 was used, internal standard - Si in melt inclusions). Most useful are dets. of Mg, Al, Ca, Fe, Ti, Mn, Cu, calculated on a statistical basis. Individual rocks differ in modal values and in dispersion (S^2), see table (...). Comparison of mean values of petrogenic elements in a series of rocks permits evaluation of the evolution of the melt. Note the tendency for increase of Cu content in melts of acid rocks most close to period of chalcopyrite mineralization.

Table

Mean values (W) and dispersion (S^2) of conc. of elements in incs. from acid porphyric rocks of Uchalinskoe ore region

		1	2	3	4
Mg	W	0.49	0.32	0.43	0.74
	S^2	0.11	0.05	0.14	0.05
Al	W	0.11	0.07	-0.14	0.08
	S^2	0.06	0.03	0.06	0.03
Ca.	W	1.12	1.14	1.23	1.01
	S^2	0.10	0.11	0.18	0.23
Fe	W	0.23	0.26	0.44	0.44
	S^2	0.03	0.03	0.03	0.01
Ti	W	-0.27	-0.58	-0.44	-0.50
	S^2	0.13	0.23	0.21	0.24
Mn	W	-0.57	-0.61	-0.43	-0.36
	S^2	0.20	0.03	0.01	0.02
Cu	W	-1.40	-1.23	-1.00	1.16
	S^2	0.44	0.47	0.36	0.37

(Ed. note - Presumably W is in log wt. %)

Note: 1 - dacitic porphyrites, 2 - liparite-dacitic porphyry, 3 - liparite porphyry, 4 - dacitic & andesite-dacitic porphyrites.
(Authors' abstract, shortened by A.K.)

BOGDANOV, B., and MINCEVA-STEFANOVA, J., 1974, The Borieva lead-zinc deposit; in Twelve ore deposits of Bulgaria, P. Dragov and B. Kolkovski, eds.: Sofia. Internat. Assoc. on the Genesis of Ore Deposits, p. 228-256 (in English).

The Borieva lead-zinc deposit is one of the largest deposits in the Madan ore district, in the southeastern part of the Rhodope metallogenic zone. The district occurs in highly crystalline metamorphic rocks. Extensive paragenetic sequences have been worked out. Studies of T_H in quartz, sphalerite, carbonates and barite belonging to the different stages show that the skarn formation took place at a temperature exceeding 400°C. Sulphide deposition began between 350 and 325°C and finished at about 210°C. During the deposition of carbonates and barite, the temperature was 160 to 90°C, dropping to about 50°C towards the end of the ore-forming process. The bulk of workable lead-zinc mineralization was deposited in the range 250 to 320°C, which assigns these deposits to the group of medium- to high-temperature deposits. Important and complex hypogene zoning is observed. (ER)

BOGOLEPOV, V.G., 1974, Method of determination the origin of solutions by means of argon isotopes in fluid inclusions of minerals (abst.): Internat.

Mineral. Assoc. Ninth Gen. Meeting, West Berlin and Regensburg, W. Germany, Collected Abstracts: West Berlin, German Mineralog. Soc., p. 37 (in English). Author at Alma Ata, USSR.

Based on data of argon isotopes Ar_{40}/Ar_{36} from lunar rocks, delivered by "Apollo 2" (sic.) and "Luna 16", the ratio for solar wind equals one, but for present-day atmosphere this ratio is 296. It is also a constant in the potassium-containing rocks, where all of Ar is represented by the heavy isotope which is formed from K_{40}. This is born out by a similar ratio of Ar/N in underground waters and in the air, on agreement of observed and calculated data of concentration and argon pressure in different depth, and data of isotopes of argon. According to data of argon isotopes in G-L incs. of minerals and rocks, determined in the laboratory of Kasakh Institute of Mineral Resources, two types of solutions are established. Solutions of the first type containing Ar_{40} are juvenile and produce metamorphism up to granitization, formation of mica pegmatites in metamorphic belts and Alpine quartz veins. The second type of solutions is characterized by the dominant role of argon from the air (50-100%). Argon is transported from air into hydrotherms indirectly by way of underground waters. Hydrotherms of this type as well as waters of some volcanic zones, form greisens, skarns, and pegmatites in weak metamorphic effusive sedimentary rocks of upper structural steps in fold areas. (Author's abstract).

BOGOLEPOV, V.G., DAVIDENKO, I.V., NAYDENOV, B.M. & POLYVYANNYI, E.Ya., 1974, Evaluation of nature of hydrotherms and scale of muscovitization of granitic pegmatites by isotopes of argon in inclusions in minerals: Internat. Assoc. on the Genesis of Ore Deposits, Fourth Symposium, Varna, Sept., 1974, Abstracts of Papers: Sofia, IAGOD, p. 183-184 (in Russian; translation courtesy A. Kozlowski). Authors at Kazakh Inst. of Mineral Raw Materials, Alma-Ata.

The same data as in Bogolepov et al., 1973 (*Fluid Inclusion Research - Proc. of COFFI*, v. 6, 1973, p. 23-24) with added items 21-23 in the Table concerning rock-crystal-bearing pegs. (A.K.).

BOGOMOLOV, A.Kh, 1973, Phase composition and zoning of quartz precipitation of ore-bearing quartz-molybdenite veins from Tyrnyauz: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 272-273 (in Russian; translation provided through the courtesy of A. Kozlowski). Author at Rostov Univ.

Studies were made for comparison of fine-lamellar ore-bearing quartz-molybdenite veinlets from the central part of ore field with the Northern Plot of the Tyrnyauz deposit.

At the Northern Plot (Severnyi Uchastok), where Mo-W ore mineralization was found last year, quartz from ore veinlets is fine-grained, reticulate, massive, or coarse-grained.

In coarse-grained quartz, gas-liquid and essentially gaseous inclusions strongly (text has "rarely"; probably a misprint; translator) prevail, bearing 25-30 and 80-90% of gas phase respectively. In some cases inclusions bear CO_2 liquid. Vacuoles are distributed in individual groups independent of fractures, their shape is equilibrated, rarely tabular or irregular, with dimensions up to 25-30 µm. Very rarely in coarse-grained quartz polyphase inclusions were found, with 1-2 daughter minerals.

In fine-grained quartz GL and LG inclusions in faceted vacuoles (size up to 40 µm) prevail. Gas phase occupies 50-60% of vacuole. In this quartz naturally decrepitated inclusions were found, with irregular, asterisk-like shape, filled by gas + small amount of liquid.

Massive or fine-lamellar, chalcedony-like quartz with lamellae of fine scales molybdenite bears essentially only one type of inclusions at Northern Plot and at the central part of the ore field. The main mass of inclusions are minute (1-3 μm) oval, drop-like single-phase vacuoles, connected with intergranular surfaces. In central parts of quartz grains one, two, or rarely more relatively large (8-12 μm) inclusions occur. These inclusions have characteristic, syneretic internal structure. Often they bear 2 or 3 phases, concentrically arranged around a gas bubble. From these features one may conclude that the microgranular quartz has crystallized from colloidal solutions.

Inclusions in coarse-prismatic, sometimes drusy quartz differ in the domination of essentially gaseous and GL inclusions bearing 20-30% of gas (size 25-40 μm).

The investigated varieties of quartz and the fluid inclusions occurring in them are closely similar at the Northern Plot and the central part of the ore field, testifying to similar conditions of origin. T_D of quartz from the Northern Plot in the interval 300-400 m increases 80-100°C with decrease in depth. (Authors' abstract)

BOGOYAVLENSKAYA, I.V. and NAUMOV, V.B., (compilers), 1974, Bibliography of Soviet literature for 1973 on inclusions of solutions and melts in minerals: Moscow, Vernadski Inst., Akad. Nauk S.S.S.R., 61 pp., (in Russian; N.P. Ermakov, Editor).

This little volume, issued in only 300 copies, lists 339 references (plus author index). Many references are to sources such as theses that are otherwise impossible to locate. It represents a continuation of the previous issue (Fluid Inclusion Research — Proc. of COFFI, v. 6, 1973, p. 25-26). (ER).

BONATTI, Enrico, HONNOREZ, Jose, and GUERSTEIN, M.H., 1974, Metal sulfide mineralizations from the Romanche fracture zone (equatorial Atlantic) (abst.): Amer. Geophy. Union Trans., EOS, v. 55, no. 4, p. 455. Authors at Univ. of Miami, Miami, Fla. 33149.

Metal sulfide mineralizations were discovered at two sites in the Romanche offset, equatorial Mid Atlantic Ridge. At one site, located near the western axial segment of the Ridge, a series of iron and copper sulfides were found as veins and segregations in slightly metamorphic basalts. At another site, close to the bottom of the Romanche transverse valley, a concretion was recovered made mainly of pyrite and melanterite. A model is presented which relates the presence of metal sulfides primarily to hydrothermal circulation in the oceanic crust. The potential for metalliferous deposits in transverse fracture zones is discussed. (Authors' abstract)

BONEV, I.K., PIPEROV, N.B., and PENCHEV, N.P., 1974, Primary fluid inclusions in galena crystals and their chemical composition (abst.): Internat. Assoc. on the Genesis of Ore Deposits, Fourth Symposium, Varna, Sept. 1974, Abstracts of Papers: Sofia, IAGOD, p. 267 (in English). First author at Geol. Inst., Bulgarian Acad. of Sci., Sofia, Bulgaria.

Large galena xls. from the Pb-Zn deps. in the Rhodope Mountains (Madan and Luki districts), as well as in other ore districts (Trepca, Yugoslavia; Tetyukhe, USSR; Freiberg, GDR) contain abundant fluid incs. The vacuoles enclosing them are negative xls. of cubic, cubo-octahedral or octahedral habit up to several mm in size. The incs. are P and are distributed in the growth pyramids of the cubic faces (100). The surface of the galena xls. immediately above the incs. is plastically deformed as a result of the difference between the inner and the external P produced during cooling, and peculiar sagging depressions are thus formed. In a few cases (Kratovo, Yugoslavia) the xl. faces above the incs. bulge out. The deformation of galena allows for a visual estimate of the inc. localization, size, and approximate shape.

Some incs. were punctured and the chemical comp. of the fluid was examined by mass spectrometry, spectral and atomic absorption, and turbidimetry. The liquid is a comparatively conc. aqueous sol. containing Na, K, Ca, Mg, Mn, Cu, Fe, Cl, HCO_3, SO_4. The gas released is almost pure CO_2. After evaporating the brine, a solid residue remains, identified as NaCl+KCl. (Modified by ER from the authors' abstract.)

BOSSI, J., 1974, Use of fluid inclusions in the genetic study of vein deposits: in Formation of Uranium Ore Deposits, Proceedings of a Symposium, Athens, Greece, 6-10 May 1974: Vienna, Internat. Atomic Energy Agency, p. 583-592. Author at Facultad de Química, Montevideo, Uruguay.

The formation process of the "properly uraniferous" type of uranium vein deposits (according to Geffroy and Sarcia) is still under discussion. This paper proposes the study of fluid incs. in order to contribute to the interpretation of the genetic process. The behaviour of fluid incs. of a vein deposit of lead-zinc in the south of the French Central Massif, which, in the author's opinion, is believed to be dep. by sols. moving downward, is taken as a model and it is proposed that such a criterion be applied to uraniferous deps.

The aim of the paper is to interpret the genesis of these uranium vein deposits, in the belief that this will be of great importance in assessing guides for provisional prospecting, once the theoretical conditions that control the supergenic process are known. (Author's abstract).

Data are presented from the lead-zinc mineralization in Asprieres-Bouillac, France, from the author's 1972 thesis, including T_H from quartz, sphalerite, and barite collected at various levels (to 350 m, presumably representing heights above some unspecified datum). Salinities varied from 8-13% NaCl equiv. Data on the distribution of G/L and L only inclusions are used to suggest the presence of gas bubbles in the upper levels. (ER)

BOWMAN, J.R., 1974, Amphiboles in high-temperature marbles from the Bancroft-Haliburton area, Ontario (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 6, no. 7, p. 665. Author at Department of Geology and Mineralogy, University of Michigan, Ann Arbor, Michigan 48104.

The observations suggest variation in fluid composition toward higher X_{CO_2} and lower X_F to the W-NW. Since the amphiboles contain significant F and less than ideal OH contents, X_{CO_2} values derived from experimental data involving only CO_2-H_2O mixtures (Bancroft area X_{CO_2} = .10-.15; Haliburton area $X_{CO_2} > .20$) are only estimates. The observed divariancy in the $Tr+Cc = Di+Fo+CO_2 + H_2O$ isograd is due primarily to variation in fluid compositions. (Author's abstract, abbreviated)

BRATUS', M.D., 1974a, Conditions of fluorite formation in the Korsun-Nowomirgorodsky pluton pegmatite: L'vov. Min. Sborn., v. 28, no. 2, p. 106-109 (in Russian).

Study of the liquid inclusions in fluorite from the Korsun-Novomirgorodsky pluton pegmatite reveals two generations. High temperature pale green fluorite formed at >260°C and contains considerable (0.83%) rare earths. Low temperature fluorite crystallized from acid (pH=4.9 - 5.3), dilute (2.0 - 2.3%) solutions at 220-160°C, and is nearly free of rare earths. (Author's abstract.)

BRATUS', M.D., 1974b, Certain typomorphic features of quartz crystals from pegmatites of Korsun'-Novomirgorodskiy pluton, in Typomorphism of Ukrainian Quartz, edited by Ye. K. Lazarenko, Acad. Sci. Ukr. SSR: Kiev, Naukova Dumka Pub. House, p. 43-45 (in Russian; translation courtesy A. Kozlowski). Author at Inst. of Geol. and Geochemistry of Fuels of Acad. Sci. Ukr. SSR, L'vov.

The low-T zones of smoky quartz in peg. voids bear fluid incs. with T_H = 130-140°C. Smoky quartz has formed from alkaline sols. (pH = 7.6-8.0); transparent (colorless? - A.K.) parts have xlized from acid sols. (pH = 6.0-6.5) (A.K.).

BROWNE, P.R.L., ROEDDER, Edwin, and WODZICKI, Anthony, 1974a, (Prehistoric temperatures of geothermal fields (abst.)): Geol. Survey Research 1974, U.S. Geol. Sur. Prof. Paper 900, p. 146 (see next item).

BROWNE, P.R.L., ROEDDER, E., and WODZICKI, Antoni, 1974b, Comparison of past and present geothermal waters, from a study of fluid inclusions, Broadlands field, New Zealand (abst.): Amer. Geophy. Union Trans., EOS, v. 55, no. 4, p. 456. First author at N.Z. Geol. Survey, Box 30368, Lower Hutt, New Zealand.

P aqueous incs. occur in hydrothermal quartz, sphalerite, and adularia crystals from boreholes in the Broadlands geothermal field, New Zealand. T_H from various depths in seven bores range from 37° below to 28° above present borehold temperatures (T_B, 164-281°C) and average 16° below the boiling-point curve for pure water at equivalent depths. However, quartz from several bores contains both vapor-rich and liquid-rich incs. trapped from boiling solutions solutions containing no more than -0.25 atm. CO_2. These paired incs. yield essentially identical T_H values. Freezing temperatures for inclusions range from -0.3 to -0.8 ± 0.05°C (salinity 5100-13,600 ppm NaCl equiv.); present deep-water salinities are about 3000 ppm. The differences between the inclusion data and the present T_B and compositions appear to represent actual changes in the fluids with time, but although the fluids now discharged from the bores are quartz saturated, the actual time of growth of the host crystals during the approximately 10^5-year history of the field is unclear. We suggest that continuous fluid losses, plus meteoric water recharge, have flushed much of the original salt out of the system, whatever its source. The relatively small differences between T_H and T_B require an exceedingly stable heat-flow regimen. (Authors' abstract)

BROWNE, P.R.L., ROEDDER, E., and WODZICKI, A., 1974c Past and present-day geothermal waters from fluid inclusion studies, Broadlands field, New Zealand (abst.): Internat. Symp. on Water-Rock Interaction, Czechoslovakia, Sept. 9-17, 1974, Abstracts: Prague, Geological Survey, p. 58 (in English). First author at N.Z. Geol. Surv., Box 30368, Lower Hutt, New Zealand (see preceding item).

BURNHAM, C.W., 1974, Thermodynamics of melting in experimental silicate-volatile systems (abst.): Internat. Mineral. Assoc. Ninth Gen. Meeting, West Berlin and Regensburg, W. Germany, Collected Abstracts: West Berlin, German Mineralog. Soc., p. 160-161 (in English). Author at Penn. State Univ., Univ. Park, Pa.

An extensive review of new developments. The calculated and experimental phase relations agree within experimental error up to 10 kilobars for all H_2O-bearing compositions. (ER)

BURNHAM, C.W. and DAVIS, N.F., 1974, The role of H_2O in silicate melts: II. Thermodynamic and phase relations in the system $NaAlSi_3O_8$-H_2O to 10 kilobars, 700° to 1100°C: Amer. Jour. Sci., v. 274, p. 902-940.

BURRUSS, R.C., and HOLLISTER, L.S., 1974, "Self-consistent P, T data relevant to "freezing" studies of CO_2-rich fluid inclusions."

The figure below, originally presented by L.S. Hollister (1973), illustrates in self-consistent units (bars, °C) the P, T equilibrium relationships for the CO_2-H_2O system at low T. It has been synthesized from the literature data originally reported in various units (°C, atm.; °F, psia.; etc.). It is presented here as an aid to fellow fluid inclusion research workers. The letters designating "interesting temperatures" on the figure follow the appropriate references below.

The data for the -6°C CO_2 gas-liquid homogenization isochore, CH_4 hydrate melting, and the C_2H_4 hydrate melting are included as reference points for observed equilibria in the pure CO_2-H_2O system. Reader beware: this is not a true phase diagram! All the clathrate gas hydrates form solid solutions and the addition of CH_4 or C_2H_4 component or both to the CO_2-H_2O system changes the topology (see Waals and Platteeuw (1959)). The data compiled here are only for end member compositions.

Also, recent references (Juza, et al. (1965)), and Altunin, et al. (1971) on the P-V-T properties of CO_2 at high P and T have been included as an aid to anyone attempting thermometric of barometric calculations on high density pure CO_2 inclusions.

Note: This diagram was originally presented as a slide in a verbal presentation, and the editor believes it and the references are of sufficient interest to users of COFFI to warrant publication, with thanks to the authors.

Altunin, V.V., and Gadetskii, O.G., (1971), "Equation of state and thermodynamic properties of liquid and gaseous carbon dioxide", Thermal Engineering, v. 18, no. 3, pp. 120-125. (Trans. of Russian original in Teploenergetika, (1971), v. 18, no. 3, pp. 81-84.)

Deaton, W.M., and Frost, E.M., Jr., (1948), "Gas hydrates and their relation to the operation of natural gas pipelines", Bureau of Mines, Monograph 8, U.S. Department of Interior, 103 p. (c,d,e).

Hollister, L.S., (1973), "The Khtada Lake (British Columbia) metamorphic complex: The role of CO_2-rich fluid inclusions," (abst.), Geological Society of America Abstracts with Programs, v. 5, no. 7, p. 672.

Juza, J., Kmonicek, V., and Sifner, O., (1965), "Measurements of the specific volume of carbon dioxide in the range of 700 to 4000b and 50 to 475°C", Physica, v. 31, pp. 1735-1744.

Larson, S.L., (1956), "Phase studies of the two-component carbon dioxide-water system involving the carbon dioxide hydrate", University Microfilms No. 15,235, Ann Arbor, Michigan, Dissertation Abstracts, (1956), v. 1, no. 6, p. 248(d)

Lowry, H.H., and Erickson, W.R., (1927), "The densities of coexisting liquid and gaseous carbon dioxide and the solubility of water in liquid carbon dioxide", Journal of the American Chemical Society, v. 49,

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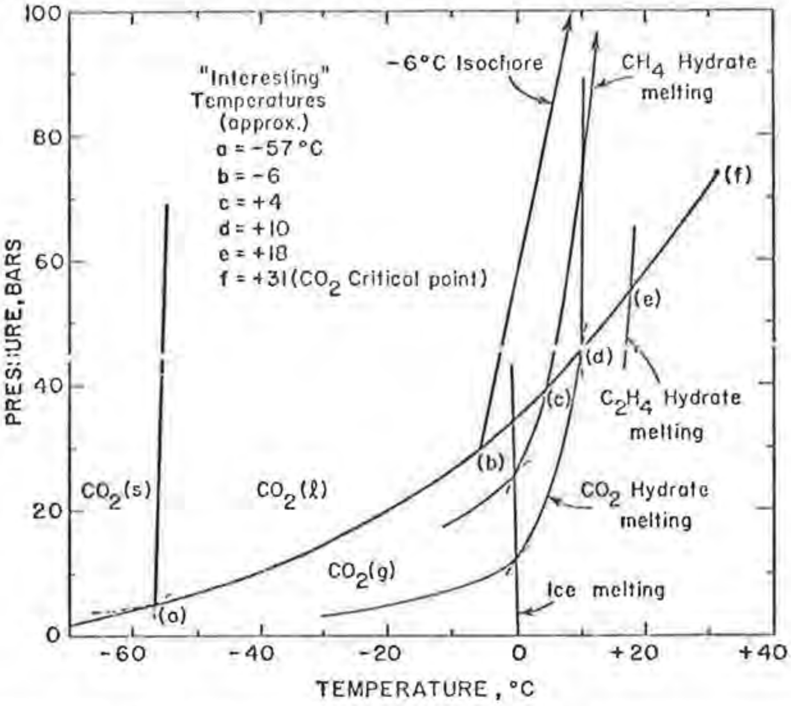
Marshall, D.R., Saito, S., and Kobayashi, R., (1964), "Hydrates at high pressures: Part I. Methane-water, argon-water, and nitrogen-water systems", American Institute of Chemical Engineers, Journal, v. 10, pp. 202-205. (c)

Takenouchi, S., and Kennedy, G.C., (1965), "Dissociation pressures of the phase $CO_2 \cdot 5\text{-}3/4\ H_2O$", Journal of Geology, v. 73, pp. 383-390. (d)

Waals, J.H. van der, and Platteeuw, J.C., (1959), "Clathrate solutions", in Advances in Chemical Physics, v. 2, ed., I. Prigogine, Interscience Publishers, Inc., New York, pp. 1-57.



BÜSCH, W., SCHNEIDER, G. and MEHNERT, K.R., 1974, Initial melting at grain boundaries. Part II: Melting in rocks of granodioritic, quartz-dioritic and tonalitic composition: Neues Jahrbr. Mineral. Mitt., 1974, v. 8, p. 345-370 (in English). Authors at Institut für Mineralogie der Freien Universität, D-1 Berlin 33, Takustr. 6, West Germany.

Includes microprobe studies across glass-crystal boundaries of interest to melt inclusion studies. (ER)

CALAS, Georges, HUC, Alain-Yves, and PAJOT, Bernard, 1974, Study of fluid inclusions by infrared spectrometry (abst.): Soc. fr. Mineral. Crist., Bull., v. 97, no. 6, p. XI (in French). First author at Lab. Minér. Crist. Ass. Au C.N.R.S., Univ. Paris VI.

A brief discussion of the possibilities and problems. (ER)

CARPENTER, A.B., 1974, Origin and chemical evolution of lead- and zinc-rich oil-field brines in Central Mississippi (abst.): Internat. Symp. on Water-Rock Interaction, Czechoslovakia, Sept. 9-17, 1974, Abstracts: Prague, Geological Survey, p. 23 (in English). Author at Dept. of Geol., Univ. of Missouri, Columbia, Missouri 65201, USA.

Oil-field brines containing high concentrations of lead and zinc occur at depths ranging from 8,000 to 13,000 feet over a more than 2,000 sq. mile portion of central Mississippi. The occurrence of these brines containing up to 110 mg/l lead and 575 mg/l zinc over such a large stratigraphic interval and over such a large areal extent has important implications for the origin of some types of stratiform ore deposits. The data indicate that the saline waters in the Jurassic and Lower Cretaceous petroleum reservoirs in central Mississippi are undiluted residual brines produced by the evaporation of sea water accompanied by halite deposition. I suspect that these brines were originally interstitial fluids in the Louann Salt which have been expelled upwards as a result of loading by younger sediments. The relationships between brine composition and stratigraphic position indicate that the metal-rich brines acquired their metal content by interaction with shaley rocks approximately 3500 feet above the top of the Louann Salt. (Author's abstract.)

CASADEVALL, Tom, OHMOTO, Hiroshi, and RYE, R.O., 1974, Sunnyside Mine, San Juan County, Colorado: Results of mineralogic, fluid-inclusion, and stable-isotope studies (abst): Econ. Geol., v. 69, p. 1178. First author at The Pennsylvania State University, University Park, Pennsylvania 16802.

The Sunnyside mine, in the Eureka mining district, southwestern Colorado, produces 700 tons/day of gold-silver-base metal ore and is the State's leading gold producer. Production is from fault and fracture fillings within the northern walls of the Eureka graben, which formed during the resurgent doming of the San Juan-Uncompahgre calderas about 28 m.y. ago. The six periods of mineralization and their approximate volumetric abundances, are: 1, pyrite-quartz ores (10%); 2, banded quartz-sulfide ores (30%); 3, massive galena-sphalerite-chalcopyrite-tetrahedrite-hematite ores (40%); 4, gold ores (<1%); 5, manganese-anhydrite ores (15%); 6, quartz-fluorite-carbonate-barite ores (5%). Heating studies of fluid inclusions in quartz and fluorite indicate temperature ranges of 260°-330°C for Periods 1-5 mineralization and 170°-240°C for Period 6 minerlization. This temperature change, coupled with the evidence of boiling in fluid inclusions from Period 6 quartz and a change in the oxygen isotope data, suggests that conditions of mineralization changed after Period 5. δD values of inclusion fluids from quartz and fluorite range from -116 to -129‰. $\delta^{18}{}_{C}$ values calculated for Periods 1-5 and Period 6 hydrothermal fluids range from -5.7 to -8.0 and -12.4 to -14.1‰, respectively. Apparently the hydrothermal fluids were predominantly meteoric water which underwent moderate isotopic exchange with wall rocks during Periods 1-5, but slight exchange during Period 6. $\delta^{34}S$ values are -4.5 to +2.3‰ for sulfides and +16.2 to +17.6‰ for anhydrite, suggesting an igneous source for hydrothermal sulfur. $\delta^{13}C$ values of carbonates are -1.8 to -7.9‰, suggesting a mixed source for hydrothermal carbon. (Authors' abstract).

CATHLES, L.M., and NORTON, Denis, 1974, Pluton driven ground water convection (abst.): Amer. Geophy. Union Trans., EOS, v. 55, no. 4, p. 488. First author at Ledgemont Lab., Kennecott Copper Corp., Lexington, Mass. 02173.

Plutons that intrude water saturated strata can produce ground water convection. The flowing water interacts geochemically with the rock and may be of importance in determining the distribution of mineralization in porphyry copper deposits. A rough finite difference model of the convective cooling of a pluton was made to compute quantities of interest to study of the geochemical alteration. A pluton 2Km wide, 2.75Km high and buried 2.75Km below the surface was assumed. Initially the pluton was 750°C hotter than its surroundings. The permeability of the pluton was 0.15 millidarcies and the surroundings 0.3 millidarcies. The pluton was found to cool to 20% its initial T in 10^5 years. The ground water in a radius around the pluton about equal to the depth extent of the system (5KM) cycles about 100 times through the pluton. The volume of water cycled through the upper part of the pluton is about three times the volume of the upper pluton. Fluid velocities at the top of the pluton averaged 30 m/year. These numbers are rough estimates only, but appear to permit the deuteric alteration required by isotope data (Taylor, JGR, 1971, p. 7855) and the formation of porphyry deposits by scavanging of copper from surrounding extrusives. (Authors' abstract)

CERNÝ, P., 1974, Granitic pegmatites and their minerals: selected examples of recent progress (abst.): Internat. Mineral. Assoc. Ninth Gen. Meeting, West Berlin and Regensburg, W. Germany, Collected Abstracts: West Berlin, German Mineralog. Soc., p. 5 (in English). Author at Winnepeg, Canada.

The pace of systematic investigation of granitic pegmatites has slowed in the few past decades but considerable progress has been made in the crystal chemistry of some minerals and in petrological interpretation based on experimental work. Recent developments in the mineralogy of pegmatites will be shown on examples of the Fe, Mn, Ta, Nb oxides, phosphates, lithium micas, and pollucite.

Advances in pegmatite petrology will be demonstrated on the Jahns-Burnham and Stewart models, primary vs metasomatic assemblages, lithium aluminosilicates, feldspar chemistry, and the graphic granite problem. A review of the petrography and mineralogy of the giant Tanco pegmatite in southeastern Manitoba will be presented. The pegmatite, the world's largest deposit of tantalum, cesium, and refractory-grade spodumene, displays many characteristics supporting recent petrological theories, but it also shows some puzzling phenomena which are yet to be explained. (Author's abstract.) Note: This was the introductory lecture to a major session on pegmatites and pegmatite minerals, only one other of which could be included here. See the Collected Abstracts for additional items. (ER).

CHAMPNESS, P.E., FYFE, W.S., and LORIMER, G.W., 1974, Dislocations and voids in pyroxene from a low-temperature eclogite: mechanism of eclogite formation: Contr. Mineral. and Petrol., v. 43, p. 91-98. First author at Department of Geology, University of Manchester, Manchester M13 9PL, England.

A transmission electron microscope study of dislocations and imperfections in omphacites of a low-T California eclogite has revealed a dislocation array related to a continuous creep phenomenon. Structures are appropriate to a combination of deformation and annealing processes similar to those observed in the hot working of some metals. The study has revealed the presence of voids or possible fluid inclusions which may indicate that the basalt to eclogite reaction was catalysed by a fluid phase which must have had a very low partial pressure of water. (Authors' abstract).

CHAROY, Bernard, and WEISBROD, Alain, 1974, Interactions between rocks and solutions in mineralized greisens from St. Renan (Brittany, France) (extended abst.), in Metallization associated with acid magmatism, v. 1, p. 254-261, ed. M. Stemprok: Prague, Geological Survey (a volume of papers presented at the MAWAM Symposium, Karlovy Vary, Czechoslovakia, Oct. 1974) (in English). Authors at Géol., Nancy CRPG, Vandoeuvre, France.

A study of Sn-W deposits in quartz veins and greisens. Fluid incs. are abundant in both granites and greisens. They are generally L/V and S, but liquid only incs. are not rare. Two groups have been recognized: Group (1) is typical of greisens from both units, and never occurs in unaltered granites. These have low salinity (4 to 10 wt. % NaCl equiv., avg. 7 wt. %) and homog. in liquid at 120 to 270°C (avg. 180°C). Group (2) occur mainly in less altered granites, but are also found in some quartz from greisens. Most have high salinity (13 to 18 wt. %, avg. 15) and homog. in liquid at 120 and 300°C (avg. 200°C). But some, which occur only in the upper unit, are quite different. They have low salinity and a variable but always large volume of CO_2-rich vapor. This vapor yields liquid CO_2 at about -20°C, and solid CO_2 at about -60°C. Similar incs. (both groups) have been found in a quartz vein from the upper unit, though T_H is 120 to 170°C (avg. 150°C).

From the T_H (180°C) and salinity of solutions, the calculated fluid P at St. Renan is about 1.5 to 2 kbar. Assuming a roughly isobaric process, and becuase most T_H is between 140 and 260°C, it can be seen that the process began at 400-450°C and ended at 250-300°C. Tentative interpretation is that group (1) incs. are the initial solution infiltrating the granitic rocks, in equilibrium with the greisens. When it enters the granite, it dissolves the feldspars and becomes enriched in alkali salts until it is buffered by and saturated with respect to the orthoclase-albite-muscovite association. Group (2), equilibrated with less altered granites, could represent such a saturated solution. Since contacts between less altered granites and greisens are rather sharp, and because intermediate salinities are not common in fluids (1) and (2), local equilibrium must have proceeded quite fast. Fluid (2) unmixed in the upper unit, yielding a CO_2-rich vapor. (Modified by ER from the authors' abstract.)

CHENG, C-N., and PONNAMPERUMA, Cyril, 1974, Extraction of amino acids from soils and sediments with superheated water: Geochimica et Cosmochimica Acta, 1974, v. 38, p. 1843-1848. First author at Chemical Evolution Branch, NASA Ames Research Center, Moffett Field, California.

A method of extraction for amino acids from soils and sediments involving superheated water has been investigated. About 75-97 per cent of the amino acids contained in four soils of a soil profile from Illinois were extracted by this method. Deep penetration of water into soil aggregates and partial hydrolysis of peptide bonds during this extraction by water at high temperature are likely mechanisms responsible for the release of amino acids from samples. This extraction method does not require subsequent desalting treatments when analyses are carried out with an ion-exchange amino acid analyzer. (Authors' abstract) (Of pertinence to studies of amino acids in fluid inclusions, Ed.).

CHEPUROV, A.I., 1973a, 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; trans. in Doklady Acad. Sci. USSR, v. 213, 1975, p. 165-168; abst. in Internat. Geol. Rev.,

v. 16, no. 2, p. 236). Author at Institute of Geology and Geophysics, Siberian Division USSR Academy of Sciences, Novosibirsk. Abst. courtesy T.M. Sushchevskaya.

Glass incs. in olivine, pyroxene and apatite from pseudoleucitites were studied. Incs. in olivine are $3 \cdot 10^{-3} - 5 \cdot 10^{-2}$ mm in diameter and usually contain a small gas bubble and colorless needle-like crystals. Melting of the incs. occurs at 1140-1160°, and T_H is at 1180-1240°. At 800-900°C new gas bubbles appear. In incs. in pyroxene a gaseous phase appears at 1100°, melting occurs at 1110-1130° and homogenization into liquid occurs at 1160-1180°C. Melting of incs. in apatite occurs at 900-950° and homogenization at 1150-1170, but usually the incs. leak. T_H slightly decreases with increasing temperature of heating while temperature of appearance of gas phase increases. 20 minutes of heating is quite sufficient for attaining equilibrium. T_H obtained for pseudoleucitites of Central Aldan (Yakutia) are somewhat lower than T_H for analogous rocks from other regions.

CHEPUROV, A.I., 1973b, Evaluation of errors of temperature of homogenization measurements by the heating stage with an inert medium: Geologia i Geofizica, 1973, no. 6 (162), p. 134-138 (in Russian; abstract courtesy T.M. Sushchevskaya).

The method of det. T_H for melt incs. was described for a heating stage with inert gas medium. Experimental evaluation of accuracy for natural melt incs. in diopside showed that the theoretically calculated error (1%) and the error obtained for natural incs. (1.17%) are very close.

CHEPUROV, A.I., 1973c, Melt inclusions in minerals of alkaline rocks from Central Aldan: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 206 (in Russian; translation through the courtesy of A. Kozlowski). Author at Inst. of Geol. and Geophysics, Siberian Branch, Acad. Sci. of USSR, Novosibirsk.

Melt inclusions in minerals of individual alkaline rock types from Central Aldan were investigated by the use of a heating microstage with inert atmosphere and a water-cooled objective. T_H was as follows:

Rock	Mineral	T_H, °C (± 15°C)
a. Olivine psuedoleucitite	Olivine phenocrysts	1180-1250
	Pyroxene phenocrysts	1210-1190
	Apatite	1180-1160
	Pyroxene - matrix	1170-1150
b. Psuedoleucitite from Tommot massif	Pyroxene-phenocrysts	1170-1140
Pseudoleucitite from Yllymakh massif	Pyroxene-phenocrysts	1180-1160
c. Biotitic peridotite-porphyrite	Olivine	1440-1420
	Pyroxene	1270-1230

The X-ray microanalyzer (Model MS-46) was applied to ascertain the composition of silicate phases of melt inclusions. (Author's abstract, modified by A.K.)

CHEPUROV, A.I., 1974, Thermometric investigations of metasomatic inclusions in olivines of dunites from Inagli massif (Central Aldan region), in Mineralogy of endogenetic deposits, Yu. A. Dolgov and V. S. Sobolev, eds.: Novosibirsk, Acad. Sci. USSR, Sib. Branch, Inst. Geol. and Geophys., p. 126-130 (in Russian; abstract courtesy A. Kozlowski).

Secondary melt inclusions, 0.001 to >0.1 mm, occur in olivine in the named massif; they now contain anisotropic colorless crystals and grains of opaque ore mineral. Phase relations vary. Electron microprobe analysis shows the crystals to be Cr-diopside and phlogopite. During heating to 250 to 500°C - gas (?) bubbles appear and the inclusions partly become dark; at 500 to 700°C - a mobile phase (liquid) appears and decrepitation occurs during fast heating; at 1000°C - the crystals begin to melt; at 1250 to 1320°C - increase of ore mineral; at 1450°C and above - melting of ore mineral and complete melting of inclusion filling, with coexistence of melt and gas bubble. The daughter minerals are very similar to those from feldspathic pyroxene-phlogopite metasomatites formed by the alteration of dunite. The temperatures are not real temperatures of inclusion formation and the inclusions should be termed metasomatic inclusions, after Ermakov (1972).

CHERNYSHEV, V.F., and SAFONOV, Yu.G., 1974, Zonality of ore mineralization in deposits and fields of skarn type: in: Zonality of hydrothermal ore deposits, G.A. Sokolov, ed.: Moscow, Izdat. "Nauka," v. 1, p. 117-238 (in Russian; abstract courtesy A. Kozlowski).

Authors use data of L.N. Khetchikov and P.S. Garbuzov, 1964, Geol. Rudnykh Mestorozhd., no. 4, and of V.D. Sazonov, 1962, Trudy Inst. Geol. AN Tadzh. SSR, no. 6 (summarized in Roedder, 1972, Data of Geochemistry), as well as of V.C. Sazonov, 1964, Trudy Inst. Geol. AN Tadzh. SSR, no. 8 (not given in Roedder, 1972). T_D and T_H data on fluid inclusions are given for the Kurusay-1 deposit and the Verkhne-Tyetyukhe ore field.

CHESNOKOV, B.V., 1974, Depression of the wall of a gas-liquid inclusion in a galena crystal during an increase in the pressure in the druse cavity: Zap Vses. Mineral. Obshchest., 1974, v. 103, no. 3, p. 388-390 (in Russian). Author at Sverdl. Gorn. Inst., Sverdlovsk, USSR. C.A. v. 81, no. 11, 1974, 1385411

Crystals from the Berezov and Tetyukhin deposits were studied. The obsd. depression of the inclusion may be used to solve some problems of thermometry and barometry. (Author's abstract)

CHI, J.M., and HWANG, H.S., 1974, A study of genesis by homogenization temperature and paragenesis of the Dalsung mine: Korean Institute of Mining Geology, Jour., v. 7, p. 23-35 (in Korean with English abstract).

The Dalsung mine, located in Kyungsang puk-do, Korea, is well known as a typical breccia pipe filling, hydrothermal W-Cu dep. T_H of incs. in quartz crystals (330 samples) by heating microscope stage, fell in two T ranges, 154°-267°C (average 210°C), and 283°-335°C (average 309°C). Paragenetic data indicate that mesothermal W-Cu mineralization proceeded throughout the ore body and later katathermal Cu mineralization was limited to under the 4th level. (From the authors' abstract).

CHIEN-MIN, Keng, 1974, Preparation of doubly-polished thin sections for fluid inclusion study: Geochimica, v. 12, 1974, no. 4, p. 268-271 (in Chinese with English abstract).

The author describes the technique used (including use of shellac for cementing plates and ethanol as a solvent.) (ER)

CHRISTIE, J.M. and ARDELL, A.J., 1974, Substructures of deformation lamellae in quartz: Geology, 1974, p. 405-408. First author at Department of Geology, University of California, Los Angeles, Los Angeles, California.

By careful correlation between the microstructures observed at optical and electron microscopic magnifications, perfectly basal deformation lamellae in an experimentally deformed quartz crystal were identified as thin layers of glass, commonly associated with arrays of dislocations. Nonrational lamellae in a naturally deformed quartzite were identified as recovered zones containing submicroscopic bubbles. Previous interpretations are considered in the light of these results. (Authors' abstract).

CHUKHROV, F.V., et al., editors, 1974, Minerals Handbook - diagrams of phase equilibria: v. 1 (514 pp.) - Phase equilibria important for natural mineral formation, 2 (490 pp.) - Phase equilibria important for technical mineral formation, Moscow, "Nauka" Publ. House, under the aegis of the Inst, of Ore Deposits, Petrography, Mineralogy, and Geochemistry, Acad. Sci. USSR (in Russian; abstract courtesy A. Kozlowski).

The first vol. contains 1775 phase diagrams, each with reference, arranged as follows: systems under normal or less pressure (including elements, carbides, sulfides, metal-O_2 with elements with unstable valence oxides, salts); systems without volatiles, under elevated P (incl. elements carbides, nitrides, sulfides, tellurides, selenides, oxides, salts); systems bearing volatiles under elevated P (incl. phase diagrams of volatiles, elements under P of H_2O or under P of H_2O with determined partial P of O_2 (H_2), various substances under P of H_2O, oxides under P of CO_2, oxides under P of $H_2O + CO_2$, various substances under P of $H_2O + CO_2$, water-salt systems under elevated P, water-salt systems with CO_2 under elevated P). The second vol. contains 1679 diagrams: systems with borides carbides, nitrides and carbonitrides, systems metal-O_2, systems of oxides, systems with oxides, halides and other components, salt systems (halides, nitrates, nitrites, sulfates). Index of systems, index of mineral and rocks and authors' index is added to each vol.

CHUPIN, V.P. 1973, Conditions of granite-formation in the process of regional metamorphism of rocks of various composition from Aldan metamorphic complex: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 223-224 (in Russian; translation through the courtesy of A. Kozlowski). Author at Inst. of Geol. and Geophysics, Siberian Branch, Acad. Sci. of USSR, Novosibirsk.

1. As a result of complex studies of inclusions in quartz of some types of autochthonous granites (including the granitic component of migmatites) in rocks of Aldan metamorphic complex (two-pyroxene-gneiss plus partly amphibolite facies), primary crystallized melt inclusions were found and investigated, proving the magmatic origin of

the named granites.

2. Crystallized inclusions are an aggregate of grains of quartz and feldspars plus a gas phase (up to 10-15 vol. %) that is deformed by the crystal phases. These inclusions may be taken as a granitic microsystem, with volatiles. Their investigation provides data on T and some other peculiarities of natural granitic melt. Phase ratios and morphologic features of the inclusions testify to a slow and quiet process of crystallization of the granites.

3. A series of crystallized inclusions in quartz from these granites homogenized at T_H = 860-880°C for layered migmatites replacing quartzites and at T_H 870-940°C for small massifs of autochtonous granites in quartzites of the granulitic facies. Especially interesting are new, but as yet not very numerous data on significantly lower T_H of similar melt inclusions in quartz of anatectic granites of amphibolite facies (770-780°C). Thus, the difference in T of origin of anatectic granites in various metamorphic facies zones in noted.

4. In crystallized inclusions, beside H_2O the following volatiles were found: CO_2 (35-60% of gas phase vol.) and a group of undifferentiated gases $NH_3 - H_2S - SO_2 - HCl - HF$ (40-65 vol. of %). Major amounts of CO_2 were found in the metamorphic solutions (in the wall quartzites). CO_2, NH_3, H_2S, etc. lower the amount of H_2O in the fluid and under stable high general P of fluid, increase the T of melting and crystallization of granite in comparison with respective T in the presence of pure water. This factor, probably, explains the relatively high T of crystallization of natural anatectic melts, as indicated by inclusion studies.

5. These data support the earlier hypotheses of a regional anatectic origin of granitic magmas. (Author's abstract)

CHUPIN, V.P., 1974, Errors during measurement of temperatures of inclusion homogenization and ways to remove them, in Mineralogy of endogenetic deposits, Yu. A. Dolgov and V. S. Sobolev, eds.: Novosibirsk, Acad. Sci. USSR, Sib. Branch, Inst. Geol. and Geophys., p. 137-145 (in Russian).

The relation between error in measurement of T_H of inclusions and various factors is described: erroneous calibration of heating stage, cooling from various microscope objectives, vertical and horizontal temperature gradients in mineral plates, etc. Methods of obtaining higher precision are suggested (author's abstract, translation by A.K.).

CIESLEWICZ, W.J., 1971, Some technical problems and developments in Soviet petroleum and gas production: The Mines Magazine, Nov., 1971, p. 12-16.

Includes (p. 14-15) a section on the large solid natural gas deposits in the Soviet Union, consisting of clathrate compounds (methane hydrate and higher organic hydrates). These are currently producing gas by pressure reduction, temperature increase, or the addition of "catalysts" (e.g., methanol). Of interest to freezing studies on organic-bearing inclusions. (ER)

CLOCCHIATTI, Robert, and MERVOYER, Bernard, 1974, Contribution to the study of quartz from Guadeloupe: VII Conférence géologique des Caraïbes, Pointe-à-Pitre, 1974 (in French; translation courtesy Chris Eastoe). Authors at E.R. n° 45, CNRS, Lab. de Géochimie, Fac. des Sciences, 91 Orsay, France.

Vitreous incs. in quartz phen. have been studied in samples from laterites and fresh or little-alt. volcanic rocks, mostly from the western half of Guadeloupe. Three types of quartz have been defined according to the morphology, the d, the degree of fill and the chem. comp. of incs. formed during xliz. These types correspond to the "nuée ardente" facies of northern Guadeloupe, to the widely-spread "pumice-fall" facies and to the southern "pumice-flow" facies. Thus material lateritised in *situ* can be distinguished from transported material bearing a mixture of quartzes of diverse provenance. The magmatic origin of the quartzes is confirmed by: (1) chem. comp. of the trapped glass (by electron microprobe); (2) thermal behavior: optical thermometry indicates a form. $T \leq$ 800-900°C; (3) ion probe det. of magmatic min. (pyroxene, plagioclase, ilmenite and apatite) in the incs.; and (4) the presence of analogous incs. in quartz from ignimbrites from Katmai (Alaska) and pumice from Mont Dore (France).

The presence of magmatic quartz in andesite and dacite is compatible with the high Ps invoked for the genesis of island arc volcanism.

CLOCCHIATTI, Robert, and PERNA, Guiliano, 1974, A study of the inclusions in quartz phenocrysts from acid volcanic rocks and in detrital quartz from the Permian of the Italian Dolomites: Rendiconti della Società Italiana di Mineralogia e Petrologia, v. 30, p. 441-458 (in Italian; translation courtesy Chris Eastoe). First author at CNRS, E.R. n° 45, Lab. de Géochimie, Fac. des Sciences, 91 - Orsay, France.

A study of incs. in quartz from the volcanics of the "porphyry platform" of the Trente region, and in detrital quartz from the "Arenarie della Val Gardena" and the *Bellerophon* formation of the Dolomites. Vitreous melt incs. in quartz phen. throughout the porphyries are of similar morphology, although preservation of the glass varies according to the age and the lithology of the rock. The "Arenarie della Val Gardena" contains quartz derived from the porphyries and from the xline. basement. The quartz grains of eruptive origin are better preserved than the xls. in the "Arenarie della Val Gardena." There are no detrital grains of basement origin in the *Bellerophon* formation; here authigenic quartz coats quartz of rhyolitic origin.

CLOCCIATTI, Robert, and WEISS, Jacqueline, 1972, Ion probe evidence for the growth of a mineral from the glassy phase trapped in its cavities: Comp. Rendus Acad. Sci. Paris, v. 276, p. 3405-3408 (in French; translation courtesy Chris Eastoe). Authors at Equipe de Recherche n° 45 du CNRS, Lab. de géochimie, Univ. de Paris-Sud, 91405 Orsay, France.

The vitreous incs. in eruptive quartz xls. sometimes contain xlites. These may have been present in the melt before the quartz xlized. from it, or may have formed from the glass of the inc. The latter case is generally termed "magmatic devitrification", the principal characteristic of which is the absence of the exchange of matter between the xl. and the surrounding mesostasis. Quartz phenocrysts from a borehole in the lateritic clays of Pointe-à-Pitre Bay were studied by microscope and ion probe.

Magmatic devitrification consists of two stages:

1) The *initial* stage, in which a lightly tinted aureole, sometimes birefringent and clearly distinct from the glass, forms a layer $\lesssim$10 µm thick against the cavity wall. The rest of the glass is sprinkled with minute gas bubbles, very small opaque crystals (< 2 µm) and sometimes lamellae of quartz (2-5 µm.) 2) The *final* stage, in which the aureole is replaced by sheaves and bundles of pleochroic green birefringent $\gtrsim$10 µm xls., with parallel extinction. Stacks of hexagonal lamellae,

thought to be biotite or chlorite, have been observed, and in the cavity centers tabular or arborescent quartz xls. assoc. with gas bubbles appear simultaneously. All intermediate stages of devel. have been encountered.

Ion probe images (and electron microprobe scanning) of the initial stage incs. show two types of distrib. of Si, Al, Fe, Ca, Mg, Na, and K, both representing inward growth of the cavity walls:

1) A zone several μm thick, depleted in Si but enriched in the other elements, is found against the walls of automorphic cavities, e.g., Mg may be enriched 10 times over its mean conc. in the glass. Si has diffused towards the xl. , and the cavity walls have grown inward slowly enough to permit the diffusion of the other elements in the glass.

2) An aureole of glass droplets or of small min. particles conc. in all the elements but Si forms behind the silica xliz. front, marking at its outer limit the former cavity wall. The speed of the silica xliz. was greater than that of the diffusion of the other elements which have therefore been left behind the xliz. front.

For the final stage, the growth of phyllosilicates is explained by the form. in front of the growing cavity wall of a zone of favourable chemical comp. for the xliz. of hydrated ferro-magnesian mins. This was confirmed by heating identical but wholly vitreous incs. After 4 days at 770°, modification of the walls by the dep. of silica is very clear. After 14 days at 740°, red flakes of biotite appear on the periphery.

Thus it is confirmed that eruptive xls. can grow from melt incs. The ion probe has permitted the details to be understood, including a special type of devitrification. Automorphic cavities can result from the evolution of initial cavities, and the comp. of the glass in them may be locally modified. (Authors' abstract, abbreviated)

CLOCCHIATTI, Robert, and WESTERCAMP, D., 1974, The nature and origin of quartz phenocrysts from the lavas of Martinique, Lesser Antilles: Bull. Volcanologique, v. 38, p. 44-64 (in French; translation courtesy Chris Eastoe). First author at E.R. n° 45, CNRS, Lab. de Géochimie, Fac. des Sciences, 91 Orsay, France.

The lavas of Martinique may be divided into two volcanic series: high-Al basalts resulting from fractional xliz., and low-K calc-alkaline rocks resulting from the contamination of the former magma by rocks rich in Si and Al. The study of glass and min. incs. in quartz phen. allows constraints to be placed on the nature of the siliceous contaminant. Possible mechs. range from the incorporation alone of quartz xenocrysts to the absorption of free silica and the early pption. of quartz phens. In the case of the more acid massive lavas the two processes have taken place together, with later resorbtion of the quartz in biotite dacites and andesites. Comparison of the glass incs. in the lavas with those in assoc. tonalitic enclaves rules out the possibility of mechanical incorporation of quartz from such coarse-grained rocks. The evidence identifies the quartzes of the massive lavas with those of the pumices.

COLLINS, A.G., 1974a, Geochemistry of oil field waters: Amsterdam, Elsevier, about 430 pp.

Of interest to many working with inclusions in sediments. (ER)

COLLINS, A.G., 1974b, Geochemistry of oil-field water applied to exploration: Oil and Gas Journal, May, 1974, 5 pp.

A short discussion of the chemical and physical parameters and their significance in oil exploration, of pertinence to students of inclusions in sediments. (ER)

COLLINS, A.G., 1974c, Geochemistry of liquids, gases, and rocks from the Smackover Formation; U.S. Bur. Mines Rept. Invest. 7897, 84 pp plus 22 figures and 16 tables.

An extensive discussion of the chemical features of the oil field brines of this formation in southern US, of pertinence to students of inclusions in sediments. (ER)

COOPER, A.F. and GITTINS, J, 1974, The system Na_2CO_3-K_2CO_3-$CaCO_3$ at 1 Kb and its significance in carbonatite petrogenesis (abst): Geol. Assoc. Can. - Mineral. Assoc. Can. 1974 Meeting, Newfoundland Program, p. 20. (Also printed in The Canadian Mineral., v. 12, pt. 6, p. 430). First author at Depart. of Geology, University of Otago, New Zealand.

Details of the subject system are delineated. The crystallization of natrocarbonatite lavas in Tanzania is interpreted in terms of this ternary system. It is concluded that the lavas have probably separated immiscibly from a nephelinitic magma.

It is suggested that alkali carbonatite liquid can develop only if the silica activity is too low for the development of silicates and the magma is dry. In wet magmas alkalis not bound as silicates are lost in the hydrous fluid phase. Alkali carbonatite magmas are probably common but most lose their alkalies and leave a residual melt that crystallizes as the common calcitic, dolomitic and ankeritic carbonatites. Fenitizing fluids can be derived from both carbonatitic and ijolitic (nephelinitic) magmas. (Authors' abstract, abbreviated by ER).

COPLEN, T., 1974, The origin of ground water from various sources in the Imperial Valley, California (abst.): Internat. Symp. on Water-Rock Interaction, Czechoslovakia, Sept. 9-17, 1974, Abstracts: Prague, Geological Survey, p. 9-10 (in English). Author at Inst. of Geophys., Univ. of Cal., Riverside, Cal. 92502, USA.

CORLISS, J.B., 1974, Sea water, seafloor spreading, subduction, and ore deposits (abst): Geol. Assoc. Can. - Mineral. Assoc. Can. Meeting, Newfoundland, 1974, Program, p. 21. Author at School of Oceanography, Oregon State University, Corvallis, Oregon.

The existence of extensive sea water-basalt hydrothermal systems accompanying submarine volcanism is supported by a large set of independent geological, geochemical, geophysical, and oceanographic observations. These hydrothermal solutions have produced extensive basal metalliferous sediments in the modern oceans and massive stratiform sulfide bodies and other metal deposits now exposed on land. It is likely that this process is important for the formation of a wide variety of ore deposits related to the marine environment. In addition, there is evidence that the hydrothermal circulation of sea water alters the crust to a significant depth, at least several kilometers, adding both water and chloride to the rocks. Following subduction, this altered upper part of the oceanic crust, including any basal metalliferous sediment, is the low melting component of the lower crust-upper mantle complex along the subduction zone.

These observations suggest that sea water may be the ultimate source of magmatic water accompanying igneous activity overlying subduction zones, that the chlorine from this sea water is responsible for the association of ore deposits with this igneous activity and that the study of the factors controlling the formation and distribution of deep-sea metalliferous sediments may provide insight into the patterns of distribution of these ore deposits. (Author's abstract).

CRERAR, D.A., and BARNES, H.L., 1974, Reactions of chalcopyrite-rich sulfides in hydrothermal solutions (abst.): Amer. Geophy. Union Trans., EOS, v. 55, no. 4, p. 483. First author at Dept. of Geol. and Geophys. Sci., Princeton Univ., Princeton, N.J. 08540.

Solubilities of the assemblages chalcopyrite + pyrite + bornite, and copper + chalcocite have been measured in subcritical aqueous NaCl and NaHS-H_2S solutions under the following conditions: 200°-350°C; neutral pH ±2.5; up to 10.4 m NaCl and 2.85 m NaHS; and 15-256 atm total pressure. (From the authors' abstract)

CROSS, Christina, and HOLLOWAY, John,1974, A megacryst-bearing alkali basalt, San Carlos, Arizona (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 6, no. 5, p. 437. First author at Department of Geology, Arizona State University, Tempe, Arizona

The euhedral nature of the megacrysts of kaersutite, anorthoclase, magnetite, mica and olivine and the inclusions in them suggest that the megacrysts formed by cotectic crystallization from the magma. Olivine microphenocrysts more magnesian than the olivine megacrysts suggests an unusual differentiation sequence. (Authors' abstract, greatly abbreviated by ER).

CUNEY, Michel, 1974, The paragenetic succession of the uranium deposit of Bois-Noirs-Limouzat (Forez, France). Introduction to the analysis of the associated fluid phases: Réunion Annuelle des Sciences de la Terre, 2ème, Pont-à-Mousson, April 1974, p. 127 (in French; translation courtesy Chris Eastoe.) Author at Centre de Recherches Pét., et Géochim., C.O. n° 1, 54500 - Vandoeuvre-les-Nancy, France.

Six phases of min. have been recognized: (1) $FeS_2 + UO_2$, (2a) $SiO_2 + Fe_2O_3$, (2b) $SiO_2 + CuFeS_2$, (3) $CaCO_3 + CaMgCO_3$, (4) $Bi + Bi_2S_3$, (5) secondary U mins. The phases have characteristic assoc. fluids which have been studied by optical microthermometry, crushing and gas-chromatography.

CURRIE, J.B. and NWACHUKWU, S.O., 1974, Evidence on incipient fracture porosity in reservoir rocks at depth: Bulletin of Canadian Petroleum Geology, v. 22, no. 1 (March 1974), p. 42-58: First author at University of Toronto, Toronto, Ontario, Canada.

In assessing the origin of fracture porosity a question arises as to the depths at which fractures develop and become openings that conduct fluid flow. Information bearing on this question can be gained by determining the homogenization temperature of gas-liquid inclusions in the mineral-filling which now occupies some of these fracture openings. Samples are taken from fractures in Cardium sandstone that outcrops in Foothills structure along South Ram River, from fractures in Cardium beds cored within the Ricinus field, and from wells east of this field, in the Foreland. For each locality fluid inclusions display ranges of homogenization temperatures which are interpreted as indicating that opening of fractures developed progressively as an accompaniment to tectonism, regional uplift and erosional unloading. The evidence also indicates that incipient fracture porosity at depth can develop gradually into a network of open fractures under conditions of continued uplift and erosional unloading. (Authors' abstract).

CZAMANSKE, G.K. and RYE, R.O., 1974, Experimentally determined sulfur isotope fractionations between sphalerite and galena in the temperature range 600° to 275°C: Econ. Geology, v. 69, p. 17-25.

Of pertinence to any comparison of isotopic and inclusion temperatures. (ER).

DAVIDENKO, N.M., 1973, Genetic classes and zoning of gold-ore deposits of the Mesozoic Chukotka folded belt (based on 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. 271-272 (in Russian: translation provided through the courtesy of A. Kozlowski). Author at NE Complex Scientific-Research Inst. of Far-East-Scientific Center of Acad. Sci. of USSR, Magadan.

1. In various gold-ore deposits of the Chukotka fold system, differing in structure and mineral composition, a typomorphic series of inclusions of mineral-forming medium were found which, together with textural and structural peculiarities of the ores, provided the main criteria for classification of individual deposits as plutonic, volcanic, subvolcanic and other genetic classes of V.I. Smirnov (1969).

It was ascertained that gold-ore deposits of the plutonic class (mainly Au-quartz-low-sulfide) are characterized by syngenetic gaseous and gaseous-liquid inclusions in early minerals, homogenizing in gas phase $\geqslant T_H$ 350°C. The main stage of quartz has polyphase microinclusions with liquid CO_2, but gas-liquid inclusions with T_H 230-240°C (homog. in liquid) are the main type.

Endogenic deposits of Au of volcanic class (mainly Au-Ag-quartz-moderate-sulfide and Au-Sb-quartz-moderate-sulfide) may be easily recognized by minute liquid inclusions.

Subvolcanic contact-metasomatic Au-ore mineralization in this region (Au-Mo-Cu-moderate- to essentially-sulfide) is characterized by various types of polyphase inclusions (also GL with solid phase). In minerals of productive associations liquid or gaseous-liquid inclusions with a minute mobile gas bubble prevail.

2. T_H revealed a temperature zoning of the Au-ore deposits. For the central parts of Au-quartz-low-sulfide deposits a simple vertical temp. zoning occurs, but in outer parts the reverse vertical zoning was found. In complex Au deposits of the subvolcanic contact-metasomatic class horizontal temp. zoning is prominent. (Author's abstract)

DAWSON, K.M., 1972, Geology of Endako mine, British Columbia, PhD Diss., The University of British Columbia (Canada); Diss. Abst., Int., v. 33, no. 12, pt. 1, p. 5912B, 1973.

Endako Mo dep. and surrounding area were examined in detail, including fluid inc. geothermometry of vein quartz. Hydrothermal fluids that altered and mineralized the stockwork were generated contemporaneously with the cooling of Endako pluton. Abundant early potassic alteration and relatively high fluid inc. Ts attest to the paramagmatic affiliation of vein and alt. min. assemblages. Cross-cutting relations indicate a relative age sequence among the potassic, sericitic and argillic alt. stages that is in agreement with a chem. control based primarily on the activity ratio of K+/H+. Alt. zonation suggests decreasing T from the ore zone towards the south, implying similar T variations for sulphide dep. Fluid inc. studies support this trend. Avg. minimum T_H for fluid inc. in quartz veins from potassic, sericitic and argillic assemblages are >500°C, 480°C and 400°C. Minor element studies show similar T-dependent trends. (Author's abstract considerably abbreviated by ER)

DE, Aniruddha, 1974, Silicate liquid immiscibility in the Deccan traps and its petrogenetic significance: Geological Society of America Bulletin, v. 85, p. 471-474. Author at Department of Geology, University of Calcutta, 35 Ballygunge Circular Road, Calcutta 19, India.

The residual glass in specimens of Deccan trap basalt collected from widespread areas in western and central India shows evidence for the existence of two immiscible silicate liquids, now preserved as globules (0.002 to 0.010 mm in diameter) of dark-brown glass in a groundmass of colorless or light-brown glass. Such clear evidence for the existence of silicate liquid immiscibility was first noted by Roedder and Weiblen (1970a) in the Apollo 11 lunar rocks and subsequently in four occurrences in the United States and Greenland.

It is postulated, because of widespread occurrence of liquid immiscibility in the Deccan traps, that liquid immiscibility should play a significant role in similar igneous magmas in the very late stages of differentiation in a closed system. The ferrodiorite specimens of the Upper Zone of the Skaergaard intrusion show four lines of evidence which indicate the possibility that their iron enrichment might have been partly caused by settling of high-iron immiscible silicate liquid globules. (Author's abstract).

de BOER, R.B., 1974, Thermodynamic and experimental aspects of pressure solution (abst.): Internat. Symp. on Water-Rock Interaction, Czechoslovakia, Sept. 9-17, 1974, Abstracts: Prague, Geological Survey, p. 29 (in English). Author at Koninklijke/Shell Exploratie en Produktie Laboratorium, Rijswijk, Holland.

DEICHA, Georges, 1974a, Tendances actuelles de l'investigation des cavités intracristallines à inclusions fluides: Soc. fr. Minér. Crist., Bull., v. 97, no. 6, p. XIV (in French).

A review of recent inclusion conferences. (ER)

DEICHA, G., 1974b, Fluid inclusions in crystals: Internat. Mineral. Assoc. Ninth Gen. Meeting, West Berlin and Regensburg, W. Germany, Collected Abstracts: West Berlin, German Mineralog. Soc., p. 23 (in English). Author at Saint-Germain-en-Laye, France.

An introductory review of the importance of fluid inclusion studies and recent meetings involving them. (ER)

DEMIN, V.M. and KURSHEV, S.A., 1973, Determination of the dimensions of inclusions in minerals by the decrepitation method: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 291-292 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Rostov Univ.

1. Determination of the dimensions by the optical method is limited by the wavelength of light, precluding investigations of inclusions smaller than 1-2 μm. The investigator must study inclusions subjectively and obtain objective data by statistical treatment. In addition, opaque minerals are not suitable for this method.

2. Electron microscopy provides data on minute inclusions in each mineral by the use of replicas, but very high resolving power permits study of only small, local areas of crystals, and large inclusions are out of the range of observation.

3. Recent decrepitometric apparatus permits recording of the breaking of inclusions, beginning with a minimum dimension determined by band pass of the microphone. No other existing apparatus for registration of inclusion decrepitation differentiates by size. During evaluation of final results of the analysis, important characteristics related to the sizes of broken inclusions are not taken into account.

4. The effects of similar inclusions, breaking within a given bandpass for the sensitive element of the apparatus, will differ in amplitudes depending mainly on inclusion dimension.

5. Including in the design an element for amplitude selection permits one to distinguish the spectrum of decrepitation effects. Then for each temperature interval decrepitation curves will be recorded (depending on number of amplitude selectors used), corresponding to each group of dimensions used.

6. The sensitive element for such apparatus should have a wide band of frequency transmission. Low-background lamp LM-2 or piezoceramic elements are recommended.

7. The data obtained by the above mode is more complete. In some cases it provides estimates of the speed of crystallization of minerals, degree of ordering of the structure, and gives data on some aspects of the conditions of crystallization. (Authors' abstract).

DEMIN, Yu.I., KROPACHEV, S.M., and MEL'NIKOV, F.P., 1973, Application of decrepitometry for prospecting of ore deposits: Geol. Rudn. Mest., v. 15, no. 5, p. 120-122 (in Russian; abstract courtesy A. Kozlowski). Authors at Moscow State Univ.

The paper presents the methods of decrep., studies of eluvial-deluval samples from Starkovskoe polymetallic dep., the decrep. map of the dep. and discusses the ore and barren decrep. anomalies.

DENIS, Michel, 1974, Alteration and associated fluids in the Sierrita porphyry copper (Arizona, USA). Comparison with other deposits of the same type: Thèse de Spécialité, CRPG - ENSG - Université de Nancy, June 1974, 146 pp. plus 7 plates (in French; translation courtesy Chris Eastoe). Author at Centre de Recherches Pét. et Géochim., C.O. n° 1, 54500 - Vandoeuvre-les-Nancy.

At Sierrita the zones of alt. conform to the classical pattern, close to that of Lowell and Guilbert (1970), with a clearly predominant potassic zone and a late propylitic alt. superimposed on the general pattern. The min. (pyrite, chalcopyrite, molybdenite) is essentially conc. in the zone of potassic alt., and is assoc. with fracture zones related to the contacts of the different intrusions. Chalcopyrite and molybdenite have been dep. by separate gens. of fluids which show neither low d, nor very high salinities. Boiling, the characteristic phenomenon of porphyry coppers, has occurred only to a small degree at Sierrita. Max. T_H is ∿400°C. The P, from the microthermometric data, ranged from 250 to 1500 bars. It is thought that this dep. formed at a greater depth than that normally proposed for porphyry coppers, in an environment of little fracturing. More than 50 chem. anal. for K, Na, Ca, Mg, Cl, and SO_4 show the fluid phase contemp. with the potassic alt. to have been rich in Na and Cl, with K/Na (atomic) = 0.10.

Fluids incs. in porphyry copper deps. of world-wide dist. [including Copper Cities, Tyrone, Santa Rita, Ajo, Morenci, Nacozari, and Mineral Park, and a "barren porphyry" in the Chiricahua Mountains (pp. 117-132)] were also studied. T_{Frz} ranged to <-30°C; T_H ranged up to 500°C, and halite dms are present in incs. in most (all?) deps. Some of these dissolve at $\leqslant$ 600°C; liquid CO_2 is common. These data are shown to represent prospecting criteria of considerable certainty in the recognition of deps. of this type. (Author's abstract, modified by ER.)

DEREVYAGIN, V.S., 1973, Investigations of some microelements in liquid inclusions of rock salt from South of Middle Asia: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 167-168 (in Russian; translation provided through the courtesy of A. Kozlowski). Author at Rostov Univ.

Samples of Upper Jurassic and Lower Cretaceous halite, sylvite and carnallite were extracted for separation of solutions from microinclusions by absolute ethyl alcohol using the routine mode (Slivko, Petrichenko 1967). Three fractions: fresh salt rock, dry residue of alcohol leachates, and salt after extraction were analysed for Li, Rb, Cs, Tl, B and Br.

Following results were received:

1. Li and Cs were found in all analysed dried alcohol leachates in trace amounts (0.0001%). Cs is present in trace amounts in samples of carnalite washed with alcohol. Li and Cs accumulate in solutions during crystallization of salts of various composition, and Cs accumulates in carnallites.

2. The amount of Rb in the dried residue of alcohol leachates regularly increases from halite to carnallite: 0.0022-0.0024-0.0030%, also proving the accumulation of Rb in solution during salt crystallization. The amount of Rb in sylvite and carnallite after washing with alcohol remains relatively high (2-10 times more than in the solutions). For this reason, it seems that Rb accumulates mainly in the solid phase of these K-salts.

3. The lack of Tl (<0.0001%) in all fractions of carnallite rock supports the conclusions (Malikova 1967) on precipitation of this element in the solid phase before crystallization of Carnallite. In halite the concentration of Tl is equal 0.0002, 0.0015 and 0.0001% respectively, i.e. amount of Tl in liquid inclusions in halite is nearly 10 times higher than in the host mineral.

4. Concentration of B in all types of rocks is lower than the sensivity of method of determination (B_2O_3<0.01).

5. On the basis of calculated bromine/chlorine ratios ($4.8\text{-}8.0^{*}$) in inclusions of brine in halite of various age saline formations from Middle Asia, similar ratios were calculated for halite crystallized from solutions included in fluid inclusions (0.18-0.30). The last values are lower than normal ones (0.11-0.087), as obtained during evaporation of ocean water (Valyashko 1956).

Sedimentary solutions, developed in the salt rocks, and in underlying and overlying deposits are also characterized by low bromine/chlorine ratios. Probably the brine of the parent salt basins of J_3 and C_{r1} age was poor in bromine. On the other hand, the calculated ratios for halite are 2-3 times (for salts of J3 age) and 15-30 times (for salts of Cr_1 age) higher than the analytical determinations on samples of fossil salt (halite) from the region discussed.

Results: 1) statement of forms of occurrence of trace elements in salts and ascertaining of the mechanism of accumulation of these elements during crystallization of salt; 2) proposition of existence of additional factors (discussed in another paper), leading to decrease of amount of Br in salt rocks.

Some solutions from this area that have concentrations of Li, B and I that are sometimes higher than in solutions of liquid inclusions, evidently had, in addition to ocean water, additional sources of enrichment of these elements. (Author's abstract). * (Br/Cl data are given as an "index": Br x 1000/Cl)

DIMAN, Ye.N., 1974, Action of hydrothermal HCl- and NaOH- bearing solutions on association native silver-argentite: Geol. Rudn. Mest., v. 16, no. 1 p. 83-88 (in Russian). Author at Geol. Inst. of Yakutian Division of Siberian Branch of Acad. Sci. USSR.

DOBROVOL'SKAYA, M.G., and SHADLUN, T.N., 1974, Mineral associations and conditions of formation of lead-zinc ores, "Nauka", Moscow, 208 pp. and 64 plates (in Russian, abstract courtesy A. Kozlowski).

Authors have investigated six Pb-Zn deposits: Blagodatskoe, Ekaterino-Blagodatskoe, Tsentral'noe and Vozdvizhenskoe (Nerzavodskaya Group); Mikhailovskoe and N. Akatuevskoe, as well as the Shakhtaminskoe Mo deposit and the Novo-Shirokinskoe Au deposit with well developed Pb-Zn ores. Using reference data, authors accepted following Ts based on T_H of incs. in barren mins. and sphalerite: quartz-pyrite-arsenopyrite, pyrrhotite-or pyrite-sphalerite assocs. - 350-250°C, carbonate-sphalerite -galena assoc. - 225-160°C, post-ore quartz-carbonate assoc. - 190-60°C. Authors' dets. of T_D of sphalerites indicate 350-300°C as T of xliz.

DOLGOV, Yu.A., and SHUGUROVA, N.A., 1974, Gas composition in inclusions of authigenous minerals, in Mineralogy of endogenetic deposits, Yu. A. Dolgov and V. S. Sobolev, eds.: Novosibirsk, Acad. Sci. USSR, Sib. Branch, Inst. Geol. and Geophys., p. 119-125 (in Russian; abstract courtesy A. Kozlowski).

Materials were collected during 48th voyage of oceanographic ship "Vityaz'" (May-September 1970). Gas phase composition of individual inclusions in authigenic minerals, crystallized under conditions of ocean bottom deposition at various depths, was investigated. The following minerals were investigated: phillipsite, palagonite, Fe-Mn microconcretions, and mineralized shells of foraminifera. Over 200 analyses in 17 specimens were made. Analysis showed the bottom waters to contain $CO_2 + O_2 + N_2$ + rare gases, with CO_2 varying with depth. CO_2 increases slightly from shallow depths to 4800 m. From 6000 to 9000 m the increase is about 3%. A zone of unstable amounts of CO_2 lies at 4800-6000 m. Generally CO_2 makes up 62.5-83.6 vol. % of gases.

DOLGOV, Yu.A., and VISHNEVSKIY, S.A., 1974, Inclusions in metamorphosed quartz from rocks of the Popigayskaya structure, in Mineralogy of endogenetic deposits, Yu. A. Dolgov and V. S. Sobolev, eds.: Novosibirsk, Acad. Sci. USSR, Sib. Branch, Inst. Geol. and Geophys., p. 51-64 (in Russian; abstract courtesy A. Kozlowski).

Inclusions in diaplectic quartz glass and lechatelierite include gas-liquid inclusions and solid and solidified inclusions.

Many details are covered in abstract by Dolgov, Vishnevskiy, and Shugurova, 1973, in the Rostov volume - see Fluid Inclusion Research - Proc. of COFFI, v. 6, p. 38, 1973. Inclusions in former quartz together with host mineral were formed under action of impact-metamorphism. The shape of inclusions changed to rounded and spherical forms, and the sudden increase of temp. caused a fast increase of pressure inside inclusion to form the enlarged or decrepitated vacuoles. Under such conditions the chemical composition of inclusion may change to form H_2, hydrocarbons, etc.

DOLOMANOVA, E.I, BOGOYAVLENSKAYA, I.V., BOYARSKAYA, R.V., LOSEVA, T.I., and GUNTAU, M., 1974, Data on the conditions of formation of the Ehrenfriedersdorf tin-ore deposit [German Democratic Republic] by means of gas-liquid inclusions: Z. Angew. Geol., 1974, v. 20, no. 8, p. 352-363 (in German with English and Russian abstracts). C.A., v. 82, no. 7, 88549n, 1975.

In addn. to geol. and mineralogical data for the Ehrenfriedersdorf Sn ore deposit, a pneumatolytic-hydrothermal high-temp. cassiterite-quartz formation, the chem. and phys. properties of cassiterite were detd. by x-ray spectral microanal. and microdiffraction. Sylvite, sulfohalite, jacobsite, muscovite, and hauynite were found in the mineral inclusions. Halides, silicates, aluminosilicates, oxides, carbonates, sulfates, and tungstates were detd. Detn. of homogenization and decrepitation temps. of the gas-liq. inclusions in cassiterite, topaz, and quartz showed that such inclusions resulted at temps. near the crit. temp. of water (370-400°, depending on the pressure) when supercrit. solns. become hydrothermal. The hydrothermal solns. are highly concd. and consist of several components contg. volatile material. Changes in pH and Eh values as a function of time indicate the origin of the cryst. minerals and the conditions involved in forming these deposits. (Authors' abstract). Note - see also Dolomanova, Loseva, and Tsepin, 1974, this volume.

DOLOMANOVA, E.I., LOSEVA, T.I., and TSEPIN, A.I., 1974, On the chemical composition of solid precipitates in the vacuoles of cassiterite, tourmaline, and quartz from tin ore deposits, in Problems of endogenetic ore deposits, N.V. Pavlov, ed.: Moscow, Izdat. "Nauka", p. 138-149 (in Russian; see Translations).

DOLOMANOVA, E.I. and VLASOVA, E.V., 1974, Distribution of carbon dioxide in quartz of tin-ore deposits of Transbaikal (from data of infra-red spectroscopy): Zapiski Vses. Mineralog. Obshch., v. 103, no. 6. p. 711-714 (in Russian; see Translations).

DOMBROWSKI, H., 1973, Comparison of biochemical efficiency of living Paleozoic bacteria from the Cambrian to the Permian period, in Symposium on Hydrogeochem. and Biogeochem, Proc, v. 2, Biogeochem; p. 126-132 (in English). Author at Freiburg, Germany.

(Ed note: The author received considerable publicity in the popular press in 1960 when he reported the presence of viable bacterial spores in Paleozoic salt, which he believed to be Paleozoic in origin and hence to have stayed in a dormant state for that time. The presence of secondary fluid inclusions in at least some of the samples (Roedder, 1972, Data of Geochem., USGS Prof. Paper 440JJ, p. JJ-61) raised a question as to the true age of the bacteria found.)

The author made bacterial cultures only from such selected samples "which were considered to be of primary genesis", from the German Zechstein, Nova Scotia Carboniferous, Saskatchewan Devonian, New York Silurian, and Precambrian (Angara series) from Irkutsk. The exterior of the samples was carefully removed under aseptic conditions before culturing. The samples contained liquid inclusions, which are frequently "aligned in stringers which may be observed to cross different grains, while lying in a preferential plane." The author believes these "correspond to the primary channels of dehydration, which are now crossed by the grain boundaries of later recrystallizations". They were presumably formed during early diagenesis. "A suspicion of small posthumous influence cannot be discarded" in the case of the New York sample. The possibility of groundwater contamination to form planes of secondary inclusions is said to be "highly improbable," but without further explanation, except that "the solidity of the specimens is also an argument against a secondary bacterial contamination..." (ER)

DOMINIQUE, Joseph, LHEGU, Jean, and TOURAY, Jean-Claude, 1973, Evidence of geothermal activity in the Lias of Le Morvan: the René-bis vein (La Petite Verrière, Saône-et-Loire, France): B.R.G.M. Bull., 1973, Sect. 2, p. 389-401 (in French; abstract courtesy Chris Eastoe). First author at Lab. de Géol. Appliq., Univ. d'Orléans, France

The René-bis vein is one of several veins making up the Voltenne fluorite dep. It occurs in a volcano-sed. series of Viséan age. The vein contains (in order of pargenesis): 1. "striated" quartz; 2. a "ribboned zone" of quartz, violet fluorite and potash feldspar; 3. milky quartz with green fluorite; 4. "rusty" quartz containing goethite; 5. yellow fluorite bearing sulfides; and 6. barite bearing sulfides. The structure is complicated further by four episodes of fracturing during the dep. of the mins. The K-Ar date of adularia from the vein is 185 ± 5 my: this is the date of the initial min. The depth of the vein at form. is estimated to have been 500 ± 100 m.

Fluid incs. from five fluorite samples were studied. The violet fluorite was dep. by a sol. with a salinity of ∿0 % equi. NaCl at 163 ± 8°C. The green fluorite formed at 140° ± 10°C. The yellow fluorite was dep. by a boiling sol. of ⩽15 % equiv. NaCl at 110° ± 10°C. Green and violet fluorite samples from another vein of the Voltenne dep. gave Ts similar to those of the violet fluorite above. A T of 163 ± 8° at a depth of 500 m implies the existence of abnormal geothermal activity in the region during the Lias.

DONALDSON, C.H., 1974a, Experimental investigation of olivine morphology, (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 6, no. 7, p. 712. Author at Lunar Science Institute, Houston, Texas 77058; and University of St. Andrews, Scotland.

A discussion of the sequence of morphologic types with change in cooling rates for a synthetic hydrous feldspathic peridotite melt. Of pertinence to the problems of trapping silicate melt inclusions. (ER)

DONALDSON, C.H., 1974b, Olivine crystal types in harrisitic rocks of the Rhum pluton and in Archean spinifex rocks: Geol. Soc. Amer. Bull., v. 85, p. 1721-1726. Author at Department of Geology, University of St. Andrews, St. Andrews, Fife, Scotland.

Skeletal and dendritic olivine crystals in the Archean volcanic ultramafic spinifex rocks and in harrisitic ultramafic layers of the Rhum pluton are classified as (1) plate, (2) randomly oriented, (3) porphyritic, or (4) branching type. Volcanic and plutonic examples are remarkably similar. Each type records the degree of pre-nucleation supersaturation with olivine that was attained by the parent melt. The rapid induction of supersaturation necessary to form skeletons and dendrites in a plutonic environment is attributed to changing water content or adiabatic expansion of the magma. The olivine crystals in harrisitic and spinifex rocks are not quench crystals; they grew rapidly from olivine-rich melts as the result of extreme supersaturation induced by slow cooling and slight supercooling below a liquidus with shallow slope in temperature-composition space. Skeletal and dendritic olivine crystals grow readily in magma and are poor indices of cooling rate and crystallization environment. (Author's abstract)

DORFMAN, M.D., IKORSKIY, S.V., LEBEDEV, V.S., and MALOV, V.V., 1973, The origin of aegirine inclusions in nepheline of the Khibiny alkalic pluton: Akad. Nauk SSSR, Doklady, v. 210, no. 1, p. 183-186 (in Russian; trans. in Doklady Acad. Sci. USSR, v. 210, (1974) p. 119-122; abstract in Internat. Geol. Review, v. 15, no. 8, p. 978-979).

Petrologically, such zonal incs. in peg. nepheline may be interpreted as products of the "self-purification" of structural iron in the nepheline, and not as mechanical admixtures, because their shape, size, orientation, and parageneses are very much as in aegirine scattered in the rock-forming nepheline. EPR studies of iron in nepheline, the IR spectra, and other evidence indicate derivation of aegirine from nepheline as an independent xline phase, in marginal parts of the nepheline crystals, by reaction with postmagmatic K-bearing sols. (Authors' abstract, modified)

DOROGOVIN, B.A., 1973, Inclusions in metamorphic and magmatic rocks from a region of the Aldan Shield: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 233-235 (in Russian; translation provided through the courtesy of A. Kozlowski). Author at All-Union Scientific-Research Inst. for the Synthesis of Mineral Raw Materials, Alexandrov.

By thermobarometric methods, inclusions were studied in minerals of metamorphic and magmatic rocks of Verkhnealdanskiy and Fiodorovskiy complexes of Iyengrskaya series, consisting of gneisses and schists, formed under conditions of amphibolitic and granulitic facies. Various types of inclusions were distinguished:

A — Crystallized and solidified inclusions in hypersthene and amphibole (T_H 1100-1200°C), and in garnet from granites (T_H 820°C).

B — One- and two-phase inclusions of CO_2 (V_{CO_2} 1.10 and 1.25 respectively) occur in quartz grains of all types of rocks, except the Upper Archean and Proterozic intrusives. Partial P_{CO_2} at $T = 720°C$ is 5-3 kbars, corresponding seemingly to granulitic facies.

C — Gas inclusions ($F = 0.05 - 0.3$, $T_H = 330\text{-}620°C$ in gas, $P = 0.6 - 1.6$ kbar) are typical for migmatites and granitized gneisses, and schists. Scattered values of T and P are caused by a long-lasting anatexis process and decrease of role of volatiles at the end of process.

D — Highly concentrated G-L inclusions (T_H = 520-560°C in liquid), typical for feldspathic and tourmaline pegmatites.

E — G-L inclusions (F = 0.35 to 0.40, T_H = 410 to 460°C, P_H 1.3 to 1.6 kbar) occur in quartz of all types of rocks and in microcline of feldspathized quartzites.

F — CO_2 plus H_2O inclusions in recrystallized quartzites near mineralized zones.

G — Liquid two-phase inclusions, occurring everywhere; their connection with processes of regional or local metamorphism is not stated.

Data obtained from studies of inclusions allowed distinguishing between ortho- and para-rocks in the metamorphic complex and initially revealed the evolution of the regime of CO_2 and H_2O in the process of progressive metamorphism of rocks, especially the increase of CO_2 and the decrease of H_2O in the granulitic facies. (Author's abstract).

DOWGIAŁŁO, Jan, 1974, Problem of the origin of Cl - HCO_3 - Na mineral waters of the Polish Flysch Carpathians (abst.): Internat. Symp. on Water-Rock Interaction, Czechoslovakia, Sept. 9-17, 1974, Abstracts: Prague, Geological Survey, p. 10 (in English). Author at Zaklad Nauk Geologicznych, Warszawa, Poland.

DOWTY, Eric, KEIL, Klaus, and PRINZ, Martin, 1974, Lunar pyroxene-phyric basalts; crystallization under supercooled conditions: Jour. Petrology, v. 15, no. 3, p. 419-454.

Of interest to the trapping of silicate melt inclusions. (ER)

DRAGOV, P., and KOLKOVSKI, B., eds., 1974, Twelve ore deposits of Bulgaria; Sofia, Internat. Assoc. on the Genesis of Ore Deposits, 268 pp., (in English)

This book, published in only 300 copies, was prepared for the Fourth Symposium of the Internat. Assoc. of the Genesis of Ore Deposits, at Varna, Bulgaria, September, 1974. It includes detailed descriptions, by individual authors, of the following deposits: Sedmochislenitsi (polymetallic); Chiprovtsi (Ag-Pb); Medet (Mo-Cu); Radka (Cu-pyrite); Govedarnika (polymetallic); Obrochishté (Mn); Vurli Bryag (Cu); Krumovo (Fe); Madjarovo (polymetallic); Broussevtsi (Cr); Borieva (Pb-Zn); and Kremikovtsi (Fe). Much of this material has never been available before except in Bulgarian. (ER)

DURNEY, David, 1974, Relations between the temperatures of homogenization of fluid inclusions in metamorphic minerals from the Swiss Nappes of Valais: Soc. Géol. de France, Bull., 7th Series, v. 16, no. 3, p. 269-272 (in French with English abstract). Author at Macquarie University, Earth Sciences, North Ryde. NSW 2113 Australia.

The principles of fluid inclusion geothermometry are extended to synkinematic fibrous crystal growths of low grade metamorphic origin. This provides detailed information on the history of temperature changes (and potentially also on the fluid compositin) during synkinematic regional metamorphism and tectonic deformation. The results obtained for inclusions in extended belemnites of the Helvetic nappes are compared with the published information on alpine metamorphic assemblages and reconnaissance information on illite crystallinity.

The highest peak temperatures deduced from the inclusions do not correspond to the apparent metamorphic temperatures. The upper limit of Kubler's anchizone would be placed in about the middle of the Pennine-Helvetic stilpnomelane zone, corresponding to a T_h peak of about 385°C (uncorrected for pressure). The lower limit of anchimetamorphism probably lies in the laumontite stability field at a T_h lower than 250°C. (Author's abstract).

EADINGTON, P.J., 1974, Microprobe analysis of the non-volatile constituents in fluid inclusions: Neues Jahrbk. Mineral. Mitt., 1974, no. 11, p. 518-525 (in English). Author at North Ryde, N.S.W., Australia.

Minerals which have decrepitated by opening along a cleavage surface through fluid inclusions may have an evaporated residue from the inclusion deposited on the cleavage surface. These residues can be analyses qualitatively by EPMA (electron probe microanalysis).

Using this technique, the elements Na, K, Cl, Fe, Mn, S, Sn and W were identified in the evaporated residues of inclusions in fluorite from a pegmatitic tungsten deposit near Torrington, New South Wales. The elements Pb, Zn, Cu, As, Ni, Mg and Bi could not be detected and, if present, were below the sensitivity of the microprobe (approximately 10^{-13} to 10^{-14} g).

The method, although qualitative, seems useful for the study of fluid inclusions, since data are obtained on individual inclusions. In addition, it is possible to analyse for elements which are otherwise difficult to determine when present in trace amounts. (Author's abstract).

EFIMOVA, M.I., GERSHOYG, Yu.G, AND RESHETNIKOVA, O.M., 1973, Physicochemical conditions of formation of vein quartz from Krivbass: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-20 Sept. 1973: Rostov, Rostov Univ. Press, p. 231-232 (in Russian; translation through the courtesy of A. Kozlowski). Authors at Krivoy-Rog Mining Inst.

1. Vein quartz at Krivbass is wide-spread in wall rocks as well as in ores. Some genetic groups of quartz may be distinguished (...). All quartz was investigated by the decrepitation method, and most transparent varieties by the homogenization method. Four monomineralic samples were analyzed by the water leachate method.

2. (...) In vein quartz, primary, pseudosecondary and secondary inclusions were found, of the following varieties: one-phase gaseous, one-phase liquid, two-phase gas-liquid, three-phase with liquid CO_2, and a large amount of solid inclusions. The inclusions have various shapes but usually are equant negative crystals, dimensions 0.0X-0.00X mm. Inclusions occur in the center of grains, in the peripheries of the largest grains, and in intergranular spaces, as well as in recrystallization zones.

3. On decrepigraphs the following peaks of mass decrepitation occur: 520-560, 330-410, 180-270 and 180-200, 260-280, 350-400, 520-560°C (the peak 520-560°C is caused by $\beta \rightarrow \alpha$ quartz inversion). Maximum T_D is 350-400°C; lower T_D is caused by inclusions in healed microfractures.

4. Homogenization of primary G-L 2-phase inclusions and heterogeneous groups of inclusions both in liquid phase proves crystallization of the quartz from liquid solutions. T_H varies: the highest T_H for Annovskiy Quarry (350-370°C); secondary inclusions have T_H 90-110 and 200-205°C (...).

5. Concentrations are relatively high (31.9-42.7 g/kg H_2O); composition is Cl-Na or Cl-HCO_3^--Na type; pH 7.3-7.5. Small amounts of K-ion and constant presence of B are characteristic.

6. These data prove that this quartz crystallized from moderate-temperature alkaline or weakly alkaline metamorphic solutions. Presence of CO_2 in inclusions as individual gaseous (sic; may be misprint for liquid?) phase and prevailance of Na over K point to facies of low to intermediate depths of mineral formation. (Authors' abstract)

EGGLER, D.H., 1974, The effect of CO_2 on the melting of peridotite: Carnegie Institution of Washington Yearbook 73, p. 215-224, (pub. 1974).

EGGLER, D.H., and BURNHAM, C.W., 1973, Crystallization and fractionation trends in the system andesite-H_2O-CO_2-O_2 at pressures to 10 kb: Geol. Soc. Amer. Bull., v. 84, p. 2517-2532. First author at Geophysical Laboratory, 2801 Upton Street, Washington, D.C. 20008.

An experimental study of the Mount Hood andesite composition. (ER)

EGGLER, D.H., MYSEN, B.O., and HOERING, T.C., 1974, Gas species in sealed capsules in solid-media, high-pressure apparatus: Carnegie Institution of Washington Yearbook 73, p. 228-232, (pub. 1974).

EGGLER, D.H., MYSEN, B.O., and SEITZ, M.G., 1974, The solubility of CO_2 in silicate liquids and crystals: Carnegie Institution of Washington Yearbook 73, p. 226-228, (pub. 1974).

EGOROV, V.M., and IKORNIKOVA, N. Yu, 1973, Partial molar volumes of aqueous chloride solutions at high temperatures and pressures: Zapiski Vses. Mineral. Obshch., v. 52, no. 3, p. 272-282 (in Russian).

Includes data on NaCl-H_2O at T = 196-313°C and P = 500-1500 bars. (ER)

ELINSON, M.M, MATSKEVICH, E.B., and IGNAT'EVA, I.B., 1973, Methods of studying the composition of the gaseous phase and the amount of water in fluid inclusions, minerals and rocks: 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, the USSR Academy of Sciences, Moscow. * p. 295-296

To measure accurately the specific amounts of the components to be identified, it is necessary to know the degree of sample disintegration, i.e., the main size of the crushed particles of the sample. To this end, the absorption method has been developed to measure quickly particle sizes after sample crushing aimed at extracting gas and water.

After heating the sample, the number and size of the opened inclusions were determined under the microscope.

A comparison of the mechanical and thermal methods of gas extraction has shown that the former occasionally provided better gas extraction.

The effects of mechanical crushing on the composition of the extracted gas were tested with the use of simulated samples. It has been proved that no changes in the composition of the extracted gas took place providing that an appropriate material is chosen.

To determine more reliably and thoroughly the composition of the extracted gas, independent methods are needed to check and mutually compliment the results obtained by them.

The results of our experiments prove that a combination of chromatographic equipment with specially designed volumetric and condensation-absorption instruments is the most effective in studying the composition of a gaseous phase of inclusions. Also, use of mass-spectroscopic equipment is desirable.

Total water from fluid inclusions was measured with the use of a special apparatus involving an electrical sensor and by a measuring gas burette. (Authors' abstract).

El SHATOURY, H.M., TAKENOUCHI, Sukune, and IMAI, Hideki, 1974a, Fluid inclusion studies of some beryliferous pegmatites and a tin-tungsten lode from Egypt: Mining Geology, (Japan), v. 24, p. 307-314 (in English with Japanese abstract). First author at Geology and Nuclear Raw Materials Department, Atomic Energy Authority of Egypt, Cairo, Egypt.

Fluid inclusions from beryliferous pegmatites in the southern part of the Eastern Desert of Egypt are two-phase, plus some with liquid CO_2. T_H range between 250°C and 458°C. Secondary fluid inclusions, probably related to incipient hydrothermal argillic alteration of beryl, homogenize between 122°C and 250°C. The wide range of homogenization temperatures may reflect a rather complex history of crystallization of beryl, particularly when it is characteristically color zoned.

Fluid inclusions from quartz associated with tin-tungsten lodes at the Igla mine in the central part of the Eastern Desert are two-phase, with various degrees of filling. This indicates their formation from a heterogeneous mixture of liquid and vapor. T_H for quartz, a late mineral in the paragenetic sequence, ranges between 190°C and 390°C. From the paragenesis of mineralization and by analogy with similar occurrences, it is inferred that crystallization of cassiterite and wolframite at Igla mine took place at temperature around 400°C. (from authors' conclusions).

EL SHATOURY, H. M., TAKENOUCHI, Sukune, and IMAI, Hideki, 1974b, Fluid inclusion studies on the Toyoha mine, Hokkaido (abst.): Internat. Assoc. on the Genesis of Ore Deposits, Fourth Symposium, Varna, Sept. 1974, Abstracts of Papers: Sofia, IAGOD, p. 275-277 (in English). Authors at Dept. of Min. Dev. Eng., Univ. of Tokyo, Tokyo, Japan.

The Toyoha mine is the principal producing Pb-Zn-Ag vein-type deposit related to Miocene volcanicity in Japan. Fluid inc. studies were made to provide relevant information about the genesis of this economically important deposit.

The intrusive quartz porphyry contains glass incs. as well as two-phase and polyphase fluid inclusions with halite. The two-phase inclusions are liquid and gas in various ratios, signifying boiling. Fluid incs. in sphalerite are all L + G, but some in quartz contain birefrigent, occasionally radiating, unidentified minerals. The gas-liquid ratio in incs. in quartz associated with the ore and that from veins cutting the ore varies from gas-rich to liquid-rich, indicating boiling at the time of trapping.

The range of salinity of fluid incs. in sphalerite ranges from 0.8 to 4.0 wt. % equiv. NaCl but most are 2.4 to 3.2%. T_H of these incs. is 180°C to 220°C, with most 190°C to 210°C. Salinities in the quartz gangue, however, have a rather wider range from nearly fresh to about 4.0% (most 0.8 to 1.8). T_H range from 150°C to 230°C, plus three in the range 240°C to 260°C.

Post-ore quartz veins with a definite cross-cutting relation to ore have significantly lower T_H than the ore veins; they range from less than 150°C to 200°C, with most ∿150°C.

Incs. from quartz porphyry show a wide range of salinity from highly saline to <1%. T_H of these incs. also range widely, from 210°C to >400°C, with T_H for some S incs. = 160-170°C.

The ore-forming fluid must have been derived through dilution of parent magmatic fluids, represented in the polyphase incs. in the quartz porphyry. These magmatic fluids are thought to have been released from the deeper reservoir from which the quartz porphyry evolved. (Abbreviated by ER from the authors' abstract.)

EPEL'BAUM, M.B., 1974, Change of alkalinity and some structural peculiarities of acid water-bearing melts: in Contrib. to Physico-Chem. Petrology, V.A. Zharikov, et al., eds.: Moscow, "Nauka" Pub. House, v. 4, pp. 233-256 (in Russian; abstract courtesy A. Kozlowski).

Comparison of change of alkalinity during dissolving of water det. from exper. data on change of eutectic points in systems: quartz-albite, quartz-orthoclase, quartz-albite-orthoclase, with data derived from calc. on sol. of water in the various melts proves that water dissociates in melts releasing two protons. The change of alkalinity of quartz, albite, orthoclase, granite and basalt melts with P_{H_2O} was discussed. In melts of feldspars and granite with increase of P_{H_2O}, the alkalinity passes through a max. Possible causes of the large changes of alkalinity of these melts are discussed. The supposition was made that during dissolving of water, AlO_4 tetrahedrons decompose and Al alters into cation form. (Author's abstract).

EREMIN, R.A., 1974, Hydrothermal metamorphism and ore mineralization of Armanskaya volcano structure: SVKNII DVNC†AN SSSR, Trudy, v. 43, 134 pp. (in Russian ; abstract courtesy A. Kozlowski).

In minerals of Au-Ag deposits: Finish and Utyosone, the following Ts were determined: alunite T_H 50-80°C, antimonite T_D 170-210°C, quartz T_H 172-206, T_D 210-260°C, pyrargyrite T_D 170-220°C, adularia 230-240°C (Utyosnoe deposit); quartz T_H 80-240°C, calcite T_H 170-204°C, fluorite T_D 180-210°C, adularia T_H 195-200°C, T_D 210-260°C (Finish deposit); industrially productive mineral assemblages formed at 200-230°C.

Analyses of water leachates, mg./100g of rock

	fluorite	calcite	quartz	adularia	hydrothermal quartzites
pH of leach water	6.6	6.6	6.6	6.6	(Four samples.)
pH of leachate.	7.2	7.7	7.4	7.9	
Na^+	0.007	0.008	0.06	0.01 }	0.482-0.19
K^+	0.003	0.01	0.05	0.06 }	
Ca^{2+}	0.26	0.64	1.27	0.11	0.011-0.007
Mg2+	0.16	0.10	0.16	0.06	0.015-0.002
Σ of cations	0.43	0.76	0.54	0.24	
$HSiO_3^-$	-	0.19	-	-	-
HCO_3^-	0.34	0.56	0.41	0.53	0.155-0.075
Cl^-	0.015	0.01	0.01	0.07	0.347-0.089
SO_4^{2-}	-	-	0.08	0.11	0.34-0.034
SiO_2	37.71	48.83	37.86	-	90.0-28.0
Σ of anions	0.36	0.76	0.50	0.71	
General mineralization (sic.)	0.89	1.52	1.13	0.95	0.984-0.427

Solutions had HCO_3-Ca-Mg type composition with high concentration of SO_4 and increasing rôle of alkaline metals at the time of precipitation

of productive mineral association. (Author's abstract)
[†] NE Complex Scientific-Research Institute of Far-East Scientific Center

ERMAKOV, N.P. and PIZNYUR, A.V., 1974, Finding commercial ores by use of thermobarogeochemical indices of conditions of mineral formation (abst.): Internat. Assoc. on the Genesis of Ore Deposits, Fourth Symposium, Varna, Sept., 1974, Abstracts of Papers: Sofia, IAGOD, p. 250-251 (in Russian; translation courtesy A. Kozlowski). First author at Moscow Univ., USSR.

At E. Kounrad fluid incs., both above and below the body, bear halite + hematite. In quartz of W. plot such incs. are absent, but CO_2-bearing incs. occur, being typical for late, non-commercial mineralization. Ores were formed in narrow T_H ranges (360-280°C). P. det. on basis of P. incls. at E. and Central part of ore dep. was ~1000-1100 atm. and first molybdenite formed during P. decrease to 950-920 atm. Later fracturing was accompanied by P. decrease to 340-350 atm, resulting in boiling of sols. and separation of CO_2, especially at T = 275-290°C and P = 500-530 atm. These changes of P-T regime caused separation of sols. to give CO_2-aqueous and Cl-aqueous sols. as well as decomposition of complex soluble compounds of W, Mo, Bi to form ore (and barren) mins.

At Zhireken dep. numerous three-phase incs. with halite occurred in borehole samples from rocks bearing rich commercial ores. Similar incs. were found in samples taken at the surface at previously unsampled areas. Superposition of these areas on commercial ore was confirmed by drilling. Here sols. split into H_2O+CO_2 and $H_2O+NaCl$ types at T = 400-500°C and P - 1500-atm, followed by boiling, stimulating form. of ores at P = 1000 atm and less, T = 300-420°C. This prospecting method was named the G/L incs. typomorphic features method and it is auxiliary to decrep. and CO_2-H_2O methods of prospecting, illustrated by examples from hydrothermal deps. of Aldan. (Authors' abstract, shortened by A.K.)

ESSENE, E.J., 1974, Barometry in metamorphic rocks (extended abst.): Geol. Soc. Amer. Abstracts with Programs, v. 6, no. 7, p. 724-726. Author at University of Michigan, Department of Geology and Mineralogy, Ann Arbor, Michigan 48104.

A discussion of the various geobarometers and their dependence on fluid compositions. (ER)

ETMINAN, Hachem, 1974, The distribution of fluid inclusions in the porphyry coppers of Sar Cheshmeh and Darreh Zar, Iran: Réunion Annuelle des Sciences de la Terre, 2ème, Pont-à-Mousson, April 1974, p. 167 (in French; translation courtesy Chris Eastoe). Author at Centre de Recherches Pét. et Géochim., C.O. n° 1, 54500 - Vandoeuvre-les-Nancy, France.

Three main inc. types have been found:
(1) Multiphase: small gas bubble, aq. sol., halite and often sylvite, hematite, chalcopyrite and ? anhydrite. The size of the chalcopyrite tetrahedra implies a Cu conc. of 2000-3000 ppm, in the brine.
(2) Essentially gaseous: (85% of all incs.) Occasionally these contain halite or chalcopyrite and, at Sar Cheshmeh, a film of liquid CO_2.
(3) Two-fluid phase: present in all samples but constituting only 5% of total incs.

	Multiphase			Essentially gaseous		Two-phase		
	T_H	T_S*	T_D	T_H	T_D	T_H	T_{Frz}	T_D
Sar Cheshmeh	270-360	410-470	650	300-470	680			
Sar Cheshmeh Apex	180-270	230-390	470-500	relatively rare		200-300	-1 to -30°	400°
Darreh Zar	230-360	180-310						

*T_S = T of sol. of NaCl dm.

EVANS, B.W., and TROMMSDORFF, Volkmar, 1974, Stability of enstatite + talc, and CO_2-metasomatism of metaperidotite, Val d'Efra, Lepontine Alps: Amer. Jour. Sci., v. 274, p. 274-296.

In amphibolite facies ultramafics of the Central Alps, regional metamorphism accompanied by CO_2-metasomatism involved the formation of enstatite + talc in textural and chemical equilibrium, and a later growth of anthophyllite. The pertinent systems are examined in an attempt to evaluate T, P, and CO_2/H_2O. (ER)

FEISS, P, 1974, Reconnaissance of the tetrahedrite-tennantite/enargite-famatinite phase relations as a possible geothermometer: Econ. Geol., v. 69, p. 383-390. Author at Department of Geological Sciences, Albion College, Albion, Michigan.

Data from the Julcani mining district, Peru, agree with unpublished fluid inclusion data (325-365°C) (p. 389). (ER)

FORESTER, R.W. and TAYLOR, H.P., Jr., 1974, Oxygen, hydrogen and carbon isotope systematics in the early Tertiary igneous province of Skye, Northwest Scotland (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 6, no. 7, p. 742. First author at University of Saskatchewan, Department of Geological Sciences, Saskatoon, Canada.

In southern Skye, $\delta^{18}O$ analyses of 350 samples show that almost all the rocks within 4 km of the central intrusive complexes are depleted in ^{18}O due to extensive interaction with heated meteoric ground waters. The δD values (SMOW) of sericites (-104 to -107)*, and amphiboles, chlorites, and biotites (-105 to -128) from the igneous rocks are all low compared to "normal" igneous rocks, indicating that Eocene surface waters at Skye had $\delta D \approx -90$ and $\delta^{18}O \approx -12$. The average integrated water/rock ratio for the Skye hydrothermal system is approximately one; at least 1000 km^3 of heated meteoric waters were cycled through these rocks. (Authors' abstract, abbreviated) * Probably all values are per mil.

FOURNIER, R.O., and TRUESDELL, A.H., 1974a, Estimating subsurface temperatures where warm springs result from mixing of hot and cold waters (abst.): Internat. Symp. on Water-Rock Interaction, Czechoslovakia, Sept. 9-17, 1974, Abstracts: Prague, Geological Survey, p. 59 (in English). Authors at U.S. Geol. Surv., Menlo Park, Cal., USA.

FOURNIER, R.O. and TRUESDELL, A.H., 1974b, Geochemical indicators of subsurface temperature-part 2, estimation of temperature and fraction of hot water mixed with cold water: U.S. Geol. Survey Jour. Research,

v. 2, no. 3, May-June 1974, p. 263-270. Authors at U.S. Geological Survey, Menlo Park, Calif.

The water in many warm springs with large rates of flow consists of mixtures of hot water that has come from depth and of shallow cold water. Under favorable conditions the original temperature of the hot water and the fraction of the cold water in the mixture can be estimated by using the measured temperature and silica content of the warm spring water and the temperature and silica content of nonthermal water in the region. The method has been applied with apparent success at Yellowstone National Park. (Authors' abstract).

FOURNIER, R.O. and TRUESDELL, A.H., **1974c**, Geochemistry applied to exploration for geothermal energy (abst.): Econ. Geol., v. 69, p. 1179-1180. Authors at U.S. Geological Survey, Menlo Park, California.

The chemical and isotopic compositions of hot spring waters and gases are now widely used to estimate sub-surface temperatures in geothermal systems. To date, the most useful geothermometers utilize dissolved silica, Na/K ratios, Na-K-Ca relationships, fractionation of O^{18} between dissolved sulfate and water, fractionation of C^{12} between CO_2 and bicarbonate and between CO_2 and CH_4, and fractionation of hydrogen isotopes among H_2, CH_4, and H_2O.

In using chemical geothermometers, it is necessary to consider, in addition to the kinetics of the reactions, possible effects of mixing hot water ascending from deep in the system with cool shallow water of different composition. Studies of the temperature and composition (chemical and isotopic) of normal ground water in a given region, combined with data on temperature and composition variations of thermal springs give valuable information about subsurface mixing. Where mixing of hot and relatively cold water appears to have taken place, it may be possible on the basis of chemistry to estimate the original temperature of the hot water component and the fraction of cold water in the mixture.

Variations in chemical and isotopic compositions of water and gas also may give information about directions of subsurface flow and the existence of aquifers at different depths and temperatures. Where subsurface boiling (adiabatic cooling) occurs during ascent along a dipping structure, the following ratios should decrease in the direction of flow: Cl^-/HCO_3^-, H_2S/CO_2, $(H_2S + CO_2)$/total gas, and total gas/water. (Authors' abstract).

FOURNIER, R.O., WHITE, D.E., and TRUESDELL, A.H., 1974, Geochemical indicators of subsurface temperature-part 1, basic assumptions: U.S. Geological Survey Jour. Research, v. 2, no. 3, May-June 1974, p. 259-262. Authors at U.S. Geological Survey, Menlo Park, Calif.

The chemical and isotopic compositions of hot-spring water and gas are used to estimate subsurface temperatures. The basic assumptions include (1) a temperature-dependent reaction at depth, (2) a supply of the solid phase involved in the reaction to permit saturation of the constituent used for geothermometry, (3) water-rock equilibrium at depth, (4) negligible re-equilibration as the water flows to the surface, and (5) no dilution or mixing of hot and cold water. The first three assumptions are probably good for a few reactions that occur in many places. The last two assumptions probably are not valid for many hot-spring systems; information obtained is therefore for the shallower parts of those systems, or a limiting temperature (generally a minimum) is indicated. (Authors' abstract).

FREEMAN, Tom., 1973, Temporal dolomite-calcite sequence and its environmental implications (abstr.): Am. Assoc. Pet. Geol., Bull., v. 57, no. 4, p. 780.

Where dolomite and calcite cements occur together, calcite is commonly the younger. This is true of cements that fill both primary (intergranular and intraskeletal) and secondary (vug and vein) pores. Rarely there is an alternation of cement types, but where this occurs, dolomite is still usually the penultimate and calcite the ultimate.

In primary pores, the most likely unidirectional process producing the sequence, dolomite-calcite, is a change from marine to freshwater phreatic conditions through a lowering of sea level, elevation of the land, or increase in freshwater head.

In secondary pores, fluid inclusion studies of epigenetic dolomite-calcite show the dolomite to be both hotter and saltier than the associated younger calcite. Therefore, this sequence most likely records precipitation concomitant with erosional unloading, which should both reduce the geothermal environment and promote a freshening of the water. (Author's abstract).

FRIEDMAN, Irving, GLEASON, J.D., O'NEIL, J.R., and ADAMI, L.A., 1974, (Revised fractionation factor (abst.)): Geol. Survey Research 1974, U.S. Geol. Sur. Prof. Paper 900, p. 143.

Knowledge of the oxygen-isotope fractionation factor between CO_2 and H_2O at 25°C is of prime importance in oxygen-isotope geochemistry. Published values range from the generally accepted value of 1.0407 to 1.0428, while precision assoc. with the det. is ±0.0001. New independent dets. have been made. The new values are 1.0414 and 1.0412, resp. It is clear that the true factor is larger than the accepted value of 1.0407. (Authors' abstract)

FRIEDMAN, Irving, LIPMAN, P.W., OBRADOVICH, J.D., GLEASON, J.D., and CHRISTIANSEN, R.L., 1974a, Meteoric water in magmas (abst.): Geol. Survey Research 1974, U.S. Geol. Sur. Prof. Paper 900, p. 133-134. (See next item)

FRIEDMAN, Irving, LIPMAN, P.W., OBRADOVICH, J.D., GLEASON, J.D., and CHRISTIANSEN, R.L., 1974b, Meteoric water in magmas: Science, v. 184, p. 1069-1072. First author at U.S. Geological Survey, Denver, Colorado.

Oxygen isotope analyses of sanidine phenocrysts from rhyolitic sequences in Nevada, Colorado, and the Yellowstone Plateau volcanic field show that $\delta^{18}O$ decreased in these magmas as a function of time. This decrease in $\delta^{18}O$ may have been caused by isotopic exchange between the magma and groundwater low in ^{18}O. For the Yellowstone Plateau rhyolites, 7000 cubic kilometers of magma could decrease in $\delta^{18}O$ by 2 per mil in 600,000 years by reacting with water equivalent to 3 millimeters of precipitation per year, which is only 0.3 percent of the present annual precipitation in this region. The possibility of reaction between large magmatic bodies and meteoric water at liquidus temperatures has major implications in the possible differentiation history of the magma and in the generation of ore deposits. (Authors' abstract).

FYFE, W.S., 1974, The ocean ridge environment: Heat and mass transfer (abst.): Geol. Assoc. Con. — Mineral. Assoc. Con., 1974 Meeting, Newfoundland, Program, p. 30. Author at University of Western Ontario, London, Ontario.

The ocean ridge environment where the ophiolite suites are born is perhaps that where the most massive and pervasive hydrothermal metamorphism and metasomatism occurs. Evidence from the study of the thermal regime of the ocean floor and the metasomatic products formed, indicates that the cooling mechanism of shallow intrusive rocks is one involving massive seawater convective flow through the upper layers of ocean floor materials. In some environments, hydration and oxidation may generate heat. These processes fix vast amounts of water, sulphur, carbon dioxide and to some extent oxygen in rocks of the ocean floor; rocks which will at a later time be subducted. At the same time, circulating salt waters can perform prevasive chemical stripping and redeposition of elements (particularly transition metals) critical in the formation of ore-deposits. The conditions of transport and the scale of the phenomenon will be considered. (Author's abstract).

GABROVSKA, B., 1974, Vertical temperature zoning in the Mihalkovo ore field (abst.): Internat. Assoc. on the Genesis of Ore Deposits, Fourth Symposium, Varna, Sept. 1974, Abstracts of Papers: Sofia, IAGOD, p. 258 (in English). Author at Geol. Inst., Sofia

T_H for ∿800 P G-L incs. in fluorite from various levels in the deps. have been measured. Mean T_H are lower at the lower levels than at the upper ones, indicating a reverse T zoning in the individual deps. The range of T_H from the lower levels is narrower than that in the upper levels. The vertical distrib. of the xl forms of fluorite also shows a relationship to T_H. Cubic xls. formed at the lower levels at 110-160°C, while octahedral xls occur at the upper levels at 140-180°C. The reverse T zoning is typical over the entire ore field.

T zoning in zoned fluorite xls. has also been studied. A cubic xl. from the Neichov Chiflik dep. exhibits a progressive rise in T_H from 122-126°C to 145°C. An octahedral xl. enveloping a phantom of two cubes from the Gagovi Nivi deposit is evidence of pulsating changes in T; each xl. started growing at a lower T and finished its growth at a higher T, and each later xl. formed under higher T conditions.

The cause of the reverse zoning could be both a pulsating supply of sols. and the exothermal nature of the min.-forming process. (Modified by ER from the author's abstract.)

GALABURDA, Yu.A., 1973a, Formation conditions of specular iron from the Krivoy Rog basin; L'vov. Mineral. Sbor., v. 27, p. 61-65 (in Russian; abstract courtesy T.M. Sushchevskaya).

Specular iron (i.e., cryst. hematite) is common at Krivoy Rog, in paragenesis with vein quartz. Chem. anal. of water leachates from two such quartz samples showed predominance of Na and HCO_3, with Na/K $\gtrsim$ 5.0, HCO_3/Cl $\gtrsim$ 2.0. All incs. were two-phase, G/L, or (three-phase) with $\leq$ 5 vol. % CO_2. T_H for p. incs.: 330-335°C for one bed and 365-368°C for another.

GALABURDA, Yu.A., 1973b, Characteristics of physico-chemical conditions of metamorphism of rocks from Krivoy Rog Basin, as indicated by solutions in inclusions: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 229-230 (in Russian; translation through the courtesy of A. Kozlowski). Author at Inst. of Geochemistry and Physics of Minerals, Acad. Sci. of Ukrainian SSR, Kiev.

Fluid inclusions were studied in quartz from thin cutting veinlets, vugs and nests, occurring in ferriferous rocks and ores of Krivoy Rog series, and in rock-forming quartz from ferriferous hornfleses and jaspilites. On the basis of similar filling, shape, composition and distribution in the body of the mineral, etc., of characteristic inclusions in quartz in hornfels layers of metamorphic rocks and in quartz from veinlets cutting these rocks, a metamorphic origin for the quartz veinlets was established (...).

T_H of inclusions (with low F) are close to the real T of metamorphism (...). Metamorphic solutions circulating in the S part of the Basin have the highest T: in the region of the "Valyavko-Severnaya" mine = 330 - 385°C, for region of NKGOK = 302 - 330°C. Metamorphic processes in the central part of the Basin ranged from 250 - 290°C. Toward the North one may ascertain some increase of T of solutions (290-310°C). (...) A greater role of liquid CO_2 is noted in veinlet quartz from the Northern part, probably caused by magmatic processes developed there. The following types of solutions were obtained by the water leachate method, depending on the region of occurrence: bicarbonate-Na, bicarbonate-Na-Ca and bicarbonate-Ca, with similar pH. By gas analysis CO_2 (up to 88, 71 vol. %), hydrocarbons, and N_2 plus rare gases were found in uniform amounts. In one sample H_2 was found. The temperature of freezing is within a few degrees below °C°, so the metamorphic solutions were very dilute. (Author's abstract, modified by A.K.)

GALABURDA, Yu.A., 1974, Quartz from ferruginous rocks of Krivoy Rog Basin, in Typomorphism of Ukrainian Quartz, edited by Ye. K. Lazarenko, Acad. Sci. Ukr. SSR: Kiev, Naukova Dumka Pub. House, p. 92-94 (in Russian; translation courtesy A. Kozlowski). Author at Inst. of Geochemistry and Physics of Minerals of Acad. Sci. Ukr. SSR.

Incs. in quartz connected with metamorphism have water sol. and CO_2; T_H = 386° (southern part), 372° (northern part) and 310°C (central part), sols. are mainly HCO_3-Na type. Alkaline metasomatism was caused by HCO_3-Na-K sols. at T 220-250°C; carbonate-calcium metasomatism - by HCO_3-Ca sols. at T 50-220°C. Estimated P - 900-1100 atm. Conc. of sols. were unique $\leq$ 10% NaCl equiv; pH of leachates weakly alkaline. Gases consist of CO_2, hydrocarbons C_nH_{2n+2}, N_2 and sometimes H_2 (A.K.).

GALIBIN, V.A., KOPEYKIN, N.N., and SEDOVA, I.S., 1973, P-T conditions of formation of metamorphic zoning in the Zagan-Oluevsky massif and composition of feldspars, eastern Transbaikalia: Leningrad Univ. Vestn. Geol. Geog., v. 24, pt. 4, p. 23-26 (in Russian; abstract courtesy T.M. Sushchevskaya).

Fluid inc. data from four metamorphic zones in the Zagan-Oluevsky granite massif show that T of progressive stages of metasomatism increased from $\sim$400 to 700°C and reached $\sim$850-900° under ultrametamorphism. The P. of fluid phase was in the range 1600-2200 atm. Retrograde metamorphism (200-500°) is widely manifested in all metamorphic zones.

GALII, S.A., 1974, Genetic peculiarities of lead-zinc deposits from the Lower Carboniferous limestones of the southern slope of the Voronezh anticline: L'vov. Mineral. Sborn., v. 28, no. 1, p. 65-68 (in Russian with English abstract.) Author at Univ. L'vov.

Sphalerite is characterized by a tetrahedral crystal habit and a high content of cadmium and germanium. T_H of incs. in sphalerite is 145-152°C and 65-58°C in calcite. The interrelation between the minerals and the typomorphic peculiarities of sphalerite show that these lead-zinc deposits are a product of low-T hyd. activity. (Author's abstract)

GALII, S.A., and POPIVNYAK, I.V., 1974, On the temperature conditions for the zinc sulphide formation from the Beregovo and Began occurrences: L'vov. Min. Sbornik, v. 28, no. 2, p. 102-106 (in Russian with English abstract).

The results of investigation of inclusions confirms the presence of the two generations of zinc sulphide from Beregovo and Began. The two narrow temperature intervals for the homogenization of the initial inclusions are as follows: Beregovo - 255-220°C and 200-180°C and from Began - 245-235°C and 210-150°C. (Authors' abstract).

GALII, S.A., and RAZUMEEVA, N.N., 1973, Sphalerite from the northwestern part of the Ukrainian shield: L'vov. Mineral. Sbor., v. 27, p. 81-85 (in Russian).

Two generations of hydrothermal sphalerite are distinguished. The temperature T_H is 290-305°C. The possible cause of thermoluminescence may lie in the admixtures of In^{3+} and Ag^{+}. (Authors' abstract)

GAVRIKOVA, S.N., SHEVYREV, I.A., ALKIN, V.S., and IVANOV, V.N., 1973, Elements of vertical zoning in berezites and ores of the Itaka ore field (E. Transbaikalia): Geol. Rudn. Mest., v. 15, no. 3, p. 117-123 (in Russian;abstract courtesy A. Kozlowski). Authors at Moscow Geol. - Prospecting Inst. and Chita Geol. Office.

Gold-quartz-pyrite-arsenopyrite assoc. gave T_H = 280-310°C, quartz-polymetallic - 230-280°C, quartz-antimonite - 180-220°C, water leachate from quartz yielded fluid comp.: Ca>K>Mg>Na>Fe and $HCO_3^- > Cl^- > SO_4^{2-}$.

GDOVANOV, I.M., TSOI, A.V., and RAKHUNBEKOV, A.T., 1974, Quartz in the Almalyk copper porphyry deposits (trace elements, decreptometry, and thermoluminescence): Zap. Uzb. Otd. Vses. Mineral. O-va. 1974, v. 27, p. 70-76 (in Russian). C.A., v. 83, no. 7, 118674q (1975).

Decrepitation of fluid incs. in the quartz indicates a broad T. range (300-360°); the detd. T values vary with depth in the mine; at 100-300 which is the depth of max. ore concn., decrep. showed an anomalous decrease. This anomaly also appears in the curve of thermoluminescene of quartz samples.

GEGUZIN, Ya.E., and DZYUBA, A.S., 1973, Study of liquid inclusions in rock salt crystals in the entire range of their existence: Kristallografiya, v. 18, no. 7, p. 800-807 (in Russian; abstract courtesy T.M. Sushchevskaya.) Note - this was abstracted briefly in *Fluid Inclusion Research* - *Proc. of COFFI*, v. 6, 1973, p. 53.)

Influence of heating and cooling on liq. incs. in natural single crystals of NaCl was studied visually. Vapor phase appears (sic.) at $\sim$370°C and incs. become homogeneous at $\sim$410°C. Heating leads to plastic deformation of the crystals which results in increasing volume of the inc. This deformation can be measured by estimation of the volume of residual gas phase at room T. after cooling of preheated sample. Freezing of the sample and crystallization of the incs. causes cracking of the matrix. A simple theory of the observed phenomena is given. Dependence of P. inside the incs. on T. is estimated. Microphotographs of the studied incs. at different Ts are presented.

GEGUZIN, Ya. E., and DZYUBA, A.S., 1974, On the peculiarities of boundary kinetics during the motion of liquid and gas-liquid inclusions in Rochelle salt single crystals in a temperature gradient; Kristallografiya, v, 19, no. 5, p. 1030-1033 (in Russian).

An experimental and theoretical discussion of the motion. (ER)

GÉLINAS, Léopold, 1974, Textural and chemical evidences of liquid immiscibility in variolitic lavas (abst.): Amer. Geophy. Union Trans., EOS, v. 55, no. 4, p. 486. Author at Dept. of Min. Eng., École Polytechnique, Univ. of Montréal, Montréal H3T 1P8, Québec.

GERLING, E.K., SPRINTSON, V.D., and MOROZOVA, I.M., 1972, Excess Ar^{40} in the minerals of alkalic intrusives: Geokhimiya, 1972, no. 9, p. 1095-1101 (in Russian; translated in Geochem. Internat., v. 9, no. 9, 1973, p. 751-757. Authors at V.I. Vernadskiy Institute of Geochemistry and Analytical Chemistry, Acad. Sci., Moscow, USSR.

Experimental data are presented on the content of excess argon in different types of mineral structures; it was found only in cancrinite. The problem of its origin is discussed. (Authors' abstract, abbreviated by ER)

GIARDINI, A.A., HURST, V.J., MELTON, C.E., and STORMER, J.C. JR., 1974, Biotite as a primary inclusion in diamond: its nature and signifiance: Americ. Mineral. , v. 59, p. 783-789. Authors at University of Georgia, Athens, Georgia.

In recent mass spectrometric gas-analysis experiments involving the crushing of natural African diamonds that contained totally-enclosed mineral inclusions, a few small flakes of brown mica were recovered. They are identified as biotite with a Fe/(Fe + Mg) ratio of 0.61. Well-formed prismatic crystals of brown mica recovered from diamond-bearing kimberlite from Murfreesboro, Arkansas, have been found also to be biotite. The Fe/(Fe + Mg) ratio for the latter is 0.57. Chemical analyses, and optical and X-ray diffraction data are given for both biotites. Preliminary experimental data at 55 kbar suggests a similar biotite would decompose to garnet + liquid at about 1500 K. On the basis of the confirmed presence of biotite in diamond, of the decomposition products of biotite relative to pressure and temperature, and of related mineral and gas inclusions that have been identified in diamond, it is suggested that the stability boundary of iron-rich biotite may coincide closely with minimal growth conditions for natural diamond. (Authors' abstract).

GIARDINI, A. A., and MELTON, C. E., 1974, Gases released from natural and synthetic diamonds by crushing under high vacuum at 200°C, and their significance to diamond genesis (abst.): Internat. Mineral. Assoc. Ninth Gen. Meeting, West Berlin and Regensburg, W. Germany, Collected Abstracts: West Berlin, German Mineralog. Soc., p. 30 (in English). Authors at Athens, Georgia.

Thirty-eight natural diamond samples (21: 0.1 to 2.1 ct. each, Arkansas, U.S.A.; 16: 0.1 to 4.5 ct. each, Africa; one 2.5 ct.; Brazil) were crushed in the inlet of a research mass spectrometer at 10^{-9} torr and 200°C. Six 36-mesh Gen. Electric synthetic diamond samples (2 from regular production, 4 from a new high pressure and temperature process) also were crushed. Most diamonds contained totally enclosed solid inclusions. All samples released gas. The average (and range) of gas composition (vol. %) from natural diamonds and from commercial synthetics are as follows:

	Arkansas	Africa	Brazil	Average	Comm. synth.	New proc.
H_2O	32.9(2.9-75.7)	34.5(0-85.1)	85.1	34.43	---	25.8
H_2	24.1(1.5-40.4)	21.6(1-59)	1.6	22.49	33.2	26.2
CO_2	22.6(5.3-37.7)	15.2(2-28.1)	5.4	18.91	12.1	17.4
CO	3.6(0.4- 9.4)	7.6(0-45.8)		5.78	---	----
N_2	7.4(0-87.2)	14.0(0-80)	1.7	9.96	---	5.1
CH_4	8.4(0.9-25.1)	6.1(0.5-18.3)	4.0	7.32	54.7	24.8
C_2H_4	----	0.1(0 - 0.7)	0.2	0.08	---	----
C_3H_6	----	0.2(0 - 2)	---	0.09	---	----
CH_3OH	0.3(0- 5.2)	----	---	0.17	---	----
CH_3CH_2OH	0.4(0- 3.2)	0.5(0 - 3)	0.1	0.33	---	----
O_2	----	0.2(0 - 1.9)	1.9	0.14	---	----
Ar	0.3(0- 1.3)	0.2(0 - 1.2)	0.05	0.3	0.05	0.6

The ratios of average (and range) of gas volume (STP) to diamond sample volume = 4.2×10^{-3} ($1.8 - 18.5, \times 10^{-3}$) Arkansas; 3.5×10^{-3} ($0.02 - 15.7, \times 10^{-3}$) Africa; 0.3×10^{-3} Brazil.

Except for N_2 (once, Arkansas), and for H_2O and N_2 (once each, Africa), H_2O, H_2, CO_2, CH_4 and N_2 always were present. O_2 was found only in a few diamonds of cube form. The gas difference in natural diamonds and commercial synthetics indicates a different formation environment. A thermodynamic interpretation of diamond genesis with various models of the C-H-O system has been carried out. Results can be interpreted qualitatively on the basis of a gas-solid reaction mechanism. (Authors' abstract.)

GIBB, F.G.F., 1974, Supercooling and the crystallization of plagioclase from a basaltic magma: Mineral. Mag., v. 39, p. 641-653.

Of interest to the trapping of melt inclusions. (ER)

GIBBARD, H.F., Jr., SCATCHARD, George, ROUSSEAU, R.A., and CREEK, J.L., 1974, Liquid-vapor equilibrium of aqueous sodium chloride, from 298 to 373K and from 1 to 6 mol kg^{-1}, and related properties: J. Chem. and Eng. Data, v. 19, no. 3, p. 281-288.

GIBLIN, A.M., and SWAINE, D.J., 1974, The extraction of shales with brines at 60°C (abst.): Internat. Symp. on Water-Rock Interaction, Czechoslovakia, Sept. 9-17, 1974, Abstracts: Prague, Geological Survey, p. 28 (in English). Authors at CSIRO Div. of Min., North Ryde, N.S.W. 2113, Australia.

GIBSON, E.K., Jr., 1973, Thermal analysis-mass spectrometer computer system and its application to the evolved gas analysis of Green River shale and lunar soil samples: Thermochim. Acta, v. 5, p. 243-255. Author at Planetary and Earth Sciences Division, NASA Manned Spacecraft Center, Houston, Texas 77058.

A thermal analysis-mass spectrometer (TA-MS) system controlled by a computer has been developed and successfully used in the analysis of a wide variety of geochemical samples. The TA-MS computer system provides a very powerful analytical tool for the determination of volatile species released from samples over a very wide temperature and sample-size range. Use of a small laboratory computer and magnetic-tape storage units permits large quantities of analytical information to be handled and easily retrieved. The rapid scan capabilities of the quadrupole mass spectrometer operating under computer control are especially useful for following the rapidly changing composition of the evolved gases released from samples during heating under vacuum conditions. Samples of volatile-rich Green River shale and two lunar soils have been analyzed to show the utility of the TA-MS computer system. (Author's abstract)

GIBSON, E.K., Jr., and JOHNSON, S.M., 1972, Thermogravimetric-quadrupole mass-spectrometric analysis of geochemical samples: Thermochim. Acta, v. 4, 8 pp. First author at NASA Manned Spacecraft Center, Houston, Texas 77058.

Thermogravimetric-quadrupole mass-spectrometric-analysis techniques can be used to study a wide variety of problems involving decomposition processes and identification of released volatile components. A recording vacuum thermoanalyzer has been coupled with a quadrupole mass spectrometer. The rapid scan capabilities of the quadrupole mass spectrometer are used to identify the gaseous components released. The capability of the thermogravimetric-quadrupole mass spectrometer to provide analytical data for identification of the released volatile components, for determination of their sequence of release and for correlation of thermal-decomposition studies is illustrated by an analysis of the Orgueil carbonaceous chondrite. (Authors' abstract).

GIBSON, E.K., Jr., MOORE, G.W., and JOHNSON, S.M., 1974, Summary of analytical data from gas release investigations, volatilization experiments, elemental abundance measurements on lunar samples, meteorites, minerals, volcanic ashes and basalts: Natl. Aero. and Space Admin., L.B.J. Space Center report issued July 1, 1974, 201 pp. First author at TN7, Geochemistry Branch, NASA Johnson Space Center, Houston, Texas 77058.

An extensive study of gases evolved from these samples using a quadrupole mass spectrometer. (ER)

GIGASHVILI, G.M., 1973, Determination of solution concentration in "reticulate" inclusions from quartz from Ukrainian pegmatites by cryometric, refractometric and calculation methods: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 159-160 (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.

1. "Reticulate" inclusions (Tsinzerling 1948, Dolgov 1955) should contain information about the characteristics of mineral-forming solutions at temp. close to temp. of quartz phase inversion (573°C). At those temp. the transition from magmatic to pneumohydrothermal stage of pegmatite development occurred. (...).

2. Inclusions in samples from 18 pegmatites of Volodarsk-Volhynian pegmatitic field were investigated cryometrically and results are different for various bodies. Results vary in following ranges: T_F (freezing temp.) on initial cooling of inclusion, from -27 to -34°C; temp. of beginning of cryohydrate melting, from -15 to -25°C; temp. of end of melting of the last ice crystal in inclusion, from -2.2 to -5.5°C.

3. Further investigations were made on "reticulate" quartz from one pegmatitic body. Standard solutions with various concentrations but with constant composition (ratios, as) indicated by water leachate from "reticulate" quartz, were prepared. For this series of solutions

the curves: refractive index and temp. of melting of the last ice crystal versus concentration, were made.

4. "Reticulate" inclusions were opened in silicone oil (that had been) tested for insolubility of water. Kalyuzhnyi's method of measurement of refraction index was used and the cryometric investigations were then made. The results of solution concnetration are 7±1 wt %.

5. Significant influence of gases under pressure, especially CO_2, on cryometric point, was ascertained, yielding a decrease as large as 2.5°C (unopened inclusions -4.5°C).

6. An attempt was made to calculate the amount of SiO_2 necessary for healing of reticulate fractures. The author assumes that the volume of inclusions equals the volume decrease of quartz during phase inversion. Amount of inclusions determined by ignition loss at 1000°C, taking into account the average inclusion density, is 0.38% of specimen vol., versus a vol. decrease of quartz during phase inv. of 0.86%. Thus, 0.48% of primary reticulate fractures is filled by newly formed quartz. The above data prove that the fluid healing the reticulate fractures consisted of 91.5 wt % of SiO_2, 8 wt % of water and gases and 0.5 wt % of salts (sic.). (Author's abstract).

GIGASHVILI, G.M., 1974, Typomorphic peculiarities of quartzes from metasomatic zones of zanorysh type pegmatites as criteria of evaluation of presence of commercial crystal raw material, in Typomorphism of Ukrainian Quartz, edited by Ye. K. Lazarenko, Acad. Sci. Ukr. SSR: Kiev, Naukova Dumka Pub. House, p. 58-60 (in Russian; translation courtesy A. Kozlowski). Author at Inst. of Geol. and Geochemistry of Fuels of Acad. Sci. Ukr. SSR, L'vov.

Discussion of conds. of xliz. of peg. mins., and their alterations, using mainly published data on incs. (T_H, Na/K ratio, P, pH)(A.K.).

GIGASHVILI G.M., and KALYUZHNYI Vl.A., 1973, Results of complex investigations of liquid hydrocarbon inclusions in minerals of quartz-calcite veins of W. Ukraine: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 169-170 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Inst. of Geology and Geochemistry of Fuels, Acad. Sci. of Ukrainian SSR, L'vov.

1. Inclusions of hydrocarbons occur in crystals of quartz from hydrothermal quartz-calcite veins cutting Visean fine-crystalline limestones. The veins are connected genetically with the Belz-Milyatinskiy fault zone of Volhynian-Podolian shield of E. European platform. Samples are taken from a borehole, at depth 917-1162 m, in the Velikye Mosty area.

2. Quartz crystals (up to 0.7 mm long) have spotty brownish colour, with inclusions of 0.02-0.001 mm size. They were investigated by use of microthermometric, microcryometric (Kalyuzhnyi's technique) and microthermobarometric (Kovalevich's technique) stages. Inclusion filling was investigated by use of the fluorescence microscope LM-1 and mass-spectrometer MH-1303. All inclusions are divided on the basis of age into 3 groups of various age: Type "a" - the earliest inclusions, primary, have euhedral vacuoles and bear 3 phases: liquid, gas and dark brown solid bitumen occurring in small amounts on the walls of vacuole. The amount of liquid in type "a" inclusions decreases with depth from 930 to 1162 m from 85-90% to 55-60% and solid bitumen decreases to zero. The liquid phase of the inclusions was determined

to be a mixture of condensed gases at P ∿ 100 atm (measured), containing methane, ethane, butane and higher hydrocarbons. By mass spectrometry the following composition of inclusion fluid was obtained: CH_4 50-55%, N_2 25-30%, H_2 8-10%, CO_2 3.5%, C_2H_6 and C_3H_8 less than 10%. T_H of type "a" inclusions shows "simple" zoning at depth 930-950 m, and "reverse" zoning at 1162 m. In the first case T_H in liquid decreases from center to periphery of the crystals from 78 to 62°C; in the second case T_H increases in similar direction from 77 to 110°C. With depth the luminescence peculiarities and behaviour of inclusions during freezing also change. Type "b" - are later than the above inclusions. They have irregular shape and consist of yellowish paraffin-like masses (95%) (...), with ∿ 5% gas bubble and a small amount of brownish bitumen. T_H of gas - 39-50°C. Type "c", the latest, secondary inclusions, consist of gas (5-10%), with various amounts of oil-like liquid and weakly-mineralized (ca. 0.5 wt %) water solution.

4. Mineral-forming medium for quartz crystals was a heterogeneous fluid, consisting of water solution, various hydrocarbon phases and other substances. The composition of last two components varies significantly with T changes, variations of P and Eh potential during migration of fluid from deep to subsuperficial levels.

5. The possibility (exists) of use of hydrocarbon inclusions for investigation of the evolution of hydrocarbon fluids in the process of their migration along tectonic fault type discontinuities. (Authors' abstract).

GLABATSKIKH, S.F., 1974, Physico-chemical conditions of ore deposition in the Uzon thermal field: p. 221-231 in Volcanism: Hydrothermal processes and ore-formation, ed. S.I. Naboko: Moscow, Izdat. "Nedra" (Acad. Sci. USSR, Far Eastern Sci. Center, Inst. of Volcanology) (In Russian).

A discussion, with a fairly extensive plotting of data on Eh, pH, and °C for various hot waters depositing Fe, As, and Sb sulfides, S, or $Fe(OH)_3$. This is only one small section of this 263-page book dealing mainly with the Uzon area, that includes structure, tectonics, petrology, geochemistry, hydrology, heat flow, alteration, radon, hydrocarbons, ore minerals, zoning, etc. The authorship of the 21 sections is given only in the Table of Contents, a translation of which (by M. Fleischer) is available from the editor. (ER)

GOFF, S.P., 1974, Petrology of a kimberlite dike, Alanguarssuk, S.W. Greenland (abst.): Amer. Geophy. Union Trans., EOS, v. 56, no. 12, p. 1198. Author at Department of Geology, University of Alberta, Edmonton, Canada.

An isolated, flow-banded composite kimberlite dike with an olivine-and dolomite-rich, alkaline matrix (0.2% Na_2O; 0.1% K_2O; 3.17% TiO_2) occurs in the Archean basement (65° 24'N; 52°24'W). Ilmenite (7.9% MgO) and most olivine (Fo_{92}) megacryst phases are considered to be primary, whereas xenocrysts of omphacite, orthopyroxene (En_{89}) and especially two pyrope suites (one Cr-rich and the other Ti-rich) indicate that the kimberlite magma disrupted and incorporated much eclogite and some garnet lherzolite from a considerable depth range in the upper mantle. Tentative pressures and temperatures of equilibration for two garnet lherzolite fragments were calculated using the respective Ca/Ca+Mg ratio (0.47; 0.45) and weight % Al_2O_3 (4.54; 2.31) of their clinopyroxenes. These values (970°C, ∿30 kb; 1050°C, ∿40 kb) are typical of those for similar, granular nodules in kimberlites from South Africa and the U.S.S.R. The extremely high volatile content of the groundmass (24.31% CO_2+H_2O) indicates only limited degassing of the magma during intrusion, while variation in the calcite to dolomite ratio suggests fluctuations in the composition of the vapor phase in equilibrium with the magma. The groundmass mineralogy of kimberlites is considered to be largely controlled by the fugacity of magmatic CO_2. (Author's abstract).

GOGISHVILI, V.G. & AREVADZE, D.V., 1974, Temperature decreases during formation of vertically zoned pyritic-polymetallic deposits of Little Caucasus: Internat. Assoc. on the Genesis of Ore Deposits, Fourth Symposium, Varna, Sept., 1974, Abstracts of Papers: Sofia, IAGOD, p. 10-11 (in Russian; translation courtesy A. Kozlowski). Authors at Caucasian Inst. of Mineral Raw Materials, -KIMS-, Tbilisi, USSR.

In deposits of above type the middle T. interval is absent. T decrease determined by T_H and T_D methods reaches 200° per 100 m (in vertical section). Sharp T decrease is caused by adiabatic expansion of parent fluid connected with change from lithostatic to hydrostatic P. and mixing of hydrothermal sols. with vadose waters.

Vein minerals	Ore zones	T_H °C	Near-ore alteration of parent rocks		pH	Thermo-electric force	Sulfur isotopes	Thickness (m)
Barite Gypsum Quartz Pyrite	Barite & rare nests of galena & sphalerite	60-100	Weak propyllitization (quartz chlorite, albite, calcite, and relict minerals)			Positive	Both sides of standard value	300- -150
			Secondary quartzites	"Monoquartzites" with barite, sometimes jarosite, opal, and chalcedony	<<7 -			
	Galena, sphalerite, chalcopyrite, barite & wurtzite	- 180-270		Quartz-hydromica rocks with alunite, sometimes with alunite and jarosite	<7			
	Polymetallics	250-280						
Anhydrite	Cu-pyritic ores	260-300		Quartz-sericite-hydromica rocks with alunite, pyrophyllite & chlorite				
	Pyritic ores	280-370	Quartz-sericite, quartz-sericite-chlorite & quartz-chlorite rocks		≥7	Negative	Close to standard	800- -300
			Propyllites (chlorite, albite, and anhydrite)		>7			

(Authors' abstract, shortened by A.K.)

GONCHAROV, V.I., 1973, On the chemical composition of the hydrothermal solutions forming gold-silver deposits: p. 174-184 in New data on the geology of the northeastern part of the USSR: Magadan (Severo-Vostochny Complexny Inst., Trudy, v. 55) (in Russian; abstract courtesy T.M. Sushchevskaya).

Anal. (23) were made of water leachates from minerals (Na, K, Ca, Mg, HCO_3, Cl, SO_4, F). H_2O and gases were not det. The study is a continuation of mineralogic, petrographic, and geochemical work of different types of Ag-Au deposits of Ochotsko-Chukotsk region. Three main deposits were studied. Khakanginskoye is a typical high-T Au-argentite type (with rhodonite), Agatovskoye - intermediate-T, of gold-sphalerite-galena type, Karamken is low-T sulfoantimonide type. The results show very wide variations in the concs. of major components. Khakanginskoye dep. : chem. comp. of pre-ore sols. are characterized by major Cl-HCO_3-K and Na, whereas in productive and late stages the sols. were enriched in F-Ca-Mg. Wide variations of such components as HCO_3-Cl-SO_4 and Ca-Mg-K were found for incs. from Agatovskoye. The productive min. assoc. were formed by sols. rich in Ca, Mg, K and HCO_3 at Karamken, and the sols. were complex (HCO_3-Cl-F and Ca-Mg-Na-K) after ore deposition. It is concluded that high-T gold-bearing sols. have more Na and K than middle- and low-T sols., and K>Na for early stages, while Na<K for late stages.

GONCHAROV, V.I., SIDOROV, A.A., and SHAPOVALOV, 1973, Decrepitophonic survey as a method of determination of hidden veins in the ore fields of volcanogenic regions: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 261-262 (in Russian; translation through the courtesy of N.P. Ermakov). Authors at North-Eastern Complex Scientific Research Institute of Academy of Science of the USSR, Magadan, U.S.S.R.

1. Physico-chemical analysis of mineral-forming processes, based upon data of investigation of gas-liquid inclusions in minerals is of great importance not only as one of the methods of recognizing the genesis of deposits, but also as the method of solving problems of applied character. In this connection mass decrepitational analysis is of great importance.

2. It is known that decrepitational activity of minerals of veined bodies depends upon the degree of their saturation with inclusions. The latter condition connects with some factors which may be subdivided into factors favouring the appearance of inclusions, and factors opposing this process. First factors include all manifestations and processes in hydrothermal systems causing interruption of crystallization. To the second factors - two edge state in regime of hydrothermal system: the first is quiet, rather long crystallization under condition of even influx of solutions, and the second - the momentary crystallization resulting from boiling, because of high pressure gradients. Products of solution activity in the first case are large, well facetted, almost without inclusions, and the second case are cryptogranular irregular-striped aggregates which also lack of inclusions but for another reason-the short time of crystallization.

The character of decrepitation activity of altered rock depends evidently upon the degree of hydrothermal metamorphism, but as far as volcanic rocks are concerned, the last stage of alteration (monoquartzites) is characterized by rather low amount of decrepitation.

3. Use of decrepitation is appropriate for the exploration (of relaxation? sic.) of hydrothermal systems at regional centers. As the areas of maximum hydrothermal alteration of volcanic rocks in tectonically active regions are connected mainly with zones of high permeability, the section of relaxion of metalliferous hydrotherms have an anomalous greater than phonic, value of decrepitational activity of rocks, and the intervals of decrepitation move up to higher temps. (sic). The (degree) of decrepitative activity is determined by the intensity of "sonoring" of rocks of the region that have undergone regional hydrothermal metamorphism.

4. During detailed investigation of ore fields the carrying out of mass decrepitational analysis is of great importance. Data of thermometric location of mining prospecting at a gold-silver deposit showed that most of the veins (occurred) in areas of anomalously low decrepitational activity. Evidently this is the result of the high intensity of crystallization of oversaturated solutions. This led to the filling of solution pores and microfractures in the tectonically weak area surrounding the veins by cryptogranular, inclusion-free substance. This fact may be an important feature in the investigation of large zones of hydrothermally altered rocks in volcanogenic regions or under the exploration of new veined bodies within known ore fields. (Authors' abstract).

GORBATYI, Yu. Ye. and BONDARENKO, G.V., 1973, Molecular spectra of water at elevated pressures and temperatures: in Contrib. to Physico-Chem. Petrology, V.A. Zharikov, et al., eds.: Moscow, "Nauka" Pub. House, v. 3, pp. 207-231 (in Russian; abstract courtesy of A. Kozlowski).

Interval T and P is stated, where anomalous phase inversion of water from liquid-like to gas-like state occurs in the supercritical area, but existence of liquid-like state of water under parameters higher than critical point may not be impossible. (Authors' abstract shortened by A.K.).

GORDEEVA, V.I., and BAZAROV, L.Sh., 1974, Temperature conditions of apogranite formation, in Mineralogy of endogenetic deposits, Yu. A. Dolgov and V. S. Sobolev, eds.: Novosibirsk, Acad. Sci. USSR, Sib. Branch, Inst. Geol. and Geophys., p. 109-118 (in Russian; abstract courtesy A. Kozlowski).

In apogranite minerals the following four types of inclusions were found: (1) primary crystalline (not investigated); (2) primary crystallized (P); (3) secondary crystallized (S); and (4) secondary gaseous-liquid. Type 2 contains 10 vol. % gas and three or more crystalline phases (90 vol. %), plus minute amounts of liquid phase. The gas consists of ($HF+HCL+NH_3+SO_2+H_2S$) 17.0 to 18.5 vol. %, plus 83.0 to 81.5 vol. % of CO_2. Homogenization temperatures of inclusions in quartz: non-altered granites, melt inclusions 800 to 1020°C; protolitionite-microcline-albite apogranites (not investigated); zinnwaldite-amazonite-albite apogranites 640 to 710 and 200 to 560°C(s); zinnwaldite-albite-amazonite apogranites 410 to 620(p) and 200 to 350°C(s); zinnwaldite (cryophyllite)-amazonite-albite apogranites 400 to 520 (p) and 200 to 320(s)°C; quartz-amazonite veins 260 to 350(p) and 150 to 260°C(s). Zinnwaldite-amazonite-albite apogranites give $P = 1350$ atm, main salt NaCl (<26%); zinnwaldite-albite-amazonite apogranites - $P = 1000$ atm, gas composition in vol. %: H_2O, CO_2 - $\leqslant$ 65%, H_2 -$\leq$15, N_2 + rare gases - $\leqslant$20. In zinnwaldite (cryophyllite)-amazonite-albite apogranites: P at 520°C about 600 atm; H_2O, CO_2 - $\leq$36.4 vol. %. In quartz-amazonite veins: P 150-60 atm, gases H_2O, $H_2 \leqslant 10.0$, N_2 + rare gases $\leqslant 26.4$, $CO_2 \leq 63$ (in vol. %).

Homogenization data for zoned quartz phenocrysts from riebeckite-albite apogranites are as follows:

Zone No.	Incl. type	Phase composition	Phase relations	T_H, °C	Number of incl.
1	p	G + L	50 : 50	480-470	200
inner	s	G + L + CO_2 + cr.	various	360-120	500
2	p	G + L	50 : 50	470-465	180
	s	G + L + CO_2 + cr.	various	360-120	600
3	p	G + L	50 : 50	465-460	120
	s	G + L + CO_2 + cr.	various	360-120	450

4	p	G + L	45 : 55	460-440	80
	s	G + L + CO_2	various	360-120	450
5	p	G + L	40 : 60	440-430	100
	s	G + L + CO_2	various	360-120	600
6	p	G + L	40 : 60	430-425	85
	s	G + L + CO_2	various	360-120	500
7	p	G + L	40 : 60	425-420	70
	s	G + L + CO_2	various	360-120	400
8	p	G + L	30 : 70	420-410	115
outer	s	G + L + CO_2	various	360-120	480

Note: p - primary, s - secondary, cr. - crystal phase.

The density of gaseous solutions was 0.20-0.30 $g \cdot cm^{-3}$, and of liquid solutions - 0.40-0.90 $g \cdot cm^{-3}$, and higher.

GOROVOY, A.F., 1974, Quartz of mercury deposits from Nikitovskoe ore field in Donbass, in Typomorphism of Ukrainian Quartz, edited by Ye. K. Lazarenko, Acad. Sci. Ukr. SSR: Kiev, Naukova Dumka Pub. House, p. 86-92 (in Russian; translation courtesy A. Kozlowski). Author at Mining-Metallurgical Inst., Kommunarsk.

T_H of incs. in small xls of quartz syngenetic with cinnabar and antimonite, 120-150°C, P = 140-160 atm; T_H of incs. in barren quartz is 240-290°C (A.K.).

GOVOROV, I.N., 1973, Thermodynamics of hydrothermal mineral formation, mineral-indicators, and equilibria: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 137-138 (in Russian; translation provided through the courtesy of A. Kozlowski). Author at Far-East Geological Institute, Far-East Scientific Center of Academy of Sciences USSR -DVGI DVNC AND SSSR-, Vladivostok.

On the basis of thermodynamic calculations and fluid inclusion data the mineral equilibria (are used as) indicators of the pH of mineral-forming solutions. (...)

3. For rare-metal albitite-greisen and quartz-vein-greisen deposits:

		pH	T range, °C
1)	Muscovite & biotite	3-4	650-200
2)	Muscovite & albite & topaz	4-5.5	500-300
3)	Muscovite & tourmaline	2.5-4	500-250
4)	Topaz & tourmaline	2.5-3.5	450-250
5)	Topaz & pyrophyllite & diaspore	1.5-2.5	400-250
6)	Tourmaline & pyrophyllite & diapore	2-3	450-250
7)	Tourmaline & riebeckite	5-6	about 500
4.	For silicate-cassiterite-sulfide group:		
1)	Tourmaline & chlorite	3.5-5.5	500-200
2)	Tourmaline & biotite & chlorite	3.5-4.5	600-250
3)	Chlorite & muscovite	3-4.5	400-100
4)	Chlorite & topaz	3-4	400-200
5.	Zn-Pb deposits connected with propylitization:		
1)	Epidote & albite	3.5-5	450-300
2)	Epidote & biotite & calcite	5.5-7.5	500-400
3)	Epidote & chlorite & calcite	3.5 -6	500-250
4)	Epidote & garnet	4.5-6	500-250
5)	Chlorite & kaolinite	3-5	400-100

Mass precipitation of ore minerals occurs with temp. decrease down to 400-250°C and with neutralization (pH of the neutral point =

5.2-6.2) of formerly acid solutions (greisens and cassiterite-silicate deposits) or of weakly alkaline solutions (albite-greisens, cassiterite-silicate-sulfide and Zn-Pb deposits). (Author's abstract).

GREBENCHIKOV, A.M., 1973, Temperature conditions of origin of shallow Paleozoic gold deposits of Kazakhstan: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 45-47 (in Russian; translation provided through the courtesy of A. Kozlowski). Author at Central Scientific-Research Geological-Prospecting Institute of Geology Ministry USSR, Moscow -TSNIGRI MG SSSR.

Unlike the well-known shallow Au-Ag deposits of USA, Romania, Japan, NE USSR and Transbaikal, etc., the shallow deposits of S and Central Kazakhstan formed in the Upper Paleozoic.

1. The deposits formed from low-concentration hydrothermal solutions in the temperature interval 380-50°C. In some deposits there is a tendency toward low-temperature in the late stages; in others this tendency is absent. For temperature conditions of mineral-formation, interstage temperature inversions in the range 100-150°C are typical.

2. The temperature interval of deposition of productive ores was 380-160°C, (for nearly all the interval of hydrothermal mineralization). Gold-bearing mineral complexes at various deposits were formed in this interval repeatedly, within narrow ranges (gold deposits at N. Pribalkhashye) or at several different temperature levels (Au-Ag deposit in S. Dzhungarya). Temperature range of the gold-bearing stages varies from some tens to 100-200°C. The bulk of the Au crystallized during a temperature drop of $\lesssim$50°C.

3. Gold fineness variations and Au/Ag changes in ores from the investigated deposits are not related to the temperatures of the mineral-forming solutions, and depend on other physico-chemical parameters. Analyses of literature data on gold deposits in USSR corroborates this conclusion and shows that the fineness of Au and the Au/Ag ratio in ores formed in various depths and at various temperatures can be very close, not differing among themselves. For example, in shallow deposits of USSR, at various ore bodies, with a temperature interval 360-300°C, the fineness of gold is 220-960; at 250-190°C -120-966; at 145-105°C - 468-825.

4. Temperature conditions of ore-formation do not have a real influence on the mineral composition of productive ores. Au-Ag deposits formed at a given temperature interval crystallized gold in association with silver minerals (acanthite, polybasite, red silver ores) or in association with sulphides of Zn, Pb and Cu. Also complex gold ores, in which gold is associated with galena, sphalerite, chalcopyrite, formed in the same range as other complexes in which gold crystallized together with molybdenite. (Author's abstract)

GREBENSHCHIKOVA, V. I., TROSHIN, Yu. P., and PETROV, L. L., 1974, The formation mechanism of the Adun-Chelonsky massif and the origin of its geochemic zoning (eastern Transbaikalia): Yearbook, 1973, Inst. of Geochemistry, "Nauka" Pub. House, Novosibirsk, p. 56-59 (in Russian with English abstract).

The form. mech. of the Adun-Chelonsky massif of biotite granites is explained by the subsidence of a rock block in the anticline and the filling-in by magmatic melt. With the first melt portions coming from a deep chamber there has been lost Cl moderately soluble in magma. The next portions of magmatic melt have been comparatively enriched by water and fluorine having a better solubility in the melt than Cl. (Sic.)

Therefore, in the apical massif parts the Cl content is relatively higher, the intermediate zone is water-rich and the inner one is F-rich. A clear content correlation of Zn+Cl, W+H_2O, Sn+F in granite is observed. (Authors' abstract.)

GREEN, H.W.. II, 1974, Where are the incompatible elements in the upper mantle? (abst.): Amer. Geoph. Union Trans., EOS, v. 56, no. 12, p. 1198. Author at Department of Geology, University of California, Davis.

It has been known for some time that partial melting of the most "fertile" of peridotite specimens from the mantle is capable of producing normal basalts with respect to the major rock-forming elements, but that such synthetic basalts are always depleted in the so-called incompatible elements, e.g. K, U, Th and the light REE. A number of recent developments involving pyroxene geothermometry, transmission electron microscopy and detailed electron microprobe studies suggest that the incompatible elements reside in a CO_2-rich volatile phase which has exsolved from the silicate phases and in recrystallized specimens is concentrated onto grain boundaries. These observations may offer a solution to the paradox which finds oceanic tholeiites to be relatively depleted in the light REE whereas peridotite xenoliths which presumably are the source material or refractory residuum of such magmas commonly are enriched greatly. (Author's abstract).

GRIGORCHUK, G.Yu., and IVASIV, S.M., 1973, Evolution of physico-chemical conditions during hydrothermal mineralization: L'vov. Mineral. Sbornik, v. 27, no. 4, p. 316-318 (in Russian).

T_H inclusions in various minerals from several stages of ore deposition range from 460-280°C, indicating changes in the physico-chemical conditions. (ER)

GRIGORCHUK, G. Yu, IVASIV, S.M., and LYAKHOV, Yu. V, 1971, Cyclic features of hydrothermal mineralization using east Zabaikal'ye gold deposits as an example; Geol. Rudnykh Mestor., v. 13, no. 5, p. 64-75 (in Russian; abstractin Econ. Geol., v. 69, 1974, p. 1157.)

Study of pH, temperature and the mineral composition of veins and contact zones of metasomatites produced by hydrothermal solutions reveals characteristics of cyclic mineralization. The authors show that the cyclicity was produced by a pulsating supply of mineral solutions.

GRIGORCHUK, G. Yu. AND POZDEEV, K.M., 1973, On temperature conditions of formation of the ores of the Krasnoyarovo-Zolinskoe district (E. Transbaikalia): Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 68-69 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at L'vov Univ.

1. Geological setting. Complex consists of granitoids, terrigenous-volcanic deposits of Jurassic age.

2. Geological, structural, mineralogical-geochemical and thermometric investigations proved that ore formation was

a long, multistage process giving a series of mineral associations. Most widely developed are following associations (arranged in order of formation): quartz-tourmaline (440-290°C), quartz-molybdenite (490-300°C), quartz-sphalerite-galenite (330-240°C) and gold-quartz-pyrite (300-220°C). Temp. intervals of these mineral associations were determined by homogenization of primary and pseudosecondary inclusions of gaseous and gaseous-liquid type in quartz and partly in sphalerite and carbonate.

3. Veinlets and veins, consisting of these minerals, are accompanied by various near-vein alteration of wall-rocks (feldspathization, sericitization, chloritization and silicification). In each stage, a series of similar composition was formed, but accompanied by various alteration of wall rocks. (Authors' abstract)

GRITTI-BAUDRACCO, C., 1974, Fluid inclusions in some gangue minerals from deposits in southern France (abst.): Internat. Mineral. Assoc. Ninth Gen. Meeting, West Berlin and Regensburg, W. Germany, Collected Abstracts: West Berlin, German Mineralog. Soc., p. 35 (in English). Author at Toulouse, France.

Barite from Pessens, Colombies (Aveyron), and Clermont l'Hérault (Hérault) was examined by decrepitometry, decrepitoscopy, the Deicha hot stage, and by SEM. The latter reveals cavities not usually seen. (From the author's abstract)

GRITZAY, Yu.L., and PEDAN, M.V., Some data on the formation temperature of Krivoy Rog metamorphic rocks, from mineral inclusions: 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). p. 227-229

The investigation of Krivoy Rog metamorphic rocks shows that transparent minerals - quartz, carbonate, aegirine, feldspar and apatite - often have numerous monophase fluid and biphase gas-fluid or fluid inclusions in the size range 0.01 - 0.001 mm. The largest inclusions are observed in the recrystallized quartz or new quartz formed at the stage of regional metamorphism. The inclusions in quartz often have the form of negative crystals; in (other) minerals they are irregular. The ratio between the fluid and gas phase is within 1/4 - 3/4 and more. As to time of formation they are distinguished as primary, pseudosecondary and secondary. H_2, CO_2, CO, CH_4 gases are determined by analysis in ferruginous rocks in amounts of 0.06 - 21.24 cm^3/kg. H_2 and CO_2 are the major constituents. There is a relationship between the composition of rocks and their gas composition. A special thermocell and decrepitometer were used for the temperature measurement of the homogenization of gas-fluid inclusions.

The quartz contained inclusions from all stages of retrograde regional metamorphism, making interpretation of the research data difficult. Therefore the maximum measured temperatures are of greatest importance as they correspond to the most intensive metamorphism of ferruginous rocks.

The distribution of the maximum teperatures in the Krivoy Rog basin coincides with the metamorphic zoning determined by the mineral parageneses. A temperature of 360-390°C has been established for the amphibolite facies of regional metamorphism (the North and South districts) and 280-310°C for the green schist facies (Sacsagan district). For the first time a clear metamorphic zoning in the horizontal direction has been determined by temperature measurements. Thus the temperature of mineral formation of 350-360°C was observed for the West part of Krivoy Rog and 270-330°C for the East part.

GÜBELIN, E.J., 1974a, Black inclusions in diamond: Zeit, Deutsch, Gemmolog. Gesell., v. 23, no. 2, p. 109-114 (in German).

Electron microprobe examination of black inclusions in diamonds verified them to contain Fe-S and Fe-Ni-S (ER).

GÜBELIN, E.J., 1974b, The emerald deposit at Lake Manyara, Tanzania: Lapidary Journal, v. 28, no. 2, p. 338-359. Author at Lucerne, Switzerland.

The emeralds contain solid incs. of biotite and muscovite, and liquid inclusions containing liquid CO_2, water solution, and a prismatic, anisotropic solid. (ER)

GÜBELIN, E.J., 1974c, Internal world of gemstones: Zurich ABC Edition Zurich 234 pp. (in English).

Large numbers of excellent color photomicrographs of fluid inclusions in various gem minerals, including particularly in emerald from various localities (Pakistan, Sandawana, Transvaal, Urals, Chivor and Muzo (Colombia)), Ceylon sapphire and Madagascar beryl (p. 72, 76, 146-148, 179). Also some photomicrographs of organic inclusions in quartz and fluorite, but without locality. (ER)

GUREVICH, L.P., 1974, Conditions of formation of mineral parageneses of zeolite and prehnite-pumpellyite facies: in Contrib. to Physico-Chem. Petrology, V.A. Zharikov, et al., eds.: Moscow, "Nauka" Pub. House, v. 4, pp. 5-22 (in Russian; abstract courtesy A. Kozlowski).

Calcs. of min. equil. in low-T. part of system: $CaO-MgO-Al_2O_3-SiO_2-H_2O-CO_2$ at P_{H_2O} = 1000 atm and P_{CO_2}= 1 atm; P_{H_2O} = 2000 atm and P_{CO_2} 1atm; P_{H_2O} = 1000 atm and P_{CO_2}= 50 atm, are given by diagrams. Fields of stability of min. parageneses of prehnite, laumontite and pumpellyite are compared with natural assocs. and exper. data. On P-T diagrams the subfacies of prehnite - pumpellyite facies (at P_{H_2O} = 1000 atm - T = 280-380 ± 20°C and P 2000-4000 atm) are distinguished. Under P_{CO_2}= 50 atm laumontite and prehnite are unstable and field of stability of pumpellyite has narrow T and P boundary 380-420°C and 3000-4200 atm. (Author's abstract).

GUROV, Ye. P., and MARCHENKO, Ye. Ya., 1970, Relation between genthelvite and phenakite in beryllium-bearing metasomatites: Geol. Rudnykh Mestor., v. 12, no. 2, p. 107-110 (in Russian; abstract in Econ. Geol., v. 69, 1974, p. 721.)

The metasomatites containing genthelvite and phenakite are represented by microclinite, quartz-feldspar rocks and greisen. These metasomatites are the result of alteration of cataclastic granitoids, containing relicts of metamorphic rocks, at the contact with a major granite intrusion of Proterozoic age. The microscopic study of minerals and of G-L incs. indicate that the genthelvite mineralization is connected with high temperature metasomatism. Phenakite formed later than genthelvite and at lower temperature. Fluorine was a very important agent in the transportation of beryllium.

GUSEL'NIKOV, V.N., and VOLKOV, G.I., 1973, Ore decrepitation as a method of investigation of multifolded structures of ferruginous quartzites: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 283-284 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Scientific-Research Inst. of Kursk Magnetic Anomaly of Ministry of Black Metallurgy of USSR.

In Kursk Magnetic Anomaly great difficulties are caused by the folding of abruptly inclined layers and complexes of Precambrian ferruginous quartzites. Thermometric data from ore decrepitation were used for the solution of this problem. Samples of ferruginous quartzites were crushed to obtain 3-g fractions 0.25-0.50 mm, which were heated up to 1000°C, over 90-100 min.

T_D of various petrographic groups of ferruginous quartzites were sufficiently different: T_D of taconites 435°C, of itabirites 675°C, of jaspilites 830°C. At the Mikhaijlovskoe deposit these varieties build individual complexes of the Kursk series (P_{t_1}) and occur as follows (from the bottom up): taconites (K_2^2), jaspilites (K_2^3), itabirites (K_2^4).

In taconites, T_D varies from 360 to 465°C, without connection with stratigraphic localization of individual layers.

In jaspilites, T_D changes regularly from lower to upper parts: T_D decreases 150-210°C in 100-150m. Absolute values of T_D in layers decreases 20-80°C and correlates wwhh stratigraphic (depth) position: in lower parts of layers T_D is higher than in the upper ones. T_D changes insignificantly in the lateral direction.

In itabirites lowest values of T_D were 670-860°C.(Authors' abstract)

GUSYNIN, V.F., 1974, Upper range of stability of analcite: in Contrib. to Physico-Chem. Petrology, V.A. Zharikov, et al., eds.: Moscow, "Nauka" Pub. House, v. 4, pp. 23-28 (in Russian; abstract courtesy A. Kozlowski).

Equil.: 2 analcite = albite + nepheline + H_2O; respective to upper range of stability of analcite, was studied exper. Methods of monovariant assoc. and isochronic (sic), were used. Equil. point was det. by direction of reaction. T of equil. found by two in dependent methods are as follows, in °C (P in kg/cm^2): 515 (1000); 580 (2000); 620 (3000); 645 (4000). Analcite of ideal comp. at T = 450°C and $P_{H_2O} = 1000\ kg/cm^3$ alters into solid solution enriched in nepheline component. (Author's abstract).

GUTMANN, J.T., 1974, Tubular voids within labradorite phenocrysts from Sonora, Mexico: Amer. Mineral., v. 59, p. 666-672. Author at Department of Earth and Environmental Sciences, Wesleyan University, Middletown, Connecticut.

Basaltic rocks in the Pinacate volcanic field of northwestern Sonora, Mexico, contain small-to-remarkably-large phenocrysts of labradorite. Best displayed within the more transparent of these phenocrysts are subspherical to tubular voids that are believed to represent fluid inclusions of primary origin. The voids range in diameter from less than 100 microns to as much as 2 mm, and some of the tubular ones are 1 cm or more in length. The tubes typically occur in families of a few to several tens of mutually parallel individuals within a single phenocryst. In most instances they are aligned parallel to some specific growth direction within the host crystal, and commonly they are oriented perpendicular or nearly so to a crystal face. They pinch and swell along their lengths, and either are entirely sealed within the host or open upon the margin of the crystal.

It is here suggested that fluid bubbles, nucleating on the surfaces of growing crystals, may have poisoned the crystal-liquid interface and thus may have become partly included in the phenocrysts. If the fluid were exsolving from the magma as a crystal grew, each included bubble would also tend to grow. Crystal and bubble thus might grow outward together, and primary tubular fluid inclusions would result. Variations in growth rate of a crystal vis a vis that of its included bubbles could account for pinching and swelling of tubes and other textural features. (Author's abstract).

GUTSALO, L.K., and VETSHTEIN, V.E., 1974, Hydrogen and oxygen isotopes as criteria of the origin of natural waters (abst.): Internat. Symp. on Water-Rock Interaction, Czechoslovakia, Sept. 9-17, 1974, Abstracts: Prague, Geological Survey, p. 13-14 (in English). First author at Institut geologii i geokhimii goryuchikh iskopaemykh, AN USSR, L'vov, USSR.

HAJASH, Andrew, 1974, An experimental investigation of high temperature seawater-basalt interactions (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 6, no. 7, p. 771. Author at Department of Geology, Texas A&M University, College Station, Texas 77843.

Artificial and natural seawater was allowed was allowed to react with fresh oceanic tholeiite glass in Au and Pt capsules between 200 and 500°C at 500 bars with a rock/water ratio of 1:5. The experimental data indicate that substantial elemental exchange between seawater and basalt can occur in a relatively short time. Such exchange is a potential source for transition metals found associated with active spreading centers and may affect the geochemical budget of certain elements. (Author's abstract, abbreviated)

HALL, W.E., and FRIEDMAN, Irving, 1974, Evidence from fluid inclusions and light stable isotopes concerning evolution of the hydrothermal ore fluids, Climax molybdenum deposits, Colorado (abst.): Internat. Assoc. on the Genesis of Ore Deposits, Fourth Symposium, Varna, Sept. 1974, Abstracts of Papers: Sofia, IAGOD, p. 228-229 (in English). First author at U.S. Geol. Surv., Menlo Park, Calif.

A more extended abstract than given in the following entry. (ER)

HALL, W.E., FRIEDMAN, Irving, and NASH, J.T., 1974a, (Climax Molybdenum deposit (abst.)): Geol. Survey Research 1974, U.S. Geol. Sur. Prof. Paper 900, p. 143. (see next item)

HALL, W.E., FRIEDMAN, Irving, and NASH, J.T., 1974b, Fluid inclusion and light stable isotope study of the Climax molybdenum deposits, Colorado: Econ. Geol., v. 69, p. 884-901.

The Climax mine contains three molybdenite ore bodies and widespread late quartz-sericite barren mineralization, each related to separate intrusive phases of the Climax stock. Alteration zones spatially related to each molybdenite ore body include a silica zone below, a potassium-silicate zone that approximately coincides with ore, and overlying quartz-sericite-pyrite-topaz, argillic, and propylite zones.

$\delta^{18}O$ values of quartz range from +8.4 to 10.9 per mil; $\delta^{18}O$ values of muscovite and sericite range from -0.8 to +7.5 per mil. Eight of ten sericite values are between +5.8 and +7.5. All of the quartz and most of the sericite is in isotopic equilibrium with a calculated water at 350°C with $\delta^{18}O$ values of +3.0 to 5.5 per mil.

$\delta^{18}O$ values of K-feldspars range from -4.5 to +7.5 per mil. This wide range indicates partial reequilibration of the feldspar with later, isotopically light, waters.

Two muscovites have δD values of -146 and -91 per mil; sericite ranges from -168 to -116 per mil. The calculated δD values of water at 275°C in equilibrium with sericite are -144 to -92. This range is the same as that of fluid incs. in ore samples.

Kaolinite in the argillic zone has $\delta^{18}O$ values of -0.9 to -2.2 and δD values of -162 per mil. Calculated water at 250°C in equilibrium with kaolinite $\delta^{18}O$ values of -4.7 to -6 and δD of about -130 per mil.

The isotopic and fluid inc. data best fit a model whereby the Climax ore bodies were formed from a hydrothermal fluid that originated by mixing light and heavy waters. The light water is isotopically similar to present-day meteoric water; the heavy water has the isotopic composition postulated for magmatic water, although it could be meteoric water that was heavier than present-day meteoric water. (Authors' abstract)

HALLAM, Marie, and EUGSTER, H.P., 1974, Ammonium silicate stability relations (abst.): Amer. Geophy. Union Trans., EOS, v. 55, no. 4, p. 452. First author at Center for Astrophys., Cambridge, Mass. 02138.

HAUGHTON, D.R., ROEDER, P.L. and SKINNER, B. J., 1974, Solubility of sulfur in mafic magmas: Econ. Geol., v. 69, p. 451-467.

Factors controlling the solubility of sulfur in mafic magmas are temperature, composition, and fugacities of the gaseous species O_2 and S_2. In order to determine how these factors control the solubility of sulfur, experiments have been conducted at one atmosphere total pressure and at fo_2 and fs_2 controlled by mixing of SO_2, CO_2, and CO. All common mafic magmas are within a range of fo_2 and fs_2 such that sulfide sulfur is the most important species in the melt. Within this range, a temperature increase of 100°C magnifies the capacity of a magma to dissolve sulfur by a factor of 5 to 7 times, assuming a constant ratio of fo_2 and fs_2. Increases in fo_2 and fs_2 cause, respectively, decreases and increases in sulfur solubility. The general relationship between the magma composition and the sulfur-carrying capacity of a magma has also been determined. The strongest positive correlation of sulfur content is observed with the ferrous iron content. Because other components influence the activity coefficient of FeO and thereby the solubility of ferrous iron, their effect on the sulfur-carrying capacity is complex. The maximum solubility of sulfur in a magma of basaltic composition at 1,200°C, was found to vary from 0.05 to 0.2 weight percent as the FeO content was increased from 5 to 20 weight percent.

In nature all of the controlling variables change during cooling and crystallization of a magma, and each or all of them may bring a magma to saturation, thereby causing a sulfide phase to precipitate. Under most conditions the sulfide phase which precipitates from a mafic magma will be an immiscible iron-sulfide-oxide liquid. (Authors' abstract).

HAYASE, Kitaro, & MANERA, Teresa, 1973, A statistical analysis of experimental data on filling temperature of fluid inclusion in fluorite from fluorite deposits of Patagonia, Argentina: Mining Geology, v. 23, p. 1-12, (in English).

Five mines in southern Argentina were studied. The geology and mineralogy of each is given; they are all veins in volcanics, granite, or schist. The T_H data (all   ∿185°C) are treated statistically by various procedures, to reveal small but valid changes across the vein and along the vein. (ER)

HELGESON, Harold C., 1974, A theoretical model of the chemical interaction of rocks and aqueous solutions (abst.): Internat. Symp. on Water-Rock Interaction, Czechoslovakia, Sept. 9-17, 1974, Abstracts: Prague, Geological Survey, p. 5 (in English). Author at Dept. of Geol. & Geophysics, Univ. of California, Berkeley, California, USA.

HELGESON, H.C. and KIRKHAM, D.H., 1974a, Thermodynamic properties of hydrothermal systems at high pressures and temperatures (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 6, no. 7, p. 788-789. Authors at Department of Geology and Geophysics, University of California, Berkeley, California 94720.

Recent progress in high pressure/temperature solution chemistry permits theoretical prediction of chemical equilibrium and mass transfer among minerals and multi-component aqueous electrolyte solutions at pressures, temperatures, and concentrations to 5 kilobars, 600°C, and > 3 molal. Prediction and comparison of equilibrium and mass transfer with mineral relations and fluid inclusions in rocks leads to a chemical and thermodynamic model for metasomatic reactions in igneous and metamorphic processes. (Authors' abstract, abbreviated) (See next item)

HELGESON, H.C., and KIRKHAM, D.H., 1974b, Theoretical prediction of the thermodynamic behavior of aqueous electrolytes at high pressures and temperatures; Amer. Jour. Sci., v. 274, p. 1089-1261.

Consists of two parts: I. Summary of the thermodynamic/electrostatic properties of the solvent, and II. Debye-Huckel parameters for activity coefficients and relative partial molal properties.

HENRY, Jacques, 1974, Garnet-cordierite gneisses near the Egersund-Ogna anorthositic intrusion, southwestern Norway; Lithos, v. 7, p. 207-216. Author at Laboratoire de Minéralogie et de Pétrologie, Université Libre de Bruxelles, 50 Avenue Franklin Roosevelt, Bruxelles, Belgique.

Graphite-bearing garnet-cordierite rocks from the Sjelset-Vikeså region, south Rogaland, Norway have been analysed by microprobe methods. The garnets belong to the pyrope-almandine series and contain 28 mole% pyrope, while the cordierites contain about 71% of the Mg end-member. A regional temperature of about 720-750°C and a lithostatic pressure in the order of 6-7 kb have been inferred from the garnet and cordierite compositions. The petrographic observation suggests that such P-T conditions might reflect a retrograde metamorphic event. A tentative estimation of the fluid phase composition, based on the study of opaque minerals, is presented. (Author's abstract)

HEYL, A.V., LANDIS, G.P., and ZARTMAN, R.E., 1974, Isotopic evidence for the origin of Mississippi Valley-type mineral deposits: A review: Econ. Geology, v. 69, p. 992-1006.

Isotopic and geochemical data from Mississippi Valley-type ore deposits place significant constraints on models of ore genesis. Lead in galena in all large deposits in the Mississippi Valley is appreciably enriched in radiogenic isotopes compared to more ordinary lead of most other localities. This enrichment in radiogenic isotopes has 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. Each district has a distinctive regional lead isotopic pattern that reflects direction of solution flow, possible buried heat sources, and areas of localization of major deposits. Alkalic ultramafic dikes in Illinois and western Kentucky are spatially associated with ore deposits, but the strontium isotopic composition of these dikes is suggestive of a mantle derivation. Studies of fluid inclusions typically show that the ore solutions ranged in temperature from 160° to 70°C and had salinities in excess of 20 weight percent. The $\delta^{18}O$ and $\delta^{13}C$ of limestone and dolomite indicate that very little isotopic exchange with ore fluids took place in the halos adjacent to ore bodies. The $\delta^{34}S$ data suggest isotopic equilibrium during precipitation of major sulfide minerals from homogenized aqueous sulfur in the hydrothermal fluids. Sulfur isotopic fractionation and $\delta^{34}S$ variations in different possible source materials are likely to be important in controlling the $\delta^{34}S_{\Sigma S}$ of the hydrothermal fluids. Together, the evidence indicates that the main ore fluids were heated oil-field brines having a largely crustal source for lead and sulfur. Regional disturbances, probably of lower crust-upper mantle origin, initiated large convective systems that produced Mississippi Valley-type mineralization. (Authors' abstract).

HILDRETH, Wes and SPERA, Frank, 1974, Magma chamber of the Bishop Tuff (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 6, no. 7, p. 795. Authors at Department of Geology and Geophysics, University of California, Berkeley, California 94720.

HIRST, D.M., and SMITH, F.W., 1974, Controls of barite mineralization in the Lower Magnesian Limestone of the Ferryhill area, County Durham: Inst. Mining and Metal., Trans., v. 83, Sect. B, p. B49-B55. Authors at Department of Geological Sciences, University of Durham, Durham.

The mineralization corresponds closely to structurally positive features. T_H fluorite, ~105°C; barite <70°C; both have salinity ~22% NaCl equivalent. The precipitation of barite is attributed to mixing of $BaCl_2$—bearing brines, derived from the Coal Measures and localized into the positive features, with SO_4-bearing brines from the Permian, probably essentially of local derivation. The origin of the fluorite mineralization is less certain, but it probably represents a distinct earlier episode and appears to be unrelated to fluorite mineralization in the Alston Block. (Authors' abstract, modified by ER)

HITE, R.J., 1973, The possible origin of the tachyhydrite-producing brines of the Sergipe Basin, Brazil: Resumo das Comunicacoes, Simposios e Conferencias; Simposio de Evaporitos do Brasil, no. 27, Bol. 2, p. 55-56 (in English). Author at U.S. Geological Survey, Denver, Colorado.

The large deps. of tachyhydrite ($CaCl_2 \cdot 2MgCl_2 \cdot 12H_2O$) in the Cretaceous evaporites of Sergipe, Brazil, are probably primary. These deps. are direct evidence that the evaporite sequence was dep. from brines in which calcium chloride was a major constituent. The comp. of fluid incs. and connate brines assoc. with other evaporite deps. suggest that calcium chloride was also in abundance during their form.

It has been suggested that calcium chloride sols. may originate in several ways-for example, dolomitization, cation exchange in clay minerals, replacement of gypsum or anhydrite by polyhalite, and contributions by magmatic sources. A new mechanism is proposed which may be more significant, especially at Sergipe. This involves oxidation of $FeCl_2$ in the brine producing free HCl:

$$FeCl_2 + H_2O + O_2 \rightarrow HCl + (FeOH_3) \cdot nH_2O$$

The acid in turn produces $CaCl_2$. Lab. expers. have yielded pH ≤ 1.30. In the Sergipe deps. the carnallite ($KMgCl_3 \cdot 6H_2O$) contains unusually high iron, and rinneite ($K_3NaFeCl_6$) is present; other evaporite deps. have connate brines containing as much as 35 g $FeCl_2$/liter. Such iron in sol. is probably the result of reactions between evaporite chloride brines and iron-bearing minerals in detritus. The oxidation of ferrous iron in evaporite brines also provides an explanation for the scarcity of magnesium and potassium sulfate mins. in the Sergipe deps. The calcium chloride produced by this mechanism would have immediately reacted with the sulfate ion in the brines precipitating gypsum and eventually leading to almost total sulfate depletion in the brine. (Author's abstract, abbreviated)

HLADÍKOVÁ, Jana, PFEIFEROVÁ, Anna, and ŠMEJKAL, Václav, 1974, Isotopic composition of carbon and oxygen in speleothems from karst caves in northern Moravia (Czechoslovakia) (abst.): Internat. Symp. on Water-Rock Interaction, Czechoslovakia, Sept. 9-17, 1974, Abstracts: Prague, Geological Survey, p. 12-13 (in English). Authors at Ústřední ústav geologický, Prague, Czechoslovakia.

HOEFS, Jochen, 1974, The carbon isotopic composition of CO_2 in fluid inclusions (abst.): Internat. Mineral. Assoc. Ninth Gen. Meeting, West Berlin and Regensburg, W. Germany, Collected Abstracts: West Berlin, German Mineralog. Soc., p. 32 (in English).

CO_2 from fluid inclusions is extracted through decrep. in vacuum. Two sets of samples have been analyzed: 1. Quartz from the granulite facies of Norway, and 2. Olivines from xenoliths in basic and ultrabasic rocks from various localities. The $\delta^{13}C$-values of the quartz showed a variation range of -5 to -22‰ relative PDB. The majority of the analyzed samples varied between -5 and -8‰, favoring a deep-seated (juvenile) origin. The CO_2 from the olivines showed a very strange isotopic composition, $\delta^{13}C$-values, in general, varied between -20 and -28‰. Some speculations will be given about the controversial meaning of this isotopically light carbon. (Author's abstract).

HOFMANN, A.W., et. al, eds., 1974, Geochemical transport and kinetics: New York, Academic Pross, 353 pp.

This volume comprises the papers presented at a conference held in June, 1973, under the sponsorship of the Carnegie Institution. It includes many studies of diffusion and reaction kinetics of interest to students of natural fluids. (ER)

HOLDOWAY, K.A., 1974, Behavior of fluid inclusions in salt during heating and irradiation: in Fourth Symp. on Salt, v. 1, A.H. Coogan, ed.: Cleveland Ohio, Northern Ohio Geol. Soc. p. 303-312. Author at University of Kansas, Lawrence, Kansas.

Rock salt was heated and irradiated in situ by implanted radioactive wastes during the Project Salt Vault experiment, which was carried out at Lyons, Kansas, in the abandoned Carey salt mine between 1965 and 1967. Petrographic examination showed that irradiation resulted in coloration of the salt, producing colors ranging from blue-black nearest the radiation source, to pale blue and purple farther from the source. Bleached areas are common in the radiation-colored salt, many representing trails produced by the migration of fluid inclusions towards the heat source. During laboratory radiation studies, it was found that these bleached areas frequently colored much less readily than ordinary colorless salt which had not been irradiated previously. This observation, and the relationship between primary chevron structures and migrated fluid inclusions, suggests that the bleached trails represent the total amount of migration of the inclusions from the beginning of Project Salt Vault, until the ambient temperature was reached after the conclusion of the experiment. (Author's abstract)

HOLLISTER, L.S., 1974, The Khtada Lake metamorphic complex: data bearing on the origin of tonalite plutons (abst.): Amer. Geophy. Union Trans., EOS, v. 55, no. 4, p. 451. Author at Dept. of Geol. and Geophy. Sci., Princeton Univ., Princeton, N.J. 08540.

Preliminary geologic mapping suggests in situ development of plutonic bodies, tonalite in composition, from a metamorphosed pile of predominantly volcanic rocks. The plutons form the cores of overturned antiforms (1 mile exposed amplitude) but were never sufficiently mobilized to break upwards through a stratigraphically continuous blanket of concordant pelitic sedimentary rocks. Approximate P-T conditions for the incipient mobilization are determined from mineral assemblages in the overlying pelitic rocks: P exceeded 5 kb and T exceeded 700°C. The fluid phase contained over 50% CO_2 and CH_4, based on the composition of dense fluid incs. Migration of potassium out of the pelitic rocks is suggested by the very minor amount of biotite and orthoclase in rocks with up to 30% sillimanite; it may have been introduced, with other components, into the volcanic units to form the tonalite composition. From these observations, it is proposed that the tonalite plutons in the Khtada Lake area formed as a result of mobilization of metamorphosed volcanic rocks at a temperature over 700°C and pressure greater than 5 kb and in the presence of a fluid phase rich in CO_2 and CH_4. Rapid uplift preserved the critical field relations. (Author's abstract)

HOLLOWAY, J.R., and LEWIS, C.F., 1974, CO_2 solubility in hydrous albite liquid at 5 Kbar (abst.): Amer. Geophy. Union Trans., EOS, v. 55, no. 4, p. 483. First author at Geochem. Div., Chem. Dept., Arizona State Univ., Temple, Ariz. 85281.

HUAN-CHANG, Lu, CHI-HSI, Shih, and TZU-MEI, Yu, 1974, Determination of the temperature of ore formation and diagenesis of a deposit from Southern China: Geochimica, 1974, no. 3, p. 145-154 (in Chinese with English abstract).

Form. Ts have been det. on quartz of biotite granite (640°C), two-mica granite (550°C), muscovite granite (526°C), and on the feldspar-quartz zone (503°C) and quartz zone (445°C) of a pegmatoid by homog. runs made on fluid incs. in quartz from a dep. in Southern China. The Ts of microclinization, wolframite and carbonate min. of wolframite-quartz veins are 293°C, 260-287°C, and 129°C resp. From the geological setting, petrochemical comp. characteristics of min. and fluid inc. as well as form. Ts, it is apparent that biotite granite, two-mica granite and muscovite granite are comagmatic products at different stages during the differentiation process. The pegmatoid, which may serve as a good indicator of rare-element-bearing granites, formed in the late period of magmatic differentiation, and the wolframite-quartz veins proved to be postmagmatic high T hydrothermal ore deps. (Authors' abstract)

HUDSON, J.D., and FRIEDMAN, I., 1974, Carbon and oxygen isotopes in concretions: relationship to pore-water changes during diagenesis (abst.): Internat. Symp. on Water-Rock Interaction, Czechoslovakia, Sept. 9-17, 1974, Abstracts: Prague, Geological Survey, p. 44 (in English). First author at Univ. of Leicester, Leicester LE 1 7RH, England.

IKORNIKOVA, N.Yu., VASIL'CHIKOVA, I.A., and ANTOSHIN, A.V., 1973, Solubility of minerals in chloride hydrotherms: Geol. Rudn. Mest., v. 15, no. 5, p. 88-98 (in Russian; authors' abstract shortened and translated by A. Kozlowski). Authors at Inst. of Crystallography of Acad. Sci. of USSR, Moscow.

The solub. of xls of galena and calcite in aqueous sols. of LiCl, NaCl, KCl, CsCl and NH_4Cl is presented at T 100-400°C and P 200-1500 kg/cm^2. The authors discuss the role of the structure of the liquid during reaction with xls and form. of new associated ions. Two mechanisms of dissolution phenomena as well as special features of NaCl sols. connected with the position of Na on the boundary of plus and minus hydration are the other two topics of the paper.

IKORSKII, S.V., and SHUGUROVA, N.A., 1974, Composition of gases in minerals of alkaline rocks of the Khibiny massif: Geokhimiya, 1974, no. 6, p. 943-947 (in Russian; English abstract Geoch. Intern. v. 11, no. 3, p. 671. Chem. Abst. v. 81, no. 12, 155740n.

A volumetric microanal. method was used in det. the gas phase comp. of individual incs. in eudialite, sepd. from a pegmatite embedded in trachytic khibinites. Gas incs. in the eudialite were accompanied in most cases by small amts. of bitumen, and in some cases by aegirite or villiaumite (NaF). The G phase was extd. from 11 individual incs., and the comp. and P (1.3-27 atm) inside each bubble was det. With one exception, the comp. of gases was related; higher CO_2 concs. were assocd. with higher Ps. All samples contained hydrocarbon gases (77.0-95.4), CO_2 (1.0-11.3), H (1.0-14.0), and CO (0.2-5.8%). A strict correlation was established between CO_2+CO and the sum of hydrocarbon gases + H_2. Differences in the eudialite incs. indicate that they were formed at different times and under slightly different thermodn. conditions during the development and closing up fractures in the cooling peg. body.

IMAI, Hideki, 1973, The geologic structure and mineralization at the Taishu mine, Nagasaki Prefecture, Japan: Min. and Metal. Inst. Japan, Jour., v. 89, no. 1026, p. 509-514 (in Japanese with English abstract).

(The geology of the Taishu mine is described in detail.) The ore-forming fluid originated from the granitic magma, ascended along the bedding reverse faults or dikes and sheets of quartz porphyry, and then moved into the strike-slip faults. These facts are indicated by the zonal arrangement of ore minerals around the granite mass and the dist. of the ore shoots in the veins, as well as by the fluid inc. studies by means of heating and cooling microscope stages. (From author's abstract)

IMAI, Hideki, IIDA, Kohei, and TAKENOUCHI, Sukune, 1974, Fluid inclusion study in the quartz from the Ashio mine, Japan (abst.): Internat. Assoc. on the Genesis of Ore Deposits, Fourth Symposium, Varna, Sept. 1974, Abstracts of Papers: Sofia, IAGOD, p. 269-270 (in English). Authors at Dept. of Min. Dev. Eng., Univ. of Tokyo, Tokyo, Japan.

The Ashio copper dep. is a xenothermal vein type occurring in rhyolitic rocks of probably Late Cretaceous or Early Tertiary period, genetically related to an acidic batholith. There is a "reversed" zonal distrib., of mins., consisting of a central Sn-W zone; an intermediate Cu zone below and around the Sn-W zone; and a marginal Zn zone.

Fluid incs. in quartz from the vein are essentially G-L type. T_H is as follows: (a) Central Sn-W zone: T_H for ∿95% of all incs. is 310° to 240°C. Our previous studies showed that T_H for cassiterite, wolframite and scheelite are generally higher than those of the accompanying quartz. This might be due to the fact that the quartz is later. (b) Intermediate Cu zone: T_H ranges widely, from 350° to 200°C. and decreases gradually from the center of the mining area horizontally outwards towards its margin and vertically from the lower level to the upper level. (c) Marginal Zn zone: T_H = 270° to 230°C, comparable to that obtained for the marginal part of the Cu zone.

Both gas-rich and liquid-rich incs. characteristically occur in the same xl, in all levels of the mine. This observation suggests heterogeneous mixture of liquid and gas, due to boiling caused by the steep P drop at the time of min. (Abbreviated by ER from the authors' abstract.)

IMAI, Hideki, KIM, Moon Sung, FUJIKI, Yoshinori, and TAKENOUCHI, Sukune, 1974, Geologic structure and mineralization of the hypothermal or pegmatitic tungsten-tin veins in Japan (extended abst.), in Metallization associated with acid magmatism, v. 1, p. 35-39, ed. M. Stemprok: Prague, Geological Survey (a volume of papers presented at the MAWAM Symposium, Karlovy Vary, Czechoslovakia, Oct. 1974) (in English).

A description of studies of tungsten-tin deposits genetically related to granitic or granodioritic rocks, including hypothermal, pegmatitic and pyrometasomatic vein types. The Ohtani, Kaneuchi, Takatori and Higashi Iwai mines belong to the hypothermal or pegmatitic vein type, and the Yamaguchi and Yaguki mines to the pyrometasomatic type; the Kuga, Fujigatani and Kiwada mines include both types.

Fluid inc. studies indicate that the Ohtani and Kaneuchi deposits were mineralized by the underlying granitic magma which was perhaps rich in fluid with a high content of salts. The Takatori, Kuga, Fujigatani and Kiwada mines are similar.

In the Kaneuchi mine, T_D of vein quartz shows a zonal distribution relative to the distance from the granite cryptobatholith. T_H was as follows: Ohtani mine: quartz 375-225°C (mostly <300°), cassiterite 345-297°C. Kaneuchi mine: quartz 308-231°C (probably later than ore minerals), wolframite 337-286°C, and scheelite 318-276°C. Takatori mine: quartz 320-225°C (probably later than ore minerals), topaz 350-330°C, cassiterite 350-300°C and fluorite 270-215°C.

The salinities (wt. % NaCl equiv.) were as follows: Ohtani mine: quartz 7.4-4.0, cassiterite 8.7-6.1, scheelite 8.2-6.1. Kaneuchi mine: quartz 8.2-3.7, wolframite 8.4-8.1, scheelite 8.6-6.4. Takatori mine: quartz 9.0-1.0, topaz 4.0-2.0, cassiterite 10.0-8.5, and fluorite 7.0-6.0. T_H increases with salinity, as expected from dilution of the ascending ore-forming fluid by the underground water. CO_2-rich fluid incs. have been recognized in late-stage quartz from the hypothermal or pegmatitic tungsten-tin veins such as Ohtani, Kaneuchi, and Takatori. At the Ohtani mine T_H and salinity of incs. in quartz from the greisen and the granodiorite surrounding it as well as from the vein materials are nearly the same. T_D of early quartz samples in the Ohtani and Kaneuchi deposits are 382-280°C and 334-255°C respectively, and it is thus inferred that the formation temperatures of the Ohtani mine are higher than those of the Kaneuchi mine. It is generally believed that T_D is higher than T_H because of overshooting. The differences found here could be both due to stage sampled and overshooting. (Modified by ER from the authors' abstract.)

IMAI, Hideki, LEE, Min Sung, IIDA, Kohei, FUJIKI, Yoshinori, and TAKENOUCHI, Sukune, 1974, Geologic structure and mineralization of the xenothermal vein-type deposits in Japan (abst.): Internat. Assoc. on the Genesis of Ore Deposits, Fourth Symposium, Varna, Sept. 1974, Abstracts of Papers: Sofia, IAGOD, p. 148-149 (in English). Authors at Dept. of Mineral Devel. Eng., Univ. of Tokyo, Tokyo, Japan

A discussion of the Sn-W-Cu-Zn-Pb-Ag xenothermal deposits of Akenobe, Ikuno, Tada, and Ashio in Japan. Fluid-inc. evidence for boiling was found at the Ashio mine. See previous entry. (ER)

INDOLEV, L.N., KOSHIK, I.M., and ZHDANOV, Yu.Ya., 1974, Structure and mineral composition of Au-Sb Sarylakhskoe deposit, in Mineralogy of endogenous deposits of Yakutia, B.L. Flerov, ed.: Siberian Branch of "Nauka" Publ. House, Novosibirsk, p. 92-108, (in Russian; abstract courtesy A. Kozlowski). Authors at Inst. of Geol. of Yakutian Division of Siberian Branch of Acad. Sci. USSR.

Quartz of the named deposit bears minute gas-liquid inclusions with F >90 vol. % and T_H probably 100-150°C.

IRVINE, T.N., 1974, Simple and multiple oxides in magmatic rock systems: Chromitite layers in stratiform intrusions: Carnegie Institution of Washington Yearbook 73, p. 300-316, (pub. 1974).

A detailed discussion of chromitites and includes photographs and discussion of inclusions of granitic composition melt (Fig. 62) believed by T.N.I. to be from contaminating granitic melt. (ER.)

ISHAN-SHO, G.A., and MOROZOV, S.A., 1973, Thermobaric and chemical conditions for the formation of antimony and mercury deposits of central Tadzhikistan: Izv. Akad. Nauk Tadzh. SSR, Otd. Fiz.-Mat. Geol.-Khim. Nauk 1973, no. 4, p. 81-90 (in Russian). Chem. Abst., v. 82, no. 1, 5930f. Authors at Inst. Geol. Dushanbe, USSR.

Results are given of chem. anal., decrepitation, and homogenization of minerals (cinnabar, stibnite, quartz, calcite, barite, fluorite, and dolomite), anal. of gas and liq. incs. in the minerals, and aq. exts. of the minerals. Statistical treatment of the exptl. data show that the hydrothermal mineralization in the region occurred in 3 stages: quartz-carbonate, ore-formation stage I, and ore-formation stage II. The initial mineralization occurred at 360-300° and 700-650 bar in a weakly acid medium in which K and Na predominated. Minerals of the Sb stage were formed at 300-150° and 650-200 bar. Minerals of the Hg stage were formed at 180-50° and 450-130 bar in sulfato-chloro-carbonate solns. in the presence of a considerable amt. of Ca. The cinnabar and stibnite were pptd. from acid solns. (pH 5.6-5.5) in the presence of high conc.of F.

ISHAN-SHO, G.A., and PRASLOV, E.M., 1974, Argon and helium isotopes in inclusions and problems of mineral formation illustrated by antimony and mercury deposits in central Tadzhikistan: Dokl. Akad. Nauk Tadzh. SSR 1974, v. 17, no. 6, p. 38-41 (in Russian). Chem. Abst., v. 82, no. 3, 33428g. Authors at Inst. Geol., Dushanbe, USSR.

The formation of endogenic deposits by using the methods of inclusion investigation is discussed. ^{4}He and ^{40}Ar are important in the explanation of mineralization of deposits such as Hg and their genetic origin.

ISHIHARA, Shunso, 1972, The worldwide occurrence of porphyry copper deposits and the meteoric-hydrothermal model. A review: Mining Geol. (Japan), Spec. Issue no. 4, Part II, p. 205-222 (in Japanese with English abstract).

A review of the similarities and differences various porphyry coppers in age and geology, isotopes, and fluid inclusion data, with a discussion of various models. (ER)

ISHIHARA, Shunso, 1974, Magmatism of the Green Tuff tectonic belt, northeast Japan: Mining Geol. (Japan), Special Issue, no. 6, p. 235-249 (in English). Author at Geological Survey of Japan, Hisamoto 135, Takatsu-ku, Kawasaki 213, Japan.

A discussion of the relationships between the stages of igneous activity in Japan and the Kuroko deposits, and a comparison of the Kuroko with porphyry copper deposits, including the nature of the fluids. (ER)

ISHIHARA, S., and TERASHIMA, S., 1974, Chlorine contents of granitic rocks as an indicator for exploration (abst.): Mining Geol. (Japan), v. 24, p. 78-79 (in Japanese).

Granitic rocks related to Kuroko mineralization have NaCl crystals in fluid incs. in quartz and high Cl (∿800 ppm), but lava dome rhyolites have low chlorine. (ER)

IVANOV, I.P., and GUREVICH, L.P., 1974, Experimental study of T-X_{CO_2} limits of the zeolite facies (abst.): Internat. Mineral. Assoc. Ninth Gen. Meeting, West Berlin and Regensburg, W. Germany, Collected Abstracts: West Berlin, German Mineralog. Soc., p. 175 (in English). Authors at Moscow, USSR.

Laumontite and prehnite stabilities are controlled by temperature and chemical potential of CO_2 in the fluid, as is shown by topologic and experimental analysis of the system CaO-Al_2O_3-SiO_2-H_2O-CO_2. The data define the limits of the zeolite facies metamorphism of metabasites at 220 to 260± 10°C and very low CO_2 content in the fluid ($P_{CO_2} : P_{H_2O} < 0.02$). With higher CO_2 content, substantially non-metamorphosed rocks have been found to transfer directly into the greenschist facies of metamorphism. (From the authors' abstract).

IVANOV, I.P. and GUSYNIN, V.F., 1973: T-P equilibria in system SiO_2-$NaAlSi_3O_8$ -Al_2O_3 -H_2O, in Contrib. to Physico-Chem. Petrology, V.A. Zharikov, et al., eds: Moscow, "Nauka" Pub. House, v. 3, pp. 11-15 (in Russian; abstract courtesy A. Kozlowski).

Exper. and thdy. studies of equil. in the subsolidus area of system: Na_2O - Al_2O_3 - SiO_2 - H_2O, being the simplest pattern of natural meta. and metasomatic systems of alumosilicate comp. Diagrams of state, constructed on the basis of new exper. and literature data are given as well as their application to natural assemblages. (Authors' abstract).

IVANOVA, G.F., 1974a, Geochemical and physico-chemical conditions of tungsten migration and deposition (extended abst.), in Metallization associated with acid magmatism, v. 1, p. 267-269, ed. M. Stemprok: Prague, Geological Survey (a volume of papers presented at the MAWAM Symposium, Karlovy Vary, Czechoslovakia, Oct. 1974) (in English). Author at Vernadskii Inst., Moscow, USSR.

T_H, T_D, and chemical analyses were det. on 30 W deps. of Eastern Transbaikalia and Mongolia. The principal results are as follows:

(1) The W deposits formed at ∿ 400-450°C, from conc. sols., with significant Li and F. Examples include the Baga-Gazryn deps. of Mongolia (topaz-zinnwaldite type), Cinovec (Czechoslovakia), Akchatau (USSR), etc. (2) Most deps. formed in a relatively narrow T range (270-320°C). (3) Most W deps. formed from relatively dilute aqueous solutions with highly variable CO_2 ($\leq$ 27 wt. %). (4) The CO_2 permits estimates of P of 500-1600 atm, which noticeably exceeds lithostatic pressure. The principal factors in tungsten deposition were the changes in acidity and redox potential of the solutions along with the changes in chemical composition. (Modified by ER from the author's abstract.)

IVANOVA, G.F., 1974b, Geochemical peculiarities of tungsten deposits of Mongolia: Geol. Rudn. Mest., v. 16, no. 6, p. 45-54 (in Russian; abstract courtesy A. Kozlowski). Author at Inst. of Geochemistry and Analytical Chemistry of Acad. Sci. USSR, Moscow.

Author summarizes her earlier published data on T_D (230-370°C) and T_H (205-400°C), as well P values (725-1400 bar) for 13 Mongolian tungsten-tin deps.

JACOBS, D.C. and PARRY, W.T., 1974, Geochemistry of biotite from the Santa Rita Stock and its associated potassic and phyllic alteration zones, Central Mining District, Grant County, New Mexico (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 6, no. 7, p. 809. Authors at Department of Geology and Geophysics, University of Utah, Salt Lake City, Utah 84112.

A preliminary summary of the chemistry of the various textural varieties of biotite suggests that final crystallization of the stock occurred at about 800°C under water-saturated conditions with water fugacity approximately 400 bars and oxygen fugacity approximately 10^{-14} bars. The potassic alteration may have formed at a temperature and oxygen fugacity similar to or somewhat lower than magmatic crystallization and at a water fugacity of about 200 bars. (Authors' abstract, abbreviated)

JAHNS, R.H., SWOBODA, E.R. and LARSON, W.F., 1974, Tourmaline-bearing pockets in pegmatite of the Pala District, San Diego County, California (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 6, p. 197-198. First author at Department of Geology, Stanford University, Stanford, California.

Recent mining operations in the Stewart and Tourmaline Queen pegmatite dikes near Pala have provided exceptional opportunities for study of several gem-bearing pockets. These pockets were irregular in form and ranged in maximum dimension from a few inches to about 8 feet. They were typically fringed by firmly attached and inward-directed euhedral crystals of quartz, perthite, cleavelandite, and tourmaline, accompanied in places by beryl and spodumene. Separate crystals and crystal fragments of the same minerals also were found inside the pockets, either in association with cellular aggregates of albite, lepidolite, and muscovite or embedded in masses of hypogene clay minerals and fine-grained muscovite.

Crystal habit, color zoning, and degree of alteration were remarkably consistent among the principal minerals of each pocket, but varied considerably from one pocket to another. At least one episode of rupturing was indicated for every pocket by broken and locally abraded crystals, by crystals with shattered interiors and relatively intact outer zones, and by the occurrence of matching crystal fragments at separated positions in the pocket. Rupturing evidently occurred during late stages of tourmaline, beryl, and lepidolite formation. The observed relationships are consistent with a genetic model involving crystallization from two fluids (silicate rest-liquid and exsolving aqueous vapor) under closed-system conditions of decreasing temperature and rising pressure that ultimately led to rupturing of the pockets. This was followed by additional near-solidus crystallization, then by sub-solidus development of abundant albite and micas, and finally by pervasive hydrothermal alteration. (Authors' abstract).

JEHL, Vincent, 1974, Fluid inclusions in some metamorphosed oceanic rocks from the North Atlantic: Réunion Annuelle des Sciences de la Terre, 2ème, Pont-à-Mousson, April 1974, p. 167 (in French; translation courtesy Chris Eastoe). Author at Centre de Recherches Pét. et Géochim., C.O. n° 1 - 54500 - Vandoeuvre-les-Nancy.

Basic and ultrabasic meta. rocks from the Mid-Atlantic Ridge and adjacent zones and from transverse fractures conserve their original textures but contain networks of hyd. veins. Apart from secondary plagioclase of oligoclase comp., the min. assemb. are those of the continental zeolite and greenschist facies. Fluid incs. from quartz, calcite and plagioclase contain aq. sols. of 50 to 100 g/l salts and negligible dissolved gases. T_H is 230-330°C, and the incs. have densities 0.75 - 0.90 g/cm^3. For a geothermal gradient of 100°C/km and P 1-2 kbar the T range would be 350°-550°C. A large-scale convective circulation of seawater is indicated.

JOHNSON, M.L. and BAKER, D.R., 1974, Carbon and oxygen isotope evolution in the Magnet Cove Complex, Arkansas (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 6, no. 7, p. 812. Authors at Department of Geology, William Marsh Rice University, Houston, Texas 77001.

O^{18} and C^{13} determinations were made on numerous samples. A discrepancy between δO^{18}- and δC^{13}- values of the late stage silicate rocks and the carbonatite may result from early separation of an immiscible carbonate liquid. The narrow range of δC^{13}- values displayed by the complex indicates that the carbonatite carbon source (mantle C?) was uniform in isotopic composition and isotopically similar to supposed sources of carbonatites world wide. (Authors' abstract, abbreviated)

JOLLY, W.T., 1974, Behavior of Cu, Zn, and Ni during prehnite-pumpellyite rank metamorphism of the Keweenawan basalts, northern Michigan: Econ. Geology, v. 69, p. 1118-1125.

Both cooper and zinc were mobilized during prehnite-pumpellyite facies metamorphism in the Keweenawan basalts of northern Michigan. Cu, averaging 70 ppm in basalts, was leached from epidotized or more highly metamorphosed rocks in the zone of dehydration; it was introduced into hydrated rocks where pumpellyite, prehnite, laumontite, and chlorite are the principal hydrous secondary phases. Native copper is a common associate of the metamorphic assemblage in such rocks. The chemical data suggest that fluids evolved by dehydration at depth may well have contained from 1,500 to 2,000 ppm Cu. These fluids percolated upward toward lower temperature levels where hydration was dominant and where the residual concentration of Cu-ions in the fluids could have reached high levels if precipitation had not occurred. The model supplies nearly five orders of magnitude more copper than has been produced by a century of mining in the Keweenaw Peninsula. The data suggest that enrichment or depletion of native copper should be spatially related to the distribution of certain hydrous minerals in the Keweenawan lava pile. Zn, which averages 100 ppm in unaltered olivine tholeiites, was leached from all highly altered rocks in permeable zones and removed by metamorphic fluids. Abundance of Ni was not appreciably affected by the metamorphic process except where there was dilution by void-filling secondary minerals. (Author's abstract).

JONES, D.R., 1974, Determination of the kinetics of ice-brine interfaces from the shapes of migrating droplets: Jour. Crystal Growth, v. 26, p. 177-179. Author at Dept. of Metal. and Mat. Sci.,Univ. of Cambridge, England.

Obs. have been made of the shapes of liquid droplets (containing aqueous solutions of NaCl) migrating through ice under the influence of a T gradient. At 269.3 K, and in a T gradient of 0.87 K mm^{-1}, those droplets which were smaller than about 15 μm appeared spherical. However, droplets of a progressively larger size exhibited an increasing elongation in the direction of migration, inclusions of 76 μm in length being only 53 μm wide. By analysing the data it was possible to show that the kinetic coefficient for solidification at the ice-droplet interfaces was $\not< 4.1 \times 10^{-2}$ $mms^{-1}K^{-1}$ if growth occurs uniformly, or $\not< 9.3$ $mms^{-1}K^{-2}$ if growth requires screw dislocations. (Author's abstract)

JOSEPH, **Dominique**, 1974, Geological and mineralogical studies of the fluorite veins of Maine (Cordesse, 71) and Voltenne (71-La Petite Verrière): Spec. thesis, Univ. Orleans, France. (in French)

Includes fluid inclusion data - see Joseph and Touray, 1974, this volume. (ER)

JOSEPH, Dominique, and TOURAY, Jean-Claude, 1974, Underground sediments in a fluorite vein at Maine (Cordesse, 71-France): Econ. Geol., v. 69, p. 545-548. Authors at Laboratoire de Géologie Appliquée, Université d' Orléans, 45045 Orléans-Cédex, France.

The rare incs. have freezing temps. of ∿0°C and sometimes positive (metastable). T_H range 79-94°C; mean 87°C. (ER)

KAJIWARA, Yoshimichi, 1973a, Chemical composition of ore-forming solution responsible for the Kuroko type mineralization in Japan: Geochemical Journal (Japan), v. 6, p. 141-149 (in English). Author at Geological and Mineralogical Institute, Faculty of Science, Tokyo Kyoiku University, Tokyo 112, Japan

On the basis of available mineralogical and geochemical data for the Kuroko type deposits in Japan, an attempt has been made to calculate the concentrations of some elements in the ore-forming solution responsible for this type of mineralization. The result reveals that the abundances of elements in the hydrothermal system are fairly close to those observed in the present-day ocean water. (Author's abstract).

KAJIWARA, Yoshimichi, 1973b, A simulation of the Kuroko type mineralization in Japan: Geochemical Journal (Japan), v. 6, p. 193-209 (in English). Author at Geological and Mineralogical Institute, Faculty of Science, Tokyo Kyoiku University, Tokyo 112, Japan.

On the basis of a model chloride-complex solution with the same metallic abundances as the present-day oceanic water, the physico-chemical factors controlling the ore-zoning observed in the Kuroko type mineralization in Japan have been examined. The result reveals that the ore-zoning can be explained by the oxidation and/or neutralization processes of the model ore-forming solution. This is in complete harmony with the interpretation expressed in the recent sulfur isotope studies of this type of mineralization. The hypothesis that the Kuroko ore-forming solution might have been derived essentially from the coeval seawater (Kajiwara, 1973) appears to be acceptable.

Extending the hypothesis, it is suggested that many of the hydrothermal systems in the earth's crust probably represent the circulating coeval seawaters. With this view, the natural hydrothermal mineralizations may be divided into two types, (A) mineralizations due to the reduction processes of the incorporated seawater and (B) those due to the oxidation processes of the once reduced circulating seawater. The deposits formed in shallow environments such as Kuroko and those formed in relatively deep environments such as contact metasomatic deposits may represent the oxidation and the reduction-type mineralizations, respectively.

It is also probable that the generation of silicate magmas in orogenic belts is closely related to the availability of such circulating seawater in the earth's crust and possibly in the upper mantle. (Author's abstract).

KALYUZHNYI, V. A. (Ed.), 1971, Mineral-forming fluids and paragenesis of minerals of pegmatites of the "zanorish" type in the Ukraine: Kiev, Naukova Dymka Press, 216 pp. (in Ukrainian). See Translations section.

KALYUZHNYI, Vl.A., 1973a, New instruments for studies of inclusions of mineral-forming fluids and principles of their use: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 285-286 (in Russian; translation provided through the courtesy of A. Kozlowski). Author at Inst. of Geol. and Geochemistry of Fuels of Acad. Sci. of Ukrainian SSR, L'vov.

1. Contact heating of preparations with inclusions is used in an improved model of a high-temp. vacuum stage, proposed by the author earlier (1965). The mineral plate is pressed between two Pt heating plates, the pressure supplied by springs with a ring and pivot made from SiO_2 glass. The heating plates have holes (0.1-0.3 mm diam.), made for lighting the inclusions with a lamp. A thermocouple is placed at the side of hole. The heating stage is mounted on a laboratory table separately from vacuum-pumping system. The instrument was tested at 1500°C. B.D. Zhovtulya worked on the mounting of the apparatus.

2. The author used **the** principle of a flowing gas as the cooling medium for freezing of liquid inclusions. The special stage, made from thermoresistant glass, has absolute thermoisolation: observations are made through two windows from optical glass. Use of a liquid cooling medium reduces the error of measurement of T (0.01°C). B.M. Gigashvili helped in the construction and experimentation.(Liquid vs gas medium = sic.)

3. Quick separation of gas from large samples, applicable to field conditions, is possible by use of a cylindrical non-vacuum ball mill. It is useful for making of rapid determinations of endogenic CO_2 in areas of granites and other rocks. The specific principle is the removal of released gases from the samples by a plastic pump. A.D. Matviyenko mounted and tested the mill in field conditions at the Volhynian deposit: the apparatus gave positive results in studies of CO_2 distribution in the area of the Volodarsk-Volhynian pegmatite field.

4. The refractometric method of determination of the general concentration of solutions in inclusions, worked out by the author in 1953-1954, is superior to other methods. By the use of inert media and special methods of removal of solutions from inclusions, the possibilities of the method become significantly wider, and the accuracy of measurement of indices of refraction increases. Inclusions of irregular shape in the range 0.10-0.05 mm may be investigated by the method. (Author's abstract).

KALYUZHNYI, V.A., 1973b, Measurement of pH of liquid inclusions in minerals and major formation patterns of cavernous pegmatities of the Ukraine: Mezhdunar. Geokhim. Kongr., (Dokl.), 1st, 1971 (pub. 1973), v. 2, p, 500-513 (in Russian). Abstracted in Fluid Inclusion Research - Proc. of COFFI v. 4, 1971, p. 35-36.

KALYUZHNYI, V.A., and MATVIYENKO, A.D., 1974, Peculiarities of distribution of endogenic carbon dioxide (from inclusions of fluids) and possibilities of recognition of genetic types of quartz and other minerals in granites of the Volhyn pegmatitic field, in Typomorphism of Ukrainian Quartz, edited by Ye. K. Lazarenko, Acad. Sci. Ukr. SSR: Kiev, Naukova Dumka Pub. House, p. 26-29 (in Russian; translation courtesy A. Kozlowski). Authors at Inst. of Geol. and Geochemistry of Fuels of Acad. Sci. of Ukr. SSR, L'vov.

High concs. of volatiles are the specific feature of melts of acid comp., being one of causes of metasomatic rexliz. of rocks. Quartz easily rexlizes under action of aqueous sols. and is the main host min. of incs. Metasomatic quartz is usually richer in fluid incs. that that of granitic origin and it may be the typomorphic feature. Conc. of CO_2 in granite is the best indicator of occurrence of hidden pegs. giving positive anomalies. A quick method of det. CO_2 in granites was developed from samples weighing 2.5-3 kg.

1. Background conc. of CO_2 in granites of Vyshnyakovskoe field is 0.4-1.8 ml/kg, and avg. 1.25 ml/kg.

2. Wall granites bear various conc. of CO_2 in different sections. In granites above pegs. at 10-17 m from the contact the amount of CO_2 increases toward peg. (Fig. 1a); the mean value is 2-8 times higher than background. Especially high conc. of CO_2 was found in kaolinized granites surrounding peg. No. 35 (13-15 ml/kg).

3. Granites laterally adjacent to peg. have a narrower zone enriched in CO_2 (12 m) but more highly contrasted (2.8 vs 14 ml/kg; Fig. 2).

4. Granites below pegs. are most strongly altered and bear high conc. CO_2 : 15.0 ml/kg in the contact vs 2.8 ml/kg 10 m deeper (Fig. 1.b)

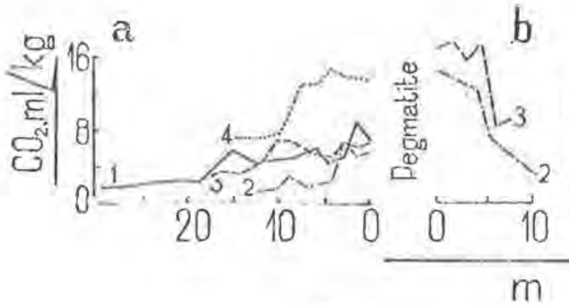


Fig. 1

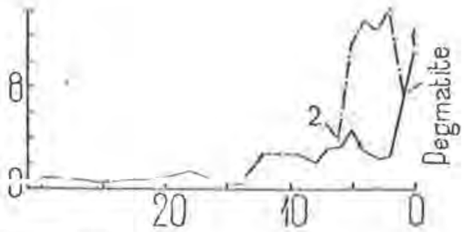


Fig. 2

Fig. 1 - Dist. of endogenic CO_2 in granites, samples from boreholes, granites bear following pegs.: 1-No. 57, 2-No. 53, 3-No. 34, 4-No. 35.

Fig. 2 - Same as previous, samples taken from walls of drifts: 1-wall granites of peg. No. 69, 2-wall granites of peg. No. 63.

KAMILLI, R.J., 1974, Paragenesis, fluid inclusions, zoning and origin of the silver mineralization of the Finlandia mine, Colqui District, Department of Lima, Peru (abst.): Econ. Geol., v. 69, p. 1182. Author at Department of Geological Sciences, Harvard University, Cambridge, Massachusetts.

The Finlandia mine is a Pb-Zn-Ag-Au vein in andesitic Tertiary volcanic rocks. The deposit is unusual in that the Ag-Au mineralization is earlier and of a higher temperature than the Pb-Zn mineralization. The hypogene paragenetic sequence can be divided into 6 distinct stages: (1) quartz, (2) quartz & muscovite & tetrahedrite & silver sulfosalts & electrum & other minerals, (3) quartz, (4) sphalerite & galena, (5) quartz, (6) sphalerite & galena. The vein muscovite yields a K-Ar age of 10.0±0.5 m.y., which corresponds to the intense late Tertiary volcanism of the central Andes.

Uncorrected fluid inclusion filling temperatures from stages 1-3 yield temperatures that range from 255° to 275°C. Stages 4-6 yield temperatures decreasing from 240°C with time. Sulfur isotope temperatures from sp-gn pairs fall in the same range. This agreement implies that the deposit was quite shallow when formed and that little or no pressure correction is necessary for the fluid inclusion data.

The distribution and nature of stage-2 mineralization is strongly controlled by elevation. The Ag-Au rich portion is restricted to a 130 meter vertical interval in the upper part of the vein, where it is very fine-grained and contains at least 15 different phases. From 40 to 60 meters below this zone stage-2 is virtually absent. At greater depths it reappears as a coarse-grained quartz-pyrite-chalcopyrite ore much poorer in Ag & Au.

The nature of the Ag-Au-rich stage-2 ore, its strong control by elevation, and the fact that primary fluid inclusions in it exhibit a markedly variable liquid to vapor phase ratio all indicate that boiling was the principal control in the formation of this ore. (Author's abstract).

KANTOR, J., and ELIAS, KAROL, 1974, Thermovacuometric impulse apparatus for the study of thermality according to liquid-gas inclusions: Geologicky Zbornik (Bratislava), - Geologica Carpathica, v. 25, no. 1, p. 97-103 (in English). Authors at Dionýz Stúr Institute of Geology, Bratislava, Mlynská dol. 1, ČSSR.

A thermovacuum impulse apparatus is described whose advantages include high sensitivity and very small samples. The results obtained by this method are compared with those from thermoacoustic and thermovacuum integration devices. (Authors' abstract, revised)

KARPOV, G.A., 1974, Experiments on the interaction between natural thermal solutions and rocks (abst.): Internat. Symp. on Water-Rock Interaction, Czechoslovakia, Sept. 9-17, 1974, Abstracts: Prague, Geological Survey, p. 31-32 (in English). Author at Institut vulkanologii, AN SSSR, Petropavlovsk - Kamchatskii, USSR.

KARPOV, I. K., KAZMIN, L. A., and KHALIULLINA, O. A., 1974, Computation of activity coefficients, species of water solutions up to 300°C and 0-3 m NaCl: Yearbook, 1973, Inst. of Geochemistry, "Nauka" Pub. House, Novosibirsk, p. 279-283 (in Russian with English abstract).

KARPOV, I.K., KISELEV, A.I., and KHLIULLINA, O., 1971 Thermodynamic properties of CO_2 at high temperatures and pressures: Geol. Rudnykh Mestor., v. 13, no. 4, p. 78-87 (in Russian; abstract in Econ. Geol., v. 69, 1974, p. 1155).

Derived and calculated data for CO_2 molecular and specific volumes and density under the following temperatures and pressures are given: 50°-1,500°C and 1-4,000 bars, 100°-1,000°C and 500-1,400 bars, 50°-1,500°C and 1,500-3,500 bars. These data can be used for the calculation of reactions with CO_2 at high temperatures and pressures.

KARWOWSKI, Lukasz, 1974, Fourth Regional Conference on Thermobarogeochemistry of Mineral-forming Processes: Przeglad Geol., v. 22, no. 7, p. 330-332 (in Polish).

A report on the conference at Rostov. (ER)

KARWOWSKI, Lukasz and KOZLOWSKI, Andrzej, 1973, Hydrocarbon inclusions in authigenic quartz from Devonian limestones at Lagów, Poland: 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 A. Kozlowski). Authors at Inst. of Geochemistry, Mineralogy and Petrography, Fac. of Geology, Warsaw Univ., 02-089 Warszawa, al Zwirki i Wigury 93, Poland. (Ed. note: This paper was presented at the Rostov Symposium, but the abstract was not included in the Abstract Volume).

Fluid inclusions in quartz and calcite crystallized in vertical fractures in Famennian bitumen-bearing limestones, were studied. Three types of primary inclusions were found: 1 - water solution and gas, 2 - bitumen and gas, 3 - water solution and bitumen and gas. T_H of aqueous inclusions in yellowish quartz ranges from 48 to 72°C, and in dark quartz from 160 to 190°C. T_H of bituminous inclusions are not suitable for determination of T of crystallization because of the unknown value of the contraction of bitumen under pressure. Homogenization of inclusions of the third type was achieved rarely and at high T (about 500°).

Analysis of a chloroform leachate proved that the bitumen consists of C_nH_{2n+2} hydrocarbons and their derivatives as well as small amounts of aromatic hydrocarbons.

The minerals crystallized at the T of wall rocks (about 50-70°C) with droplets of light yellow bitumen extracted by water from the wall rocks. Sometimes the warmer solutions have gone upward through zones of fractures (160-190°C), and were able to extract and transport heavier brown bitumens. SiO_2 and $CaCO_3$ dissolved from wall rocks in zones of stress; crystallization took place in parts with lower stress, i. e., in fractures and cavities. (Authors' abstract).

KARWOWSKI, Łukasz, and KOZŁOWSKI, Andrzej , 1974, Wolframite-cassiterite mineralization from Karkonosze-Izera area, W. Sudetes, Poland (from fluid inclusion studies)(abst.): Internat. Assoc. on the Genesis of Ore Deposits, Fourth Symposium, Varna, Sept. 1974, Abstracts of Papers: Sofia, IAGOD, p. 271-272 (in English). Authors at Inst. of Geochem., Min., and Pet., Warsaw Univ.

The area is divided into two parts: a southern Variscan granite massif (Karkonosze), and a northern meta. gneiss-schist complex (Izera Mts and Izera Upland). In the marginal zone of massif and in the meta. complex there is Na metasomatic alt. of parent rocks, reaching in many places the stage of leucogranite. Some of metasomatically alt. rocks passed into greisens, arranged in a zone about 15 km long.

W-Sn-Mo min. with sulfides and Bi occur in small vugs and in quartz veins, connected with albitized aplogranites in endocontact zone; quartz-mica-topaz greisens contain disseminated W-Sn-Bi type min. with Nb-bearing rutile. The most important cassiterite min. with arsenopyrite (+Co) was later modified by a sulfide assemb.

Fluid inc. studies show that the parent sol. was primarily pneumatolytic (T_H 480-380°C), and later condensed into hyd. sols. (T_H 380-100°C). The latest pneumatolytic stage and early hyd. stage were the main period of wolframite (385-300°C) and cassiterite (375-340°C) xliz. Other mins. xlized at lower T. The parent sols. were relatively dilute Na-Ca-Cl-sulfide fluids at $\sim$700 atm.

The min. involved mobilization of large amounts of F, B and CO_2 (evidenced by F- and B-bearing mins. and fluid incs. with major amounts of liquid CO_2). Cassiterite min. in schists formed at 390-380°C. Greisenization was caused by dilute sols. rich in CO_2 at 390-250°C and $\sim$800 atm. Greisens bear wolframite-scheelite min. with disseminated cassiterite, native Bi and arsenopyrite. Wolframite xlized during high-T greisenization (380-350°C). At 310-280°C it was alt. to scheelite by F-bearing sols. (fluorite xlized at 320-240°C). Assoc. alluvial sands containing cassiterite, wolframite, scheelite, and topaz give T_D - 400-350°C.

Inside the granitic massif, the W-Sn min. originated from dilute sols. poor in CO_2, and the intruding granite formed aureoles of mobile components in the meta. rocks, causing greisenization and preferring the origin of ore min. (Modified by ER from the authors' abstract.)

KATAEVA, V.N., 1973, Investigation of liquid phase of inclusions from siliceous rocks of Precambrian and Paleozoic age from E. Siberia: Abstracts of papers at Fourth Regional Conferene on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 171-172 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Inst. of Geology and Geophysics, Siberian Branch of Acad. Sci. of USSR, Novosibirsk.

(...) In a recent paper analyses are given of water leachates from chert-like rocks (silicites, of sedimentary origin). Investigated samples are of Middle Riphean age from Turukhanskoe anticlinorium

(17 samples), of Cambrian age from Tuva (7 samples), and of Upper Riphean age from Khakassya (7 specimens). Samples differ in each group by age, genesis, conditions of occurrence, morphology and color. Wall-rocks are of sedimentary and volcanogenic-sedimentary origin. In siliceous sedimentary and hydrothermal-sedimentary rocks from Turukhan the salt composition of inclusions is variable. For silicites of sedimentary origin the average composition is as follows: Ca > (Mg, Na, K, Li, NH_4); and Cl > F > HCO_3. For silicites whose origin is connected with thermal sources: Ca > (Na, K, NH_4, Li, Mg); and Cl > F > SO_4 > HCO_3. (...) The composition of the liquid phase of inclusions in silicites from the Cambrian Altynbulakskiy Complex from Tuva (region of Aktovrakskoe chrysotile-asbestos deposit) permits distinguishing two types of cherts: massive sedimentary and metasomatic replacement of limestones. Main ions for the first variety: Na > K > Mg; and HCO_3 > Cl > HPO_4^{2-} > F. For the metasomatic variety the average composition is as follows: Ca > Na > Mg > K; and HCO_3 > Cl > F.

On the basis of water leachate analyses one may sharply distinguish cherts from upper and middle part from cherts from lower part of Martyukhinskiy Complex of Upper Riphean from Khakassya (Batenevskiy area). In upper and middle part, the cation composition is as follows: Ca > Mg, Na > K (Mg is sometimes lacking); anions in upper part: HPO_4^{2-} > F > Cl; and in middle part: HCO_3 > Cl. In cherts of the lower part of the complex inclusions showed compositions with: Na > K > Ca > Mg; and SO_4 > HCO_3 > Cl > F, with continuous presence of F & SO_4^{2-}. (Author's abstract, modified by A.K.).

KATSURA, Takashi and NAGASHIMA, Shigeru, 1974, Solubility of sulfur in some magmas at 1 atmosphere: Geochim. et Cosmo. Acta, v. 38, p. 517-531. Authors at Department of Chemistry, Faculty of Science, Tokyo Institute of Technology, Ookayama, Meguro-ku, Tokyo.

In order to understand the distribution of sulfur in igneous rocks, we determined the solubility of sulfur in volcanic rock melts (tholeiite basalt, hawaiite and rhyodacite from Hawaii) at various gas compositions and at 1250° and 1300°C and 1 atm total pressure. The solubility of sulfur in the melt passes through a minimum with change in oxygen partial pressure, if other factors are held constant. For the basaltic liquid at 1200°C, most sulfur in the melt is as dissolved sulfide (S^{-2}) at oxygen partial pressures below 10^{-8} atm and as dissolved sulfate at oxygen partial pressures above 10^{-8} atm. Based on the present solubility data, 5 percent is inferred for volcanic gas at 1 atm total pressure in equilibrium with subaerially extruded Hawaiian tholeiite basalt (Pele's hair with 180 ppm S) at 1200°C and 10^{-8} atm P_{O_2}. (Authors' abstract)

KAZANSKII, Yu. P., KATAEVA, V.N., and SHUGUROVA, N.A., 1973, Composition of ancient atmospheres according to data from study of gaseous inclusions of quartz rocks: Geokhim. Dokembr. Paleozoiskikh Otlozh. Sib., Yu.P. Kazanskii, ed.: Novosibirsk, Akad. Nauk SSSR, Sib. Otdel., Inst. Geol. Geofiz. p. 5-17 (in Russian). C.A. v. 81, 1974, 156209h.

The compn. of the gaseous phase of incs. in quartz rocks with T_H <300°, indicates 4 stages in the development of the earth's atm.: (1) Archean (contg. mainly CO_2, NH_3, possibly HCl, HF, H_2S, and CH_4), (2) Archean-Early Proterozoic (appearance of O, reactions between O and NH_3), (3) Middle Proterozoic-Silurian (decompn. of NH_3 to N, decreasing concn. of CO_2, increasing concn. of O), and (4) Devonian-Recent (sharp decrease in the concn. of CO_2). The corresponding 4 stages of the rock weathering were described. Implications for sedimentation were suggested.

KAZANSKIY, V.I., OMEL'YANENKO, B.I., and PROKHOROV, K.V., 1974, On vertical zonality of uranium-bearing sodium metasomatites, in Metasomatism and ore-formation, ed. D.S. Korzhinskii: Moscow, "Nauka" Press p. 92-100 (in Russian; abstract courtesy A. Kozlowski).

In sodium metasomatites bearing uranium ores and occurring within Precambrian ultrametamorphic rocks, quartz and alkaline amphibole (probably riebeckite), both connected with ore mineralization, gave T_D = 280-290 and 350°C respectively.

KAZITSYN, Yu.V., AND MOSKALYUK, A.A., 1973, Composition of mineral-forming medium of rocks surrounding ores: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 189-191 (in Russian; translation through the courtesy of A.Kozlowski). Authors at VSEGEI, Leningrad.

1. (...).

2. The composition of mineral-forming medium was investigated by the water leachate method in all metasomatic zones of hydrothermally altered rocks of the following types of deposits: high-temp. gold (albitization and tourmalinization); moderate-temp. molybdenite (berezitization and orthoclasization); low-temp. Sb-Hg, Au-Ag and fluorite (argillitization). (...)

a. Solutions of the high-temp. type are of Cl-Na-K-NH_4 composition with salt concentration of 0.64 - 9.90 g per liter, and with the amount of water in the inclusions 0.14 - 3.36% of the sample; pH of water leachates 6.80 - 7.80.

b. Moderate-temp. solutions have SO_4^{2-} - Na - K composition, salt concentration of 0.95 - 47.55 g/l, an amount of water in inclusions of 0.11 - 0.76% of sample and a pH of water leachates of 6.70 - 8.20.

c. Low-temp. solutions have HCO_3^- - K - Na - Mg - Ca composition salt of samples, pH of water leachates 6.60 - 8.30.

3. Together with the change of solutions from high- to low-temp. deposits, one may ascertain differences in composition of the solutions in various zones of metasomatites of individual deposits. The main tendency of these differences is the increasing role, first of HCO_3^-, later of SO_4^{2-}, and at the end of F, in accordance with the intensity of alteration. For example, at moderate-temp. Mo deposits:

Ion	zone of weak alteration	transitional zone	zone of maximum alteration
HCO_3^-	65	53	46
SO_4^{2-}	12	44	49
F^-	1.6	2.6	4.6

Note: ion amounts in % - equiv.

An increased amount of Cl was found in peripheral zone. (...) (Authors' abstract, abbreviated by A.K.)

KEELE, R.A., and NICKEL, E.H., 1974, The geology of a primary millerite-bearing sulfide assemblage and supergene alteration at the Otter Shoot, Kambalda, Western Australia: Econ. Geol, v. 69, p. 1102-1117.

Spherical sulfide blebs (millerite, pentlandite, pyrite, and magnetite) occur in the hanging wall, closely associated with blebs of silicate material consisting mainly of talc and chlorite. Both are presumed to have originated as immiscible liquid globules in an ultramafic magma. (Authors' abstract, abbreviated)

KELLY, W.C., 1974, Panasqueira, Portugal — An unorthodox case of hydrothermal tin-tungsten mineralization (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 6, no. 7, p. 820. Author at Department of Geology and Mineralogy, The University of Michigan, Ann Arbor, Michigan, 48104.

The tin-tungsten ores of Panasqueira, Portugal, occur in unusual flat-lying veins spatially associated with a blind, granitic cupola of Hercynian age. This cupola may have played a structural role in the localization of ore, but was not in itself a significant source of vein matter. The intrusive is capped by a thick (13.3 meter) mass of quartz which formed as a hydrothermal filling of a large cave developed at the apex of intrusion by magmatic stoping and withdrawal. The vein structures are not purely tectonic in origin; they represent horizontal and near-horizontal joints selectively opened by magmatic subsidence and/or hydraulic dilation by the vein fluids themselves.

These vein fluids were hot (80-325°C), aqueous brines (3-10 wt % equivalent NaCl) which remained at or close to saturation in quartz, muscovite and tourmaline throughout the main stage of vein filling. Widespread boiling in the vein system may be the cause of asymmetry locally seen in the vein fillings, but it had no discernible effect on the lateral distribution of ore.

Cupola emplacement and mineralization occurred at surprisingly shallow depth, probably within 1.5 km of the contemporaneous ground surface. The Hercynian tin-tungsten veins were re-heated in Alpine time, but this event left only subtle imprints on the older ores such as the erasure of pre-existing fission fragment (tracks) in apatite. Panasqueira possesses the descriptive earmarks of classical "hypothermal" and "pneumatolytic" ore deposits, but, if anything, the district serves to document the obsolescence of these words as genetic terms. (Author's abstract)

KERRICH, Robert, 1974a, Aspects of pressure solution as a deformation mechanism: PhD dissertation, Imperial College, London, 255 pp.

Pressure solution (P sol.), which may be defined as the sol., diffusion, and pption. of rock form. mins. in response to stress fields, has long been recognised as an important mode by which low grade rocks deform.

Quan. information on the PT of crustal environments (Dalradian Series of Southwest Scotland, and Paleozoic rocks of the Central Pyrenees) in which P sol. is the dominant deformation mechanism has been obtained using oxygen isotope and fluid inc. therm.

Estim. of the crustal conditions over which P sol. is an important deformation mechanism in dominantly quartz-bearing assem. are 30°C to 450°C ± 50°C, irrespective of the crustal depth (= mean stress).

Oxygen isotope geochemistry has been used to assess the equilibrium relations between tectonic veins and their host rocks. In addition, T data on veins, obtained this way, have been related to the mineral assemblages and deformation mechanisms characteristic of tectonic veins at different crustal levels.

Some information is adduced from data on fluid inclusions and oxygen isotopes, in minerals from tectonic veins, concerning the nature and sources of fluids in tectonic environments.

Attention has been directed towards the problem of nonequilibrium isotopic fractionation in stress fields.

Quan. data relating to the dist. of chem. and min. species around cylindrical incs. with pressure shadows, has been obtained from XRF and XRD. The measured dist. of chem. and min. species is related to stress fields, and to considerations of kinetic effects.

Aspects of tectonic striping are discussed with regard to the physics of diffusion. (Author's abstract, abbreviated)

KERRICK, D.M., 1974b, Review of metamorphic mixed-volatile (H_2O-CO_2) equilibria: Amer. Min., v. 59, p. 729-762. Author at Department of Geosciences, The Pennsylvania State University, University Park, Pennsylvania 16802.

An extensive survey of equilibria and topology in various mixed volatile systems, with applications to a wide variety of metamorphic terrains. pertinent to many studies of fluid inclusions. (ER)

KESLER, S.E., and ASCARRUNZ-K., R., 1973, Lead-zinc mineralization in carbonate rocks, central Guatemala: Econ. Geol., v. 68, p. 1263-1274.

Lead-zinc-(silver) mineralization is widespread in carbonate rocks of the Permian Chóchal and Cretaceous Cobán-Ixcoy formations in a 250 X 50 km zone elongated east-west across central Guatemala. Massive galena-sphalerite-pyrite-quartz mineralization is concentrated along bedding planes and fault surfaces in areas up to 1,500 X 100 m. Minor barite, chalcopyrite, and pyrargyrite are present locally and the silver content of galena increases southward across part of the mineralized zone. Most mineralization is near the base of the lowest carbonate unit in the local stratigraphic section and does not appear to be related, in surface outcrop, to the depositional and collapse breccias that are widespread throughout the Chóchal and Cobán-Ixcoy carbonate rocks. Mineralization appears to be late Cretaceous in age.

δS^{34} values for sulfides in the mineralized area exhibit a spread of 25 per mil, do not center on zero, and are similar to those of many Mississippi Valley deposits. Lead isotope values are only slightly radiogenic, however, and show greater similarities to magmatic-hydrothermal lead-zinc deposits. Limited sulfur isotope and fluid inclusion data suggest that mineralization took place below 250°C. Sulfides with the observed variation in δS^{34} values could have been deposited below 250°C under a small range of f_{O_2} and pH if the bulk isotopic composition of the ore-forming sulfur was +18 to +26 per mil. The lower part of this range coincides with estimates of δS^{34} for Jurassic-Cretaceous sea water, which is widespread in the mineralized zone as the gypsum facies of a large evaporite basin that occupied northern Central America during Jurassic-Cretaceous time. (Authors' abstract)

KESSON, S.E., and HOLLOWAY, J.R., 1974, The generation of $N_2-CO_2-H_2O$ fluids for use in hydrothermal experimentation II. Melting of albite in a multispecies fluid: American Mineralogist, v. 59, p. 598-603. First author at Department of Earth and Space Sciences, State University of New York at Stony Brook, Stony Brook N.Y.

Three fluid compositions in the C-O-H-N system, each with nominal mole fraction of $H_2O = 0.25$, were used for comparative determinations of the solidus of synthetic albite at 4.4 kbar. The fluids were generated by the decomposition of guanidine nitrate $CH_5N_3.HNO_3$, ammonium oxalate $(NH_4)_2C_2O_4.H_2O$, and from a 1:2 molar mixture of oxalic acid dihydrate and anhydrous oxalic acid. Hydrogen fugacity during the experiments was not buffered and was found to lie between $Ni-NiO-H_2O$ and $MnO-Mn_3O_4-H_2O$ buffers. Excess H_2 produced by the decomposition of the C-O-H-N solid compounds diffuses out of the sample capsule, resulting in fluids consisting essentially of the species H_2O, CO_2 and N_2. The ternary nature of these fluids, which was predicted by thermodynamic equilibrium calculations, is confirmed by quantitative gas chromatographic analysis of the quenched fluids. Reversals confine the albite solidus between 954°C and 958°C(±2°C) and within experimental limits there is no significant difference between solidus temperatures for each of the three fluid compositions. This suggests that activity coefficients for H_2O are similar in each case and are independent of the CO_2/N_2 ratio in the fluid. These data place an upper bound on the activity coefficient for H_2O at 960° and 4.4 kbar of approximately 1.8 in H_2O-CO_2-N_2 fluids with the mole fraction of $H_2O = 0.25$. (Authors' abstract).

KHAKIMOV, A. Kh, 1973, Graphical and natural exposition of the theme "Inclusions of mineral-forming medium" in the Museum of Earth Sciences, first floor: Life of the Earth, Sbornik Museum Earth Sciences, Moscow Gos. Univ., v. 9, p. 189-201 (in Russian)

A description of the museum exhibits on fluid inclusions. (ER)

KHARLAMOV, Ye. S, 1973, Construction of an apparatus for fine control of the speed of freezing of preparations in a cryostage by the use of liquid nitrogen: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 296-297 (in Russian; translation provided through the courtesy of A. Kozlowski). Author at All-Union Scientific-Research Institute of Mineral Raw Materials.

Recently available apparatus for cryometric investigations permit experiments over a wide range of negative temperatures and provide data on some questions of the physical chemistry of mineral-forming solutions. The author describes a new regulator for microflow of liquid nitrogen into the cryostage (Bazarov's stage). Liquid nitrogen from a glass dewar flows over a nichrome heating element. Continuous voltage control with a LATR transformer provides fine control of the intensity of boiling of nitrogen and hence the speed of flow to the cryostage. Temperature can be maintained stably for long periods of time.

A new liquid level indicator for the dewar is proposed, as well as a method of pouring liquid nitrogen from a 15-liter glass supply reservoir to a 1-liter one, using a special electroheating element; this permits continuous cryometric studies.

These procedures (...) made laboratory cryometric investigations easier in the T range 0 to -195°C. (Author's abstract, abbreviated by A.K.).

KHAYRETDINOV, I..A, AVZYANOV, V.S., ANDRYANOVA, N.A., EVDOKIMOVA, Z.V., and PSHENICHNYI, G.N., 1973, Thermobarogeochemical conditions of origin of essential mineral associations of some sulfide deposits of S. Ural: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 324-326 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Geol. Inst. of Bashkirian Division of Acad. Sci. of USSR, Ufa.

Conditions of formation of sulfide ores by thermobarometric methods have not been investigated sufficiently. (...) Homogenization and water leachate methods (leachates made after crushing or after superheating) were the main ones used by the writers. It was accepted that fluid inclusions in barren pre-ore minerals or in minerals syngenetic with ores must also express the processes of ore mineralization. Evidently, complete decomposition of fluid inclusions by later processes needs unusual conditions.

Dimensions of the G-L inclusions studied were 0.001 to 0.020 mm. A heating stage for small inclusions was used. Points of homogenization and heterogenization were usually crossed three times. Cases of repeated heterogenization and homogenization of G-L inclusions during increase of temperature were investigated especially thoroughly. "Double homogenization" (Trufanov, 1969) was explained by desorption of part of the gases adsorbed on the walls of the vacuole. Initially the visible gas bubble dissolves in the liquid phase (first homogenization), then with desorption the repeated heterogenization takes place, and further heating leads to the second homogenization. The time necessary for the inclusion to reach its primary state, i.e., for sorbtion of part of the gas, proves the chemical nature of this process.

Evaluation of pressure in G-L inclusions was made by using the method of V.B. Naumov and S.D. Malinin (1968). For determination of critical pressures the proportional calculation of values known for quartz (850±50 atm) was made, taking into account the data on "microhardness".1/

The authors' investigations prove that at some deposits of S. Ural the earliest pyrite-bearing rocks formed under low-temp. conditions, rich in colloids. The following features testify to this supposition: a) very fine-grained opal-like structures of quartzites, b) inclusions of framboidal olive-green semitransparent globules having diameters 0.001 to 0.005 mm, that become brownish at T 300-350°C, c) lack of primary inclusions (G-L), d) leachates having essentially bicarbonate composition.

Productive stages of mineralization are characterized by an uneven increase of T and increase of P (up to 150 to 350 atm). At deposits formed at a depth of more than 1500 m the pressure increases up to 750±50 atm. (Authors' abstract, abbreviated by A.K.)

1/ (Presumably refers to the internal strength data of Khetchikov and Samoilovich, 1970b - see Fluid Inclusion Research - Proceedings of COFFI v. 3, p. 94-100, 1970)

KHETAGUROV, G.V., 1973a, Thermal conditions of forming and mineral geochemical peculiarities of ores of Central Caucasian polymetallic deposits: 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). Author at North-Caucasian Institute of Mining and Metallurgy, Ordzhonikidze, USSR. * p. 151-152

1. Polymetallic deposits were formed during various metallogenic periods:

A. The most ancient deposits of pyrite-polymetalliferous formation (Buron, Labagom, and others) are of Paleozoic age and are considered basically to be sedimentation-exhalation ores. As a result of metamorphic processes taking place at 570-400° there were formed minerals that are not characteristic of other deposits - Fe_2O_3, Fe_3O_4, graphite, $CaWoO_4$, SnO_2 and others. Sulphides Pb, Zn, Fe, Cu were deposited during the hydrothermal period (400-60°). As compared to other deposits, the ores are enriched with Sn, Co, In, Ni.

B. Hercynian deposits (Elbrus, Tyzyl, Chochukulak) were formed at 280-60°, the deposition of commercial minerals taking place at 200-80°. They are characterized by high nickel content which is due to the contaminating effect of ultrabasites (reginal mobilization of Ovchinnikov).

C. The deposits of the Kimmeric metallogenic period (the deposits of North Ossetia) were formed at 400-60°, and commercial minerals at 200-90°; the highest temperature examples being the ores of Sadon and Digora regions (Fasnal, Zgyd, Old Tsey, Sadon, Arkhon, Kholst and others), and lower temperature examples include those of the Fiagdon region (Kadat Khampaladag, Kakadur-Khanikom, Sargom and others). The latter characterized by fairly simple composition and in particualar by the lack of pyrrhotite. The ores of Sadon and Digora deposits contain more In, Ag, Bi, and Mo as impurities.

D. The deposits of the Alpine metallogenic period are mainly represented by polymetallic (Kwisa) and quartz-arsenopyrite-metallic (Mountinous Digora) subformations. The former were formed under near-surface conditions at 240-40°, the latter at 510-60°; the deposition of lead and zinc sulphides in the Digora ores occurred at 270-80°, in Kwisa at 180-80°. The ores of Kwisa are distinguished by simple mineral composition and the extensive development of collomorphic and metallocolloidal aggregates and by a relatively high thallium and cadmium content. In the ores of Oigoria a number of minerals were noted which do not occur in other deposits: stannite, bismuth hydride (sic), wolframite and others.

2. The data obtained prove definite dependence of mineral-geochemical properties of ores on the thermal conditions of their formation. The latter in their turn are connected with the depth of formation and the distance of deposits from ore-controlling faults.(Author's abstract)

KHETAGUROV, G.V., 1973b, Study of cationic composition of gas-liquid mineral inclusions: 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). Author at North-Caucasian Institute of Mining and Metallurgy, Ordzhonikidze, USSR. p. 188-189

1. It is known that determining the elemental composition of the preserved products of hydrothermal activity is rather complex and time consuming and is accomplished by analyzing individual trace elements and water-extractions.

2. Our investigations were aimed at defining the influence of gas-water inclusions on the presence of trace-elements (principally cations) in minerals. For this purpose some light-coloured specimens of sphalerites from Upper Zgyd lead-zinc deposit were studied. They were rich in gas-water inclusions. (These?) sphalerites come from one of the concluding stages of ore formation and according to the data of thermometric investigations (homogenization and decrepitation) they were deposited at 120-90°. Samples were selected under the binocular (microscope) and those rich with inclusions and those lacking them were analyzed quantitatively and spectrographically at D0C-13 of a grain (sic.).

3. The resultant averaged data prove that the samples studied are characterized by the same set of impurities. The differences in them are revealed in the relative content of elements. Samples with gas-water inclusions are characterized by fairly higher content of Cu, Pb, Mn, Al, Bi, Cr. At the same time there is no essential difference in Sn, Co, Ga, and Cd content in the samples studied.

4. Different levels of trace element content in the residual gas-water solutions depend on geochemical affinity of impurities and zinc (the principal element of the mineral-concentrator), that in its turn defines the isomorphic abilities of sphalerite. Hence, during the process of ore-forming the solutions in the inclusions will be enriched by

nonisomorphic elements (Si, Cr, Al, Pb, etc.) not assimilated by sphalerite. Speaking on the form in which the latter occurs, one should point out that the most probable one is the upsetting in solid phase on the walls of vacuoles at lowered temperatures (sic.). This probably explains the absence of the most part of the above-mentioned elements in the data by different scientists on gas-water extractions.

5. The method of differential analysis of mineral grains may be used for judging on the degree of contamination with different trace elements in gas-water inclusions in minerals. (Author's abstract).

KHETAGUROV, G.V., 1973c, Genesis of pyrite-polymetal deposits of the Buron ore field, central Caucasus: Akad. Nauk SSSR, Doklady, v. 212, no. 1, p. 180-184 (in Russian; translated in Akad. Nauk SSSR, v. 212, p. 46-49, 1974). Author at North Caucasus Mining and Metallurgical Institute, Ordzhonikidze

Study of monomineralic fractions by decrep., vacuum thermometry and homog. revealed the T ranges of ore-forming and meta. processes. The highest Ts (≥570°C) obtained for quartz, garnet and other minerals from meta. rocks are consistent with those of the almandine-amphibole facies of regional meta. The regressive (contact) meta. occurred at lower Ts, which, according to data on specimens of vein quartz and marmorized limestone, range from 300° to 500°. Finally, hydrothermal min. were dep. at Ts of 60° to 400°, which correspond to those of ore deposition in the Staryy Tsey deposit and are similar to the figures obtained for deposits of the Sadon group (Zgid, Sadon, Arkhon and Kholst). (ER)

KHETAGUROV, G.B., PANIYEV, M.I,, and RUSANOV, A.B., 1973, Sulfides of metasomatic origin in reef limestone of the Kvaysa polymetal deposit in the central Caucasus: Doklady Akad. Nauk SSSR, v. 210, no. 2, p. 422-425 (in Russian; trans. in Dokl. Akad Nauk SSSR, v. 210, p. 62-64 (1974)). Authors at North Caucasus Mining and Metallurgical Institute, Ordzhonikidze Kvaysa Ore Deposit Management.

Sphalerite from these epithermal lead-zinc deposits, both from vein fillings and metasomatic alteration product (i.e., replacement) of corallites gives a T range of 80-100°C (both T_H and T_D). (ER)

KHETCHIKOV, L.N., KOLODIEVA, S.V., KOLBIN, B.A., GAVRILKO, N.P., and KHADZHI, V. Ye., 1974, New typomorphic features of crystals of quartz, in Typomorphism of Ukrainian Quartz, edited by Ye. K. Lazarenko, Acad. Sci. Ukr. SSR: Kiev, Naukova Dumka Pub. House, p. 114-117 (in Russian; translation courtesy A. Kozlowski). Authors at All-Union Scientific-Research Inst. of Synthesis of Mineral Raw Materials, Alexandrov.

Electrical parameters of quartz change at the point of homogenization of incs. and this may provide a method of evaluation of T of origin (A.K.).

KHETCHIKOV, L.N., ONTOYEV, D.O., and DOROGOVIN, B.A., 1970, Some genetic features of rare metal deposits of the Transbaikal region according to the study of gaseous-liquid inclusions in quartz: Geol. Rudnykh Mestor., v. 12, no. 3, p. 71-83 (in Russian; abstract in Econ. Geol. v. 69, 1974, p. 725-726). Originally abstracted briefly in Fluid Inclusion Research - Proc. of COFFI, v. 3, 1970, p. 32.

The authors studied changes in the temperatures of ore deposition of various stages of mineralization, with emphasis on temperature gradients as controlled by distance from granite massifs. Specimens for these studies were obtained from the molybdenum-tungsten deposits of Dzhidinskoye and Bom-Gorkhonskoye, and from the tin sulfide deposits of Sherlovogorskoye and Khapcheranginskoye. The examination of behavior of gaseous-liquid inclusions in quartz indicates that the formation of all deposits progressed as the density of mineralizing solutions increased. The composition of mineralizing solutions was different in different types of deposits. Carbon dioxide forms up to 20 percent of the inclusions in quartz of molybdenum-tungsten deposits. It is absent in quartz of tin sulfide deposits. However, in these inclusions crystals of alkaline metal chlorides were discovered. This suggests that the solutions were quite concentrated at the time of deposition of quartz. The difference in composition of solutions is probably the result of the effect of country rocks. Sulfurous gases are common in high temperature inclusions, while carbon dioxide is typical of low temperature inclusions. There was a vertical and a horizontal temperature zoning in temperature of homogenization of inclusions with an increase in distance from granite massifs.

KHETCHIKOV, L. N., and SAMOYLOVICH, L.A., 1974, Influence of composition and concentration of salt and volatile components on relations between thermodynamic parameters of some water solutions: p. 68-71 in Hydrothermal mineral-forming solutions of the areas of active volcanism, S.I. Naboko, ed.: Novosibirsk, "Nauka" Pub. House, (in Russian). Authors at All-Union Scientific-Research Inst. on Synthesis of Artificial Raw Materials, Alexandrov.

Exper. data on quan. relations between P, T, density and comp. of water sols. of chlorides of K and Ca, sulfates of Na, K, as well as HCl. In certain expers. the influence of CO_2 was invest. (Author's abstract, translated by A.K.)

KHOLIEF, M.M., 1974, Endoscopic study on some Carboniferous detrital sediments from west-central Sinai, Egypt (abst.): Internat. Mineral. Assoc. Ninth Gen. Meeting, West Berlin and Regensburg, W. Germany, Collected Abstracts: West Berlin, German Mineralog. Soc., p. 29 (in English). Author at Cairo, Egypt.

Incs. were studied in about 60 samples of quartz grains from the Carboniferous detrital sediments of west-central Sinai. The incs. (P and S) are either solid or L-G. Many incs., especially the solid ones, have made impressions on the surface morphology of quartz grains. The nature and the mode of distribution of the incs. indicate that the source rock was mainly effusive acidic and microgranitic. Subsequent tectonic effects resulted in fissuring and formation of S incs. (Modified by ER from author's abstract).

KHRUSTALEVA, G.K., 1973, On genesis of claystones as indicated by thermobarometric studies: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 25-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 242-244 (in Russian; translation through the courtesy of A. Kozlowski). Author at Rostov Univ.

1. Detailed investigations were made of claystones occurring in coals of the productive Karaganda complex from Karaganda Basin. (...).

2. Karaganda claystones consist of 60-70% kaolinite, 30-40% mixed-layered minerals. (...). Morphological varieties testify to two possible modes of kaolinite formation: growth under quiet conditions at optimum Al_2O_3/SiO_2 ratios, and incomplete crystallization of alumina-silica gels after quick precipitation and preservation. Attention was

paid to humic acids.

3. Inclusions were investigated in kaolinite and apatite: in addition to kaolinite, apatite, siderite and pyrite from the heavy fraction of claystones were investigated by thermovacuum method. Inclusions in kaolinite have dimensions of ~1 µm and group near the contacts of the crystals (...). Due to the minute size of these inclusions, it was impossible to study individual ones; for this reason a monomineralic fraction of kaolinite was investigated by use of vacuum decrepitometer VD-2. In apatite numerous inclusions (9.5 - 75 µm) were found. They are tubular, etc.; the following phase compositions were found: homogenous metastable phase, two-phase, polyphase (liquid with drops of conserved gel), G-L with daughter mineral, 2 liquids, G-L with a "pseudohexagonally faceted" gas bubble, and crystallized gel).

4. Degree of filling (F) is high, proving a low T of trapping of the mineral-forming solution; T_H of inclusions in apatite - 145 to 160°C. Curves of thermovaccum analysis prove that T intervals of gas-releasing of kaolinite, apatite, siderite and pyrite are similar and equal 60-160°C, with maxima at 80-120°C. This testifies to similar thermodynamic conditions of origin of investigated minerals and indicates the probable T regime of growth of kaolinite crystals.

5. Thus, claystones may be considered to be authigenic formations, formed as a result of cyrstallization, and subsequent recrystallization of alumina-silica gels in the stage of diagenesis and intitial katagenesis. (Author's abstract, with abbreviations by A.K.)

KIGAY, I.N., 1973, Meeting on prospecting for hidden mineralization based on zoning of hydrothermal deposits: Geol. Rudn. Mest., v. 15, no. 3, p. 129-133. (in Russian)

On p. 133 a short abstract of a paper by Laz'ko, Lyakhov, and Piznyur on T studies of Au and Mo deposits in E. Transbaikalia is given (A.K.).

KILLINGLEY, J.S. and MUENOW, D.W., 1974, A mass spectrometric method for the determination of the size distribution of CO_2 inclusions in olivine: Amer. Mineral., v. 59, p. 863-867. Authors at Chemistry Department and Hawaii Institute of Geophysics, University of Hawaii, Hawaii.

A procedure is described for a mass spectrometric determination of the size distribution (by weight) of CO_2 inclusions in olivine. Samples are heated within a high temperature effusion-cell, and bursting of CO_2 from ruptured inclusions is detected by a quadrupole mass filter as ion-current signal-spikes. Intensities are calibrated from pressure spikes produced by the rupture of glass capillary ampules containing known amounts of CO_2.

The procedure was applied to samples of olivine, and an inverse relationship between the number and size of CO_2 inclusions was demonstrated. Inclusion sizes range from 2×10^{-9} g to smaller than 1×10^{-11} g of CO_2. No water was detected which could be associated with the bursting of CO_2. The technique clearly distinguishes adsorbed CO_2 from inclusion CO_2. (Authors' abstract)

KLYAKHIN, V.A., LEBEDEV, A.S., and RODIONOV, A.Ya, 1974, Stability of fluoroaluminate complexes under hydrothermal conditions: Eksp. Issled. Mineral., 1972-1973 (Pub. 1974), p. 149-151, A.A. Godovikov, V.S. Sobolev, and B.A. Fursenko, eds.: Novosibirsk, Akad. Nauk SSSR, Sib. Otd., Inst. Geol. Geofiz. (in Russian). C.A., v. 82, 1975, 105734p.

To show the stability of fluoroaluminates under hydrothermal conditions, the inclusion of mother liquor into $Na_5Al_3F_{14}$, $KAlF_4$, Li_3AlF_6, and $(NH_4)_3AlF_6$ crystals was studied and their T_H detd. In $Na_5Al_3F_{14}$ and $(NH_4)_3AlF_6$ homogenization of the inclusions is not obsd.; whereas in $KAlF_4$ and Li_3AlF_6 they are homogenized in the liq. phase at 280-300 and 300-20°, resp. Entrapment of incs. and growth of crystals of the compds. proceeds from supersatd. solns. of these salts at sufficiently high temps.

KNIPPING, H.D., 1974, The concepts of supergene versus hypogene emplacement of uranium at Rabbit Lake, Saskatchewan, Canada: in Formation of Uranium Ore Deposits, Proceedings of a Symposium, Athens, Greece, 6-10 May 1974: Vienna, Internat. Atomic Energy Agency, p. 531-549. Author at Gulf Minerals Canada Ltd., Toronto, Ontario, Canada

Decrepitation of massive quartz and calcite coating pitchblende occurred at <100°C (p. 542) (ER).

KOKAREV, G.N. AND MEL'NIKOVA, Ye. M., 1973, Contribution to conditions of formation of accessory minerals in rock-crystal-bearing veins of Pripolyarnyi Ural, as indicated by gas-liquid inclusion homogenization data: Abstracts of papers from the Fourth Regional Conferece on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 119-121 (in Russian; translation through the courtesy of A. Kozlowski) Authors at All-Union Scientific-Research Inst. for the Synthesis of Mineral Raw Materials - VNIISIMS, Aleksandrov.

1. Rock-crystal mineralization of Pripolyarnyi Ural is connected with the late stage of Variscan tectono-magmatic cycle. Hydrothermal quartz veins occur in deeply metamorphosed series of crystalline schists and gneisses. T_h of gas-liquid inclusions in vein quartz range from 360 to 250°C.

2. a) In quartz veins and near-vein metasomatites there occur relict minerals as well as newly formed ones.

b) Temperature drop has a significant influence on the habit of apatite and sphene crystals.

3. In near-vein metasomatites two types of apatite were found: rounded short-prismatic corroded grains with solidified and crystallized inclusions, and newly formed tabular cyrstals bearing gas-liquid inclusions, T_h 350-400°C.

4. In quartz veins two generations of apatite were found: tabular cyrstals shaped by a small number of simple forms, and with T_h of gas-liquid inclusions 380-400°C; and spherical crystals faceted by large numbers of additional forms, with T_h 230-270°C.

5. Sphene from quartz veins crystallized at temperatures as follow: envelop-like sphene at temp. 330-370°C, tabular sphene 230-240°C.

6. In zircon from vein quartz solidified inclusions were found occurring in accordance with growth zones. Primary gas-liquid inclusions were absent.

7. Zircon and short-prismatic corroded apatite are relict minerals and other minerals cyrstallized during hydrothermal process. (. . .) (Authors' abstract, abbreviated by A.K.)

KOLBIN, B.A., MALYSHEV, A.G., SAMOYLOVICH, M.I., and TSINOBER, L.I., 1974, Typomorphic significance of admixtures in quartz crystals for evaluation of conditions of forming and the value of raw material (exemplified by quartz from Ukraine and Ural), in Typomorphism of Ukrainian Quartz, edited by Ye. K. Lazarenko, Acad. Sci. Ukr, SSR: Kiev, Naukova Dumka Pub. House, p. 109-114 (in Russian; translation courtesy A. Kozlowski). Authors at All-Union Scientific-Research Inst. of Synthesis of Mineral Raw Materials, Alexandrov.

T_H of some quartz was compared with Dennen's (Al-content) geothermometer results, but differences are large (A.K.).

KOLKOVSKI, B., MAVROUDCHIEV, B., ILIEV, Z., and GERGELCHEV, V., 1974, The Madjarovo polymetallic deposit; in Twelve ore deposits of Bulgaria, P. Dragov and B. Kolkovski, eds.: Sofia, Internat. Assoc. on the Genesis of Ore Deposits, p. 192-215 (in English).

T_H of incs. in cleiophane from a special type of sporadic mineralization in miarolitic carities or veinlets in the effusive rocks of this deposit ranged from 150-200 C (p. 199). (ER)

KOLKOVSKI, B. and PETROV, P.P., 1974, Temperature conditions of forming of some hydrothermal deposits of Bulgaria (abst.): Internat. Assoc. on the Genesis of Ore Deposits, Fourth Symposium, Varna, Sept., 1974, Abstracts of Papers: Sofia, IAGOD, p. 254-255 (in Russian; translation courtesy A. Kozlowski). Authors at Kliment Okhridski Sofia Univ., Sofia

The Madan ore field (Central Rodopes) bears a number of Pb-Zn vein and metasomatic deps.; the 12 most typical were investigated. Madzharovo ore field, E. Rodopes, has Cu-Pb-Zn-Au vein min; 8 commercial veins have been invest.; data of A. Atanasov (1963) are also included. From E. Srednegor'e 10 commercial veins with Cu-Zn-Pb min. have been studied: (Vyrli Bryag and Cherni Vrykh deps.). All T data are T_H.

1. Madan and Vyrli Bryag (including Cherni Vrykh dep.) ore fields began to form at T = 360-350°C, Madzharovo ore field - at T = 290-280°C and min.-form. process at all three fields finished $\leq$ 100°C.

2. Individual min. parageneses at higher T formed in intervals about 100°C, and in lower T - about 40-50°C.

3. T at Vyrli Bryag and Madzharovo deposits during alter. parageneses changes abruptly.

4. In individual parageneses maximum T were found about 5-6 mm from the side of the vein, minimum T at the center and intermediate T in between.

5. At Madan deposit the commercial quartz-sphalerite-galena paragenesis shows T gradient* = about 8°C; for quartz-chalcopyrite commercial paragenesis at Vyrli Bryag ore field no T gradient was found. (Author's abstract, shortened by A.K.) (* Probably per 100 m)

KOLKOVSKI, B., POPOV, P., and SOKEROV, D., 1974, The Vurli Bryag copper deposit; in Twelve ore deposits of Bulgaria, P. Dragov and B. Kolkovski eds.: Sofia, Internat. Assoc. on the Genesis of Ore Deposits, p. 161-181 (in English).

This is essentially a copper deposit, but significant amounts of zinc, lead, silver, bismuth and selenium are also obtained.

T_H was measured on >600 incs. in quartz, sphalerite and calcite. The quartz-chalcopyrite association started at 350-340°C and finished at 260-250°C. The highest temperatures were measured in samples taken near the vein walls; in the places between the walls and the axial part of the vein the temperature drops to 320-310°C, and along the axial part itself - to 260-250°C. Veinlets of small thickness (several centimetres), with a granular structure to the filling material have T_H in their axial parts that are also rather high - over 300°C. This indicates that their formation was completed before that of the considerably thicker veins. This conclusion does not apply to the cases where drusy cavities are present in the veinlets. At the top of the quartz crystals taken from such cavities, T_H drops again to 260-250°C irrespective of the smaller thickness of the vein.

In a vertical direction there are no noticeable changes in temp. within the quartz-chalcopyrite association even though the investigations extend over a vertical range of about 700 m.

T_H varies across a crustified vein as follows: 350-340°C for specularite, from about 340-330°C to about 290-280°C for chalcopyrite, Cu-Bi and Cu-Pb-Bi sulphosalts, and from about 280-270°C to 260-250°C for bismuthinite, guanajuatite and cosalite.

In the quartz-sphalerite-galena assoc., mineral formation begins at 300-290°C and finishes at about 200-190°C. The calcite association, according to the preliminary data, is formed within a T range from 150 to 90°C. (Modified from the authors' abstract)

KOLTUN, L.I., 1973, Some data on temperatures and solution composition during formation of the Etyka Sn deposit, E. Transbaikalia: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 72-73 (in Russian; translation through the courtesy of A. Kozlowksi). Author at L'vov Univ.

Investigations of fluid inclusions in topaz, quartz, and fluorite revealed that the mineral-forming processes at the Etyka Sn deposit were divided into several stages and ore transport was made by pneumatolytic as well as by hydrothermal solutions.

Early topaz crystallization (and probably partly quartz) in vein bodies and greisenization-replacement process of wall rocks occurred at about the same time under the action of pneumatolytic solutions.

The pneumatolytic stage of mineral formation passed into a hydrothermal one. Early hydrothermal solutions (crystallization of quartz, topaz and probably cassiterite and sulfides) contained CO_2.

The physico-chemical regime of the early stage of hydrothermal ore formation was very unstable. Investigation of inclusions in quartz and fluorites revealed that the process was accompanied by liquation and boiling phenomena. In the named minerals, along with two-phase inclusions (gaseous-liquid), homogenizing in the liquid phase at 290-360°C, there occur inclusions exhibiting critical phenomena (310-350°C). Also there are two-phase inclusions filled only by CO_2, as well as 3-phase inclusions with CO_2 showing various phase relations.

The late hydrothermal stage is characterized by 2-phase incl. with T_h = 150-230°C.

Solution compositions from water leaches of quartz-amazonite veins showed a HCO_3^- - Na composition, with high hydrosilicate ion.

Na is present in solution in significantly higher amounts than K, and HCO_3^- ions dominate over halides. Concentrations of Mg, Ca and F are low, due to precipitation of these ions as insoluble compounds. (Author's abstract)

KOPP, O.C., and ROEDDER, Edwin, 1974, An independent check on the validity of the pressure correction in inclusion geothermometry, using hydrothermally grown quartz (abst): Geol. Soc. Amer. Abstracts with Programs, v. 6, p. 373. First author at Dept. of Geology, Univ. of Tennessee, Knoxville, Tn. (Note - this same abstract was printed in Internat. Mineral. Assoc. Ninth Gen. Meeting, West Berlin and Regensburg, W. Germany, Collected Abstracts: West Berlin, German Mineralog. Soc., p. 28 (in English).

Primary fluid inclusions were studied in synthetic quartz crystals (∿1 cm) grown in static thermal gradients from 0.5N CsOH or RbOH (partial fill 62-75%) at 0.8-1.8 kb and 377-470°C. Inclusion homogenization temperatures (T_H) were determined blind, corrected for known pressure to yield trapping temperatures (T_T), and compared with laboratory growth temperatures (T_G) in order to evaluate the validity of inclusion thermometry when pressure corrections (P_C) are large:

T_G (est.)(°C)	411	411	394	452	462	400	447	380	399
T_H (°C)	327	319	281	320	329	315	297	314	306
P_C (est.)(°C)	90	111	122	140	127	87	168	77	115
T_T (est.) (°C)	417	430	403	465	456	402	465	391	421
ΔT (T_T-T_G)(°C)	+6	+19	+9	+13	-6	+2	+18	+11	+22

In spite of relatively large values for P_C, ΔT is relatively small. ΔT is the sum of the following errors, only part of which can be evaluated with any precision: 1) Errors in measurement and interpolation of T_G in the bomb at the crystal face; 2) Errors in measurement of T_H (here probably ± 2°C); 3) Errors in calculating P_C (here probably ±5°); 4) Errors known to be intrinsic to the T_H method, such as bubble surface tension and host mineral expansion on external pressure release and on internal pressure increase (here probably <1°C); 5) Errors suggested by others to be intrinsic to the method, such as trapping nonrepresentative fluid (unknown magnitude). We believe that (1) is probably the major source of discrepancy here, and that these data prove that if the solution composition is known adequately, pressure corrections can be large and still permit relatively accurate thermometry by means of inclusions (Authors' abstract; some of the numbers in the table have been revised in a later publication).

KOPP, O.C., ROEDDER, Edwin, and BELKIN, H.E., 1974, (Fluid inclusion geothermometry validated - one more time (abst.)): Geol. Survey Research 1974, U.S. Geol. Sur. Prof. Paper 900, p. 122. (See previous item)

KOPTYUKH, Yu. M, 1971, Structure of the Beregovskoye polymetallic ore deposit in the Trans-Karpat region: Geol. Rudnykh Mestor., v. 13, no. 6, p. 88-95 (in Russian; abstract in Econ. Geol., v. 69, p. 1158, 1974).

Tectonic analyses and study of ore paragenesis show that the Beregovskoye deposit was formed in three stages: a preore stage of Lower Sarmatian time which is characterized by the development of large tectonic structures; an ore development stage which is subdivided into three substages characterized by different mineralization and wide variations of temperature, from 60°C to 250°C; and a postmineralization stage characterized by small tectonic activity which strongly influences the ore bodies.

KORYTOV, F. Ya., 1973, Peculiarities of temperature evolution during mineralization of the fluorite deposits of Zabaykal'ye: Abstracts of papers from Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 123-124 (in Russian; translation through the courtesy of A. Kozlowski). Author at VIEMS, Moscow.

At the majority of investigated deposits (Usuglinskoe, Khurayskoe, Solonechnoe, Kalanguyskoe, etc.) temperature during mineralization process dropped, and the degree of temp. drop for various stages is different (from 20 to 110°C and more). Temperature at the end of a previous stage is quite different from that at the beginning of following stage: the difference is 20-100°C and more. Sometimes the earlier is higher than later, sometimes it is lower.

At some fluorite deposits (Abagaytuyskoe, Aro-Tashchirskoe, Burin-Ul'skoe, etc.) There is an anomalous evolution of mineralization temperatures with the maximum value characteristic of the middle or last stage of mineralization. The Burin-Ul' deposit formed in four stages, the highest temperature of mineralization (200°C) was found at the end of the second stage, when octahedral, strongly colored (green & violet) fluorite cyrstallized. At the beginning of the second stage, light (yellow) cubic crystals formed. A similar temp. increase, of smaller amplitude, was found at the end of the first (quartz) stage. At the end of the third and fourth stage, a decrease of temperature took place. Anomalous temperature evolution is characteristic for some Soviet deposits and some foreign deposits (e.g., in England). Anomalous evolution of temperature may be caused by the cooling influence of wall rocks, by the dimensions of the fractures, by pressure changes, or by endo- and exothermal chemical reactions. (Author's abstract)

KOSALS, Ya. A. and DMITREYEVA, A.N., 1973, Temperature of formation of beryllium deposits of various genetic types: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 66-68 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Inst. of Geochemistry and Geophysics, Siberian Branch of Academy of Sciences, USSR - IGiG SO AN SSSR-, Novosibirsk.

Temp. conditions of formation of Be deposits genetically connected with hypabyssal intrusions of acid and subalkaline granites have not been investigated sufficiently. By homogenization and decrepitation methods liquid-gas and gas-liquid inclusions in feldspars, quartz, fluorite, beryl, phenacite, bertrandite, leucophane, milarite, carbonates, etc. from various parageneses throughout the metasomatic zone were investigated, and enclosing melt inclusions in parent granites.

Biotite granites and entrapped granite-porphyries have crystallized from a melt at 1100-800°C, and the main mass of granite-porphyries, aplites, leucocratic and subalkaline granites at 850 - 650°C. Pre-ore processes of early alkaline stage ranged from 800 - 450°C (early microclinization and muscovitization - 800 - 500°C, early albitization - 600 - 450°C, riebeckitization - 550 - 450°C). Post-ore quartz, fluorite, carbonate, etc. veins and veinlets with sulfides formed at 250 - 45°C.

Connected with acid granites 1) beryllium-bearing muscovite-albite apogranites formed at 550 - 350°C, greisens - 450 - 300°C, feldspathic-quartz - 450 - 300°C, quartz veins and veinlets - 450 -

250°C; 2) external greisens (in relation to massif contact) a. muscovite-quartz, fluorite-muscovite, etc. with beryl - 450 - 250°C (in acid alumosilicate rocks); b. fluorite, mica-fluorite, etc. with chrysoberyl, helvite and phenacite - 450 - 250°C (in skarns); c. same with beryl, chrysoberyl, phenacite - 450 - 200°C (in carbonate rocks): 3) veins and stocks in rocks occurring outside granite massif: a. beryllium-bearing albite and quartz-albite - 450 - 280°C, quartz-microcline - 400 - 280°C, quartz - 350 - 200°C, (in acid alumosilicate rocks); b. mica-albite-fluorite - 450 - 300°C, mica-microcline-fluorite - 400 - 290°C, quartz, fluorite-quartz and fluorite with helvite, rarely with beryl - 350 - 200°C (in skarns).

Connected with subalkaline granites 1) riebeckite-albite apogranites with gadolinite and phenacite formed at 550-400°C; 2) fluorite-albite and fluorite-microcline metasomatites with phenacite at 500-350 and 450-320°C respectively; 3) feldspathic-fluorite and fluorite greisens and metasomatites with leucophane - 490-200°C, with phenacite - 400-250°C, with bertrandite - 300-140°C, with milarite - 220-180°C, with bavenite - 190-150°C (in skarns and carbonate rocks).

Precipitation of late beryl in apogranites at temp. ranges 480-300°C, in internal greisens at 410-300°C, in external greisens at 380-250°C, in internal veins at 320-250°C, in external veins at 300-200°C, in fluorite, etc., greisens (metasomatites) leucophane formed at 400-300°C, phenacite at 350-200°C, bertrandite at 230-140°C, milarite at 220-180°C.

The investigated vertical temp. zonality in ranges of individual deposits or ore bodies indicates the role of temp. gradient in formation of investigated deposits. The pressure range at the deposits under study was 750-500 atm.

On the **basis** of changes of gas phase composition, as well as water leachate composition, four main geochemical types or stages of solution evolution are recognized: early alkaline - CO_2, K; and Cl, F, Na; acid halide-siliceous (Cl, F, Si) and alkaline-fluoride (Na, K, Cl, F) late alkaline-halide-sodium (F, Cl, Na) and fluoride-potassium (F, K), remnant halide-carbonate-sulfate, bicarbonate-sulfate, halide-hydrocarbonate-siliceous, etc. (Authors' abstract).

KOSTYUK, V.P., and BAZAROVA, T.Yu., 1973, Possible P-T parameters of formation of leucite: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 321-322 (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.

At some alkaline provinces of the world there is a regular connection of high-K basaltoids with lineaments or long-living deep faults (W. Africa, Rhine graben, Pribaikal'ye, Aldan Shield, E. Pamir and others). Xenoliths of eclogites, picrites, lherzolites, peridotites, pyroxenites and other ultrabasites testify to the deep origin of especially tephritic magmas.

Acceptance of a relatively deep origin of tephritic magmas is not the evidence of deep origin of leucite, as its crystallization can take place at higher structural levels under significantly lower pressures, in accordance wtih the accepted idea in petrology that high pressure precludes the crystallization of leucite.

Homogenization of primary inclusions in clinopyroxene of ferusite-porphyries from E. Pamir (1380-1250°C), tephrites of Quarternary lavas of Vesuvius (1340-1300°C, plagioclase, 1320-1300°C), leucitites from B. Anyua[1] (1300-1230°C), wyomingite from USA (biotite 1270-1240°C) together with a lack of homogenization of primary inclusions in leucite up to T of melting of host mineral and T_H >1400°C for leucite and 1320-1250 for pyroxene from leucitites of W. Africa indicate the probable T ranges of crystallization of tephritic magmas.

In pseudoleucitic shonkinites of Dezhnevskiy massif the probable T of pseudoleucitic decomposition (1020-1050°C) was noted.

High T of crystallization of cubic modification of leucite, in comparison with other tectosilicates and some Mg-silicates, points that P at the moment of crystallization, was significantly higher.

By calculations based on the well-known T of the eutectic leucite + pyroxene (1350°C) in ferusite-porphyries of Pamir and leucitic lavas of Vesuvius, the writers obtained pressures for crystallization of the tephritic melt = 8-10 kbar.

Thus experimental data on the pressure resistance of leucite, complex data on the composition of deep-seated products, the geological situation, and theoretical data, all prove that the stability of leucite in nature is not reduced by higher pressure. (Authors' abstract)

[1] The name is written on the basis of Russian transcription, A.K.)

KOVAL, V.B. and MAKIVCHUK, O.F., 1973, Temperature stages in alkaline metasomatities of central part of Ukrainian Shield: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 236-237 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Inst. of Geochemistry and Physics of Minerals, Acad. Sci. of Ukrainian SSR, Kiev.

Four groups of inclusions were distinguished in quartzes and microclines from granites, migmatities, pegmatoid granites and microclinites:

1. Primary and secondary two-phase (L_{H_2O} + G);
2. Primary two-phase (L_{H_2O} + L_{CO_2});
3. Primary one-phase (L_{CO_2});
4. Secondary one-phase (L_{H_2O}).

Inclusions in quartz of granites and migmatities homogenized in gas phase, T_H = 441 to 610°C; F = 60 to 15 % by vol. Inclusions in microclines from all 4 types of rocks bear less gas phase and homogenize in liquid, T_H = 310 to 400°C. Secondary inclusions give T_H = 205 to 290 and 127 to 188°C.

Processes of potassium metasomatism were altered by more widespread processes of albitization. Three generations of albites were distinguished. bearing primary fluid inclusions with T_H as follows: 1.) 216 to 286°C; 2.) 145 to 186°C; 3.) 127 to 140°C. Pressures (based on the density of CO_2) decreased from 3100 atm at early stages to 900 at late stages. (Authors' abstract)

KOVALENKO, N. I., SOLOMONOVA, L. A., and AFONIN, V. N., 1974, On the fluid composition in the "ongonite-H_2O-HF" system: Yearbook, 1973, Inst. of Geochemistry, "Nauka" Pub. House, Novosibirsk, p. 288-293 (in Russian with English abstract).

An acid fluid phase is in equil. with ongonite and its melt. The greatest conc. of fluorine in this fluid is 1 p.c. The ongonite melt in equil. with this fluid is sat. with fluorine (3 p.c.). By a further F increase there appears, together with the silicate melt, a fluoride rich in Al and Ca and Si-poor.

At low T fluorine transfers to the fluid together with Si and Na; at a high T there it does that greatly together with silicon (sic). Evidently the T exercises influence on the relation of fluorine with other components separating from the silicate melt. (Authors' abstract.)

KOVALENKO, V. I., SOLOMONOVA, L. A., and AFONIN, V. P., 1974, The results of ongonite investigations by X-ray microprobe: Yearbook, 1973, Inst. of Geochemistry, "Nauka" Pub. House, Novosibirsk, p. 101-104 (in Russian with English abstract).

Phenocrysts of the albite, potassium feldspar, micas and topaz have a homog. comp. The early glass of the ongonite, in P incs. of the phenocrysts, is nearly the comp. of the ongonites. The late glass, formed at the end of the xliz. of the ongonitic magma, is enriched by Ca, Al, F and is nearly an Al-Si-F comp. Late glass of this comp. is a sign of melt saturation by F in the xliz. process. (Authors' abstract.)

KOVALISHIN, Z.I., GRIBANOV, B.V., BRATUS', M.D., AND ZHOVTULYA, B.D., 1973, Composition and temperature of mineral-forming solutions of polymetallic ores from Beregovskoe Highlands: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p.90-91 (in Russian; translation through the courtesy of A. Kozlowski) Authors at Inst. of Geology and Geochemistry of Fuels, Acad. of Sciences Ukrainian SSR, L'vov; Transcarpathian Geological Expedition Beregovo.

Polymetallic deposits occur in a zone of horst-anticlinal elevations as the Began'skoe and Beregovskoe ore districts.

For the Began'skoe district the distinct vertical zonality and the change of barite mineralization to Pb-Zn mineralization at a depth of 350-400 m is characteristic.

Beregovskoe is connected with a crater of Lower Sarmatian age. Ore mineralization conforms with the circular structures, submeridional faults and subparallel cataclastic zones. The intersections of the two last structures are the places of formation of ore vertical stocks. There is no distinct vertical zonation.

Sphalerite of the Began'skoe deposit bears gas-liquid inclusions with T_h 260°C and lower. In quartz of the central parts of the ore veinlets, gas-liquid incl. have T_h 265-230 and 220-190°C.

In sphalerite of the Beregowskoe deposit gas-liquid incl. homogenize at 260°C in the liquid phase; in quartz of ore veins primary inclusions give T_h 180-190°C for subsuperficial zones and 210-230°C for internal zones of the crystals.

The main components of inclusions in sphalerites from Beganskoe are: N_2 55.57%, and CO_2 39.54 vol. %; in inclusions of Beregovskoe, nitrogen prevails (up to 94.29 vol. %) and the amount of CO_2 is 3.30-18.90 vol. %. The amount of hydrocarbons does not exceed a few tenths of a percent.

In gas phase of galena from Began'skoe nitrogen prevails (up to 93.74 vol %), CO_2 and hydrogen occupy 2.72% by vol.; in galena of Beregovskoe the amounts are: N_2 64.80 - 70.24%; CO_2 20.18 - 28.60% by vol. Among cations, the following ones were determined: Na+, K^+, Mo^{4+}, Ca^{2+}, and anion SO_4^{2-}. Inclusions in quartz of ore veins bear CO_2 30.19, CH_4 60.37, and N_2 up to 58.72 (vol. %). Cations the same as above, with the main anion - Cl^-. (Authors' abstract)

KOZLOWSKI, Andrzej, and KARWOWSKI, Lukasz, 1973, Hydrated salt melt as mineral-forming medium of high-temperature mineral associations from Alam Kuh (Iran): 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 A. Kozlowski). Authors at Inst. of Geochemistry, Mineralogy & Petrography, Fac. of Geology, Warsaw Univ., 02-089 Warszawa, al. Zwirki i Wigury 93, Poland. (Ed. note: This paper was presented at the Rostov Symposium, but the abstract was not included in the Abstract Volume).

Fluid inclusions in minerals of quartz-feldspathic (granitic) micropegmatites with fluorite are very numerous; their characteristics are given in the table. The micropegmatite bears individual crystals of biotite proving that the parent magmatic melt contained about 3% H_2O. On this basis one may suppose that the depth of separation of water solutions from the magma at T $\sim$1000°C and P_{H_2O} $\sim$1000 bars, may be accepted as $\sim$3 km, and at the T of homogenization of the inclusions (900-650°C) - about 1.5 km. Under such conditions an aqueous salt solution separated from the magma, bearing at the beginning only 15 wt % H_2O, and becoming more and more diluted with decreasing temperature. Evolution of the fluids was in the sequence: hydrated salt melt → hydrothermal brine > gaseous solution > hydrothermal dilute solution.

High-temp. origin of micropegmatites is supported by the presence of post-inversion Dauphine twins in the cores of quartz crystals.

Fluorite crystallization began at T = 380°C, from concentrated parent solutions (about 30 wt % of salts). (Authors' abstract).

Generation of inclusions		I-primary	II-primary & secondary	III-primary & secondary	IV-secondary	V-secondary
Phases, vol % at 25°C	Halite	20-30	15-20	10-15	(?)	-
	Sylvite	8-10	5-10	-	(?)	-
	Other crystals	0.13	0-5	-	(?)	-
	Gas (vapor)	25-35	10-20	10-20	(90-100?)	5-10
	Water solution	25-30	50-60	65-75	(0-10?)	90-95
Phases, wt % at 25°C, calculated by measurements of phase vol. in individual inclusions	Halite	39	32			
	Sylvite	12	11			
	Calcite (?)	23	-			
	Salt x	3?				
	Opaque crystal	0.1	3?			
	Gas (vapor)	(?)	(?)			
	Solution	23	54			
Chemical composition of fluid, wt %, calculated from vol. of phases	NaCl	44	43			
	KCl	14	17			
	$CaCO_3$(?)	23	(?)			
	H_2O	16	38			
	Others	3	2			
Concentration of salts evaluated on basis of phase changes, in wt. % of NaCl equiv.		70-80	55-68	35-40	(0.01--0.1?)	some %
Concentration calculated on basis of phase vol., wt %		84	62			

T_H°C and mode of homogenization	830-880 in liquid	460-730 in liquid	360-400 in liquid	(310--360?) in gas	270-360 in liquid
P at T_H, bars	about 800	320-390	70-100		
Density of fluid, g/cm^3	1.32	1.28	1.2	(about 0.1?)	0.95-1.0
Refilling		Refilled by IV	Refilled by IV	Refills II & III refilled by V	Refills IV

KOZLOWSKI, Andrzej, and KARWOWSKI, Lukasz, 1974, Chlorine/bromine ratio in fluid inclusions: Econ. Geol., v. 69, p. 268-271.

Aqueous leach solutions (34) were analyzed for Cl and Br. Samples were from granites and hydrothermal veins in Poland. Results (atom ratio) Cl/Br range from 39-1200. T_H and/or T_D are given for the same samples; these decrease with decrease in Cl/Br. (ER)

KRASILSHCHYKOVA, O.A., PLATONOV, A.N., and TARASHCHAN, A.N., 1974, On the colour centers in natural fluorites: L'vov. Mineral. Sborn., v. 28, no. 2, p. 31-40 (in Russian).

Of interest to compare with fluid inclusion temperatures in the same samples. (ER)

KRESTIN, E.M. and BYKOVA, T.A., 1973, Composition of magmatic inclusions in minerals and the distribution of volatile constituents as criteria of differentiation and ore content in trap intrusives: Abstracts of papers at Fourth Regional Conference on Thermobarogeocehmistry 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 Moscow Ordzhonikidze Geological Prospecting Institute, USSR.

Study of inclusions of mineral-forming melts in the main rock-forming minerals of trap intrusives in the north-western part of Siberian platform and the north half of the Kursk-Voronezhsky crystalline massif showed that their morphological special features and phase composition are typical of certain stages of formation of intrusives. Magmatic inclusions are divided into crystallized, glassy and essentially gaseous.

The early-magmatic stage (the stage of protocrystallization in the interstitial magmatic chambers) is characterized by primary crystallized, partly crystallized, and glassy inclusions in the interior parts of protocrystals of olivine 1 and plagioclase 1. The crystalline phase consists of olivine, plagioclase, pyroxene and sulphides. Sometimes a gaseous phase is noted. Temperature of homogenization of glassy inclusions with gaseous bubble is 1280-1300°C.

The stage of magma intrusion is fixed by numerous pseudosecondary essentially gaseous and glass-gaseous inclusions and somewhat later primary glassy inclusions in the external zones of the same minerals.

During the intermediate stage of crystallization in eventual chambers pseudosecondary monophase glass inclusions formed in olivine 2 and plagioclase 2.

Primary crystallized inclusions consisting of plagioclase, pyroxene and ore minerals (sulphides, titanomagnetite) are typical for minerals of the late-magmatic stage. They are developed widely in plagioclase 3 and are noted rarely in clinopyroxene.

Crystallo-fluidal inclusions are noted in plagioclase of pegmatites and pegmatoid rocks. They homogenize at 700-750°C.

The postmagmatic stages are fixed by very rare essentially gaseous inclusions of the pneumatolytic stage and gaseous-fluid inclusions of the hydrothermal stage. Both types of inclusions are noted in minerals of autometamorphic altered differentiates in sub-contact parts of intrusives.

Rather frequent finding of primary drop-like sulphide inclusions in minerals of the stage of protocrystallization point to immiscibility of sulphides, mainly in interstitial magmatic chambers. Because such inclusions are typical for all intrusives containing commercial nickel ore deposits, their finding is a basic criterion for positive estimation of potential ore content in intrusives within the limits of certain ore fields.

Decrepitometric investigations of intrusive and enclosing rocks showed that crystallization of trap intrusives occurred in a closed system. Rather even distribution of volatile constituents in section and one maximum of content of volatiles at the upper contact are typical for non-differentiated and slightly differentiated intrusives. Sharp contrasts in the distribution and several maxima of content of volatiles in the section are typical for differentiated nickel-bearing intrusives and also indicate repeated magma intrusions as independent differentiates. (Authors' abstract).

KRESTIN, Ye.M., SHUSTOV, Yu.A., and YEGOROV, A.Yu., 1974, Polymetallic ore mineralization in Paleozoic sedimentary cover of central regions of Russian Platform: Geol. Rudn. Mest., v. 16, no. 4, p. 63-69 (in Russian). Authors at Moscow Geol. - Prospecting Inst. and Territorial Geol. Office of Central Regions of Ministry of Geology of RSFSR.

T_D of incs. in calcite from village Belolutsk fall into three intervals: 80 - 120, 160 and 180 - 200°C. (A.K.)

KRISTMANNSDÓTTIR, H., and TÓMASSON, J., 1974, Nesjavellir-hydrothermal alteration in a high-temperature area (abst.): Internat. Symp. on Water-Rock Interaction, Czechoslovakia, Sept. 9-17, 1974, Abstracts: Prague, Geological Survey, p. 57 (in English). Authors at National Energy Authority (Orkustofnun), Dept. of Natural Heat, Reykjavík, Iceland.

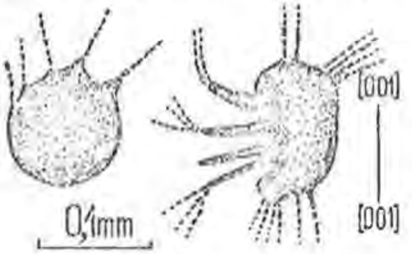
KROUSE, H. Roy, 1974, Sulphur isotope variations in thermal and mineral waters (abst.): Internat. Symp. on Water-Rock Interaction, Czechoslovakia, Sept. 9-17, 1974, Abstracts: Prague, Geological Survey, p. 11 (in English). Author at Dept. of Physics, The Univ. of Calgary, Calgary, Alberta, Canada T2N 1N4.

KUCHER, M.I., BATYRMURZAEV, A.S., MADAPULIN, V.U., and ZAKIYEVA, F.Sh., 1974, On possibility of use of peculiarities of decrepitation and distribution of gases in wall rock sandy-clayey deposits surrounding ore bodies for data on aureoles of hydrothermal impregnation (abst.): Internat. Assoc. on the Genesis of Ore Deposits, Fourth Symposium, Varna, Sept., 1974, Abstracts of Papers: Sofia, IAGOD, p. 256-257 (in Russian; translation courtesy A. Kozlowski). Authors at Dagestan Branch of Acad. Sci. of USSR.

Pyrite-Cu-polymetall. Kizil-Dere dep. was investigated by decrep. up to T = 600°C. Authors verified literature data indicating decrep. is very low or absent in shale and aleurolite wall rocks of ore bodies. Thus decrep. is almost useless as prospecting tool under these circumstances. The authors analysed by mass spectrometry the volatile components (H_2O, CO_2, N_2, O_2, H_2, H_2S, CH_4, NH_3) released during heating of rocks to reveal the influence of hydrothermal sols. on wall rocks. Most components show a max. at 2-6 m from ore and a min. at the wall rock/ore contact. CH_4 and NH_3 have weak anomalies, probably connected with peculiarities of background distribution. Background concs. of CO_2 and N_2 are very low. Results indicate removal of all gases from the wallrocks immediately surrounding "channels" transporting min.-form. sols. Results of thermogravimertic analysis agree with distribution of gases. (Authors' abstract, shortened by A.K.)

KUL'CHITSKAYA, A.A., 1974, Inclusions of mineral-forming solution in gypsum and their significance: in Mineralogy of sedimentary deposits, v. 1, 1974, Kiev, p. 34-38 (in Russian; abstract courtesy A. Kozlowski. See also Kul'chitskaya, 1973, in Fluid Inclusion Research - Proc. of COFFI, v. 6, 1973, p. 87-88.) Author at Institute of Geochemistry and Physics of Minerals, Acad. Sci. of Ukrainian SSR, Kiev.

Incs. in gypsum will leak, due to the presence of water of crystallization and its loss at 80°C, and the excellent cleavage. K's experiments prove that incs. are hermetic up to 90°C, and flat incs. in plane (010) - up to 100°C. Above that temp. gypsum recrystallizes and become turbid. Under H_2O vapor pressure the recrystallization begins at 130°C, but incs. in (010) do not leak. Incs. which have leaked have no visible fractures around them. Incs. in plates of gypsum held for 60 hrs. under $1x10^{-5}$ to $1x10^{-3}$ mm Hg were unchanged. On cooling, the incs. froze at -15 to -30°C (metastability), forming minute fractures in the host. On melting a gas (contraction?) bubble appears; this is probably the origin of some natural two-phase inclusions. The investigated specimens were taken from Tortonian gypsum of Pridnestrov'ye, Permian deposits of Donbass, and Quarternary deposits of these regions. P and S incs. were found with solution, solution + gas, and with bitumens. All types are illustrated and detailed descriptions of their morphology and mode of occurrence given. The phenomenon of inc. refilling was found. Spherical incs. >0.1 mm containing bitumens decrepitate, forming daughter inclusions like "whiskers" along fractures (see figure). The cause of decrepitation may be the presence of highly volatile components.



KURSHAKOVA, L.D., 1973, Influence of acidity-alkalinity of solutions on hydrothermal synthesis of hedenbergite: in Contrib. to Physico-Chem. Petrology, V.A. Zharikov, et al., eds.: Moscow, "Nauka" Pub. House, v. 3, pp. 194-206 (in Russian; abstract courtesy A. Kozlowski).

Conditions of synthesis of hedenbergite in dilute sols. of NaOH, HCl and NaCl were studied at T 300-700°C and general P 1000 atm. Also a series of runs at P 500, 1500 and 2000 atm in NaCl sols. was made. Results agree with data on equil. of hedenbergite invest. under det. PT conditions and P_{O_2}. Cal. values Eh and pH also support results of exper.: 1/ for synthesis of hedenbergite strongly acid conditions are most suitable; 2/ comp. of synthetized assoc. depends rather on T than on conc. of sols.; 3/ P as well as T increase the area of stability of andradite and its assoc., with decrease the area of hedenbergite. (Author's abstract).

KURSHAKOVA, L.D., 1974, Stability of ferroaxinite depending on chemical potentials of water and oxygen: in Contrib. to Physico-Chem. Petrology, V.A. Zharikov, et al., eds.: Moscow, "Nauka" Pub. House, v. 4, pp. 82-88 (in Russian; abstract courtesy of A. Kozlowski).

Stability field of axinite $Ca_2(Fe,Mn)Al_2BO_3Si_4O_{12}(OH)$ was det.; it may be modified only by change of boron conc. (A.K.)

KUSHIRO, I., 1974a, The system forsterite-anorthite-albite-silica-H_2O at 15 kbar and the genesis of andesitic magmas in the upper mantle: Carnegie Institution of Washington Yearbook 73, p. 244-248 (pub. 1974).

Includes an interesting discussion of the variation of MgO in hydrated glass near a fosterite crystal. See also next item (ER).

KUSHIRO, I., 1974b, Electron microprobe analysis of glass: Carnegie Institution of Washington Yearbook 73, p. 603-605, (pub. 1974).

Magnesium is depleted from the glass within ∿10 μm of an olivine crystal during quenching. (ER)

KUZNETSOV, Yu.A., GUREVICH, D.V., KULIK, Zh.V., and SAVICHENKO, Ya.V., 1974, Physicochemical conditions for mineral formation in ore deposits of the Nagolnyi ridge: Vopr. Geokhim., Mineral., Petrol. Rudoobraz, 1974, p. 87-90. Ed. by Semenenko, N.P.: Kiev, "Naukova Dumka" (in Russian). C.A. v. 83, no. 11, p. 182215t, 1975.

The T of min. in the ore deps. was detd. by homog. of gas-liq. incs. in quartz, ankerite, and sphalerite. Several T ranges of min. xliz. were differentiated: quartz 100-140, 150-180, 210-230, 250-280, and 320-350; ankerite 150-180, 200-140, and 290-305; and sphalerite 90-120, 124-152, 182-220, and 250-350°. P during min. was 750-800 atm. The initial T of endogenic min. in Nagolnyi Ridge was 400-415° with wide T range (100-350°) of optimal conditions of min. Min. sols. were of bicarbonate-chloride-sulfate-Na-Ca-K type with variable predominance of anions and cations. Sols. had high Li content up to xliz. of Li mins. in incs. of quartz. Gases in incs. were mostly CO_2 10-79, N and rare gases ∿50, and H_2S, SO_2, NH_3, HCl, and HF (detd. together) 1.5-22.2%.O was present in 30% of the samples (10-30% of total gases).

LAHIRY, A.K., 1974, Liquid inclusions for the elucidation of paragenetic and genetic relationships of Saxon ore deposits: Freiberger Forschungshefte, Reihe C, no.302, p. 1-109 (in German). Author at Univ. Rajasthan, Udaipur, India.

This paper, which represents Dr. Lahiry's dissertation at Freiberg, is an extensive review of many aspects of fluid inc. research, with specific applications and examples from studies of various Saxon ore deps. Incs. in quartz, fluorite, barite and calcite were studied. T_{Frz} gave salinities of 0-27 wt % NaCl; T_H ranged from 76-217°C. Chem. anals. were made for Na, K, Cl, and CO_2 in the incs. and S^{32}/S^{34} and O^{18}/O^{16} in the minerals, in relation to paragenetic sequence. (ER)

LAMBERT, I.B., and SATO, TAKEO, 1974, The Kuroko and associated ore deposits of Japan: A review of their features and metallogenesis:

Econ. Geol., v. 69, p. 1215-1236.

Includes a review of fluid inc. data (p. 1225-1226.) (ER)

LANDIS, G.P. and RYE, R.O., 1974, Geologic, fluid inclusion, and stable isotope studies of the Pasto Buena tungsten-base metal ore deposit, Northern Peru: Econ. Geol., v. 69, no. 7, p. 1025-1059.

The Pasto Bueno tungsten-base metal ore deposit is situated at an elevation of $\simeq$ 4,000 meters in the north-central Andes of Peru. Mineralization occurs in near-vertical quartz vein systems that span several hundred meters on either side of the upper intrusive contact of a 9.5 m.y.-old quartz monzonite stock emplaced in a Jurassic-Cretaceous shale and quartzite sequence. The stock exhibits four pervasive and roughly zoned alteration assemblages from core to periphery: (1) alkalic, (2) phyllic-sericitic, (3) argillic, and (4) propylitic. Greisen assemblages of zinnwaldite, fluorite, pyrite, and minor topaz and tourmaline occur within the phyllic zone.

The principal vein minerals are wolframite, tetrahedrite/tennatite, sphalerite, galena, and pyrite in a gangue of quartz, fluorite, sericite, and carbonate. Detailed studies of the hydrothermal mineral paragenesis established three major recognizable divisions: Greisen (60 to 70 percent of deposition), Vein (25 to 35 percent of deposition), and Vug (<5 percent of deposition).

Fluid inclusion studies suggest that Greisen and early Vein stage fluids were very saline (>40 equivalent weight percent NaCl), high-temperature (400° to 500°C) solutions of magmatic derivation. The subsequent main Vein stage ore fluids attained a temperature range of 175° to 290°C and a salinity range of 2 to 17 equivalent weight percent NaCl. Boiling of the ore solutions is indicated only for the Greisen and early Vein stages of hydrothermal activity.

The results of stable isotope studies on water in primary fluid inclusions indicate that the δD_{H_2O} of the ore fluids varied from -29 per mil to -88 per mil (SMOW). Analyses of water contained in secondary inclusions indicate the δD_{H_2O} of the fluids attained values as low as -145 per mil prior to the cessation of hydrothermal activity. The $\delta^{18}O_{H_2O}$ of the hydrothermal fluids, as calculated from the $\delta^{18}O$ quartz and carbonate data and the temperature data, range from +7.8 per mil to +0.0 per mil (SMOW). The δD value of present-day meteoric water is -96 per mil.

The patterns for δD_{H_2O} and $\delta^{18}O_{H_2O}$ values of the hydrothermal fluids indicate that mixing of a meteoric and possibly a metamorphic or other water component with water of magmatic derivation occurred during Vein stage deposition. Major variations in the deuterium content of the ore solutions are not reflected by fluctuations in the ^{18}O content, indicating that meteoric water circulated deep into the hydrothermal plumbing system. Wolframite deposition was associated with episodes of meteoric water influx that are reflected in the temperature, salinity, and δD values of the water in fluid inclusions. Sulfide mineralization, on the other hand, was associated with water of magmatic derivation.

The $\delta^{13}C$ data for hydrothermal CO_2 range from -4.1 per mil to -11.9 per mil (PDB) and are interpreted to indicate that the carbon in the ore fluids was derived from both sedimentary and deep-seated sources. $\delta^{34}S$ values of pyrite data exhibit a narrow range of values (-25 per mil to ±3.9 per mil) with an average of +0.6 per mil, indicating that the sulfur was derived from a deep-seated or mantle source.

Most of the components present in the Pasto Bueno ore deposits appear to be of magmatic origin. Clearly however, significant volumes of meteoric water and possibly other water were involved in some stages of the ore deposition process. (Authors' abstract)

LAPUKHOV, A.S., 1972, Early stages of establishment and developing of ore-forming fluid dynamic systems in porphyry intrusions (exemplified by Salair ore field): Acad. Sci. USSR, Inst. of Geol. and Geophysics of Siberian Branch, Trans. v. 114, Physical and physical chemical development of magmatogenic and ore systems, p. 145-157: Moscow, "Nauka" (in Russian).

T_H of melt incs. in phenocrysts of quartz in quartz and quartz-feldspar porphyries occurs at $\sim$1150°C, and T xliz. of rock matrix - 850-900°C. Gases in incs. consist of N_2 (about 95%) and CO_2 (about 5%). Ore-forming stage begins at 550°C (T_H). (Abstract by A.K.)

LARGE, R.R., 1974, Hydrothermal mineral zonation at the Juno Mine, Tennant Creek Goldfield, Central Australia (abst.): Econ. Geol., v. 69, p. 1183. Author at CSIRO, Minerals Research Laboratories, Australia.

Gold, bismuth and copper mineralization at Tennant Creek occurs in discordant magnetite- and hematite-rich lodes which have an ellipsoidal to pipe-like shape and occur within a pile of felsic sediments and pyroclastics of Lower Proterozoic age. Both gangue and ore minerals are vertically zoned within the lode at Juno Mine. Massive magnetite (>80%) and chlorite (<20%) constitutes the core of the lode and is enclosed above by a zone consisting of talc-magnetite with minor pyrite. A thin dolomite-rich zone separates the talc-magnetite zone from the enclosing chloritized country rocks. An alteration pipe, defined by irregular zones of leaching and chloritization, extends vertically below the lode.

Gold is concentrated in the center of the magnetite-chlorite body and is surrounded above by an umbrella-shaped zone rich in bismuth sulphosalts. Chalcopyrite is concentrated at the top of the lode structure above the bismuth zone. The total sulphur content and sulphur/selenium ratio of the sulphides and sulphosalts increase from the gold zone, upwards and outwards, to the copper zone. In addition the Fe/Fe+Mg) and Al/Si ratios of the associated chlorites decrease upwards from the base of the lode to its outer edge.

Hydrothermal reactions within the lode generally involved base fixation, with exchange of Fe^{2+} and Mg^{2+} in the solution for Si^{4+}, Al^{+3} and K^{+} in the rocks. Thermodynamic studies suggest that zonation of this nature can be achieved by a gradual increase in solution pH and decrease in fO_2 within an acid chloride, sulphur deficient, hydrothermal solution as it reacts with the host rocks. (Author's abstract)

LAZARENKO, E.E., 1973, Solid inclusions in low temperature quartz and topaz: L'vov. Mineral. Sborn., v. 27, no. 1, p. 88-92 (in Russian; abstract courtesy T.M. Sushchevskaya).

Mineralogical and chem. studies were made of solid phases in several samples of quartz and topaz from Volyn pegmatites (Ukraine). Transparent zoned crystals of quartz, with T_H = 230-240°C and pH - 7.8-8.0 (using Kalyzhnyi's method) for incs., were found to contain solid incs. of goethite and acicular cassiterite. In the quartz crystals from another peg. a mineral from the chlorite group was found. In topaz, in which S. and multiphase incs. had T_H 350-300°, and pH -5.6, kaolinite was identified.

LAZARENKO, E.A., 1974, Secondary quartzites from Transcarpathia: their ore-bearing and genesis, pp. 727-735 in Congrès Geologique International - Bulletin du VI^e Congrès de l'Association Géologique Carpatho-Balkanique, vol. III, Fasc. 1: Géochimie, Minéralogie, Hydrogéologie, Geologie de l'Ingénieur, Géologie des Gîtes Minéraux: Instytut Geologiczny Wydawnictwa Geologiczne (-Carpatho-Balkan Abstracts-). (In Russian; abstract through the courtesy of A. Kozlowski). Author at Ukrainian Scientific-Research Geological-Prospecting Institute -UkrNIGRI-.

Investigations of inclusions in minerals of secondary quartzites gave T_H from 300-250 to 60°C, in the liquid phase. The above data prove the near-surface (subsuperficial) conditions of hydrothermal origin of these deposits. In quartz-tourmaline rocks, fluid inclusions in quartz homogenized at temp. higher than 250°C, in gaseous phase.

LAZARENKO, N.E., 1974, Cryolite, a daughter mineral in Volyn topaz: L'vov. Mineral. Sbor., v. 28, no. 4, p. 43-45 (in Russian).

The properties of dm. cryolite (Na_3AlF_6) occurring in incs. in topaz from the chambered pegs. of Volyn are given. This occurrence verifies the presence of significant Al and F in the peg. fluids.(E.R.)

LAZARENKO, Ye.K., ed., 1974, Typomorphism of Ukrainian quartz: Kiev, Naukova Dumka Pub. House, for Acad. Sci. Ukr. S.S.R., 124 pp. (in Russian).

This book consists of a series of papers on various aspects of Ukrainian quartz, many of which pertain to inclusion studies and are abstracted in this volume, entered under their individual authors' names. This book stemmed from a meeting, held in 1974 at Volodarsk-Volynskiy (or Vladimir Volynskiy, Włodzimierz Wołynski), in the Żytomierz district ~20 km from the eastern boundary of Poland. It was organized by Acad. Sci. Ukr. SSR-Inst. of Geochem. and Physics of Minerals, the Ukrainian Mineralog. Soc., and the "Volynskiy" mine of the Ministry of Geol. USSR. (A.K.)

LAZARENKO, Ye. Ye, 1974, Certain typomorphic peculiarities of quartzes from pegmatites from the marginal parts of Volodarsk-Volynskoe pegmatitic field, in Typomorphism of Ukrainian Quartz, edited by Ye. K. Lazarenko, Acad. Sci. Ukr. SSR: Kiev, Naukova Dumka Pub. House, p. 37-43 (in Russian; translation courtesy A. Kozlowski). Author at Inst. of Geol. and Geochemistry of Fuels of Acad. Sci. Ukr. SSR, L'vov.

Zoned xls of quartz were studied and specific types of fluid incs. were found, and compared with reference data. In xls with zones of inner smoky and outer colorless quartz from the Yemel'chino area incs. bear G = 80-10 vol. %, L = 20-90 vol. %, up to 60% of dms. and variable amounts of liquid CO_2, T_H = 180-380°C, pH of sol. in incs. = 7.2-7.4. Zonal quartz from Usolusy region had similar ratios of gas and water sol. in fluid incs. but smaller amount of dms. and L_{CO_2} was absent; T_H = 100-336°C, pH = 6.2-6.8. Xls from Rikhty region have incs. with T_H = 180-410°C, T_{Frz}= -0.3°C (conc. NaCl = 1%), pH in various zones of xls changes from 6.8 to 8.2. Quartz xls from voids in granite at Yemelyanovskiy quarry gave T_H = 120-200°C.

Quartz in commercial pegs. has xlized from more acid, strongly saline sols. and at higher Ts than that in noncommercial; also decrep. incs. are most common in quartz from commercial pegs. (A.K.).

LAZARENKO, Ye.K., and PAVLISHIN, V.I., 1974, Typomorphic features of quartz, in Typomorphism of Ukrainian Quartz, edited by Ye. K. Lazarenko, Acad. Sci. Ukr. SSR: Kiev, Naukova Dumka Pub. House, p. 3-11 (in Russian). Authors at Inst. of Geochemistry and Physics of Minerals, Kiev, USSR.

Paper bears some references to data on fluid incs. (A.K.).

LAZKO, Ye.M., and LYAKHOV, Yu.V., 1973, Thermobarometry on gaseous-liquid inclusions and some questions of the systematics of postmagmatic deposits: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 318-320 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at L'vov Univ.

Abundant information on thermobaric conditions of development of endogenic mineralization, obtained during analysis of two- and polyphase inclusions of mineral-forming media in minerals, is the objective and valid basis for establishing a genetic system of deposits of many varieties of useful mineral materials. Analysis of such information for deposits of various genetic groups and ore formations proves that the majority of them have formed in the T range from 600-500 to 50-30°C. Origin of industrial ores is connected wtih T interval of one or two stages of productive mineralization. On this basis two groups of deposits were distinguished: 1) with wide T interval of industrial ore mineralization (up to some hundreds of °C); 2) with narrow T interval (some tens of °C). Group 1 bears polymetallic, rare-metal, some fluoritic and rock-crystal (chamber pegmatites) deposits; group 2 - vein rock-crystal, Au-, Sn-, Hg- and other ore deposits (Laz'ko and Lyakhov, 1968). The characteristic stability of T of ore mineralization of various types proves the possibility of use of homogenization for T contouring of the deposits.

Temperature systematics of postmagmatic deposits, in each classification made for expressing of genetic nature of the processes (Niggli, 1927; Lindgren, 1933; Graton, 1933; Buddington, 1935; Tatarinov, 1965; and Park and MacDirmid, 1966), needs a clear resolution of the problem of what part of the mineral paragenesis formed before and what after the origin of industrial mineralization. Peculiarities of ore mineralization are significantly determined by character of surrounding medium, i.e., the composition and nature of the surrounding rocks and earlier mineralization. Interacting with solutions, these also influence changes of pH and Eh. Often the influence of the surrounding rocks has the main role of localization of ore mineralization and its formation, e.g. Au-ore necks (Petrovskaya et al, 1961; Laz'ko et al, 1972). Then T of only the "main stage of ore mineralization", as Niggli and S. Smirnov have suggested, cannot be the main criterion for evaluation of genetic classification of postmagmatic deposits. Classification of deposits as high- (500-300°C), middle- (300-200°C) and low-temperature (200-50°C), as is accepted in many books, is also impossible. During systematization of deposits these authors propose to take into account not only conditions of formation of the ore stage, but also the conditions of origin of the pre- and post-ore mineralization, thus in great part determining the features of the medium supporting the concentration of ore elements of the deposits. The most representative genetic characteristics of the deposit as an industrial object is the T interval characterizing the beginning of the ore process and the end of its last productive stage. On this basis the following groups were distinguished: 1. high-middle-temperature deposits (rock-crystal-bearing and fluorite pegmatites, rare-metal, polymetallic, tin, copper-pyritic, essentially and moderately sulfidic, gold-ore); 2. middle-low-temperature (vein fluoritic, vein rock-crystal bearing, gold-silver, uranium, mercury); 3. low-temperature (barite and Iceland spar).(Authors' abstract)

LEEDER, Otto, THOMAS, Rainer, and TIMMLER, Andres, 1972, Geochemistry and geology of mineral deposits from fluid inclusions in fluorite from vein deposits of Saxony: Ber. deutsch. Ges. geol. Wiss. B, Miner. Lagerstattenf., v. 16 (for 1971), p. 93-129 (in German).

With the aid of homogenization measurements on the heating stage, micro-chemical, spectralanalytical and mass-spectrometric analyses, fluid inclusions in about 160 fluorite samples from the Saxonian fluorite-deposits Rottleberode, Strassberg and Schönbrunn (GDR) were investigated. The gas- and fluid-inclusions contained in vein fluorites can be assigned to cogenetic and supergene processes based on formal criteria (habit, grouping etc.). The number of inclusions per cubic centimeter is of the order of 10^7, and the size is mostly 2-20µm. The majority of the inclusions in vein-fluorites are two-phase inclusions; the liquid part greatly exceeds the gaseous part. On heating, the gas-phase dissolves in the liquid, whereby the homogenization temperature takes different values, according to the type of inclusion, the order, and the proportions of gas and liquid. The homogenization temperatures of primary inclusions are in regular connection with the formation temperature.

By means of the homogenization method, the probable formation temperatures of particular mineral generations as well as isothermal ranges within a distinct deposit can be determined. The example of the fluorite-deposit Schönbrunn showed the following homogenization (formation) temperatures of the succession:

1. Main phase (rhythmical layers, in the succession fluorite, paradoxite (a variety of orthoclase), quartz) I a: 400 - 330°C; I b: 310 - 280°C; 2. Main phase (massive formation, main succession); II: 280 - 160°C; III: 150 - 100°C; and 3. Phase (secondary and recrystallized formations); IV: <100°C.

At the deposit of Rottleberode an experiment was made on reconstructing the progress of the isothermal ranges between the most important veins and branches (their Fig. 10).

The fluid of the inclusions are dilute alkali-chloride-solutions with the main components Cl>Na>K. The salinity varies between 3 and 30 weight percent, subject to the type of fluorite. The K/Na-ratio is of the order of 0.18 (0.15 - 0.22), and the Na/Cl-ratio 0.21. Within the very narrow range of contents and proportions of the main components the distinct deposits can be distinguished significantly, but not (on the basis of) single samples or successions. In contrast to the main components, the deposit areas of Harz and Vogtland differ very obviously in their trace element contents.

The results obtained allow some quite interesting conclusions about the genesis of Saxonian fluorite deposits:

1. Formation (homogenization) temperatures and composition of solutions and gases indicate a hydrothermal origin. The temperatures touch the formation-areas from kata- to meso- and epi- (tele-) thermal within the depth limits 0 to >500 m. Formation temperatures decrease from the oldest to the youngest in succession and under diminishing depth. The high values for the ratio K/Na (0.18) and the salinity (ca. 20%) argue for postmagmatic solutions, since vadose waters have lower values.
2. The chemical composition of the included fluid corresponds completely with those of hydrothermal solutions.

3. It is safe to say that the three fluorite deposits are of the same genesis. (Abstract by H.A. Stalder)

LEMMLEIN, G.G., 1973, Morphology and genesis of crystals: Moscow, Izdat. "Nauka", 328 pp. (in Russian)

This is a collection of the more important articles of Lemmlein, showing the amazing breadth and importance of his works on crystal growth mechanisms and methods of their study, nucleation phenomena, crystal habit and trace element distribution, inclusions (melt and aqueous), and the ingenious techniques he developed to study them, as well as a bibliography of his works (∿150 items between 1924 and 1964. (ER)

LEROY, Jacques, 1973, Episyenite formation and the deposition of uranium in the episyenite of Point 132, Mine de Margnac, Limousin, France (abst.): Sci. de la Terre, Réunion Annuelle, Paris, 1973, p. 271 (in French, translation courtesy Chris Eastoe). Author at Centre de Recherches Pét. et Géochim., C.O. n° 1, 54500 - Vandoeuvre-les-Nancy, France.

The U dep. occurs in a column of episyenite, an alt. rock consisting almost entirely of muscovite and montmorillonite. The episyenite has formed by the alt. of the two-mica granite of Saint-Sylvestre, with the disappearance of quartz, plagioclase and biotite. Orthoclase, although unstable, is still present, and calcite and sulphides are sometimes found.

A fluid inc. study indicates that the sols. which formed the episyenite were aq., with 9% - 15% salts, the comp. varying with depth. The episyenite form. T was >320°C, at P >500 bars.

The fluids which transported and dep. the U. are present as three-phase fluid incs. containing H_2O and dissolved salts, CO_2 liquid and CO_2 gas. The U content of the samples increases with the content of CO_2 in the fluids. T_h of the CO_2 decreases with depth and with U content. The CO_2 is impure and has been found to contain CH_4 and alkanes. The large T interval between the solidus and the liquidus of the aq. phase suggests the presence of bivalent cations (Ca^{++}). T and P at the time of U dep. throughout the column were 340-350°C and 750 ± 50 bars. The fluids were close to the miscibility gap in the system H_2O-CO_2-hydrocarbons, and they oscillated from side to side of the boundary surface of the gap.

The CO_2-rich sols. have leached U from the granite and transported it as uranyl carbonates. Small T and P variations would have been sufficient to unmix (boil) the mixture, depleting the aqueous phase in CO_2, destabilizing the uranyl carbonates and dep. the ore. (Author's abstract, considerably shortened).

LETNIKOV, F.A. and SHKANDRIY, B.O., 1973, Fluid regime of progressive metamorphism and of connected palyngenic formations: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973· Rostov, Rostov Univ. Press, p. 224-226 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Earth's Crust Inst., Siberian Branch, Acad. Sci. of USSR, Irkutsk.

To understand the problem of the fluid regime during regional metamorphism and palyngenesis, the composition of G-L inclusions from Proterozoic complexes of Kokchetavskiy Block and Pribaikal'ye was studied by use of a special high-temp. chromatographic apparatus. Quantitative determinations of H_2, CO, CH_4 and H_2O (see Table) were made at T = 500-600°C, thus yielding, in contrast to other methods, the true amounts of main gases in fluid, respective to the T regime of rock origin. Based on the data obtained (over 300 determinations), minimal amounts of water are characteristic for granulites.

Rocks	Gas composition at 500°C (ml per g x 10^{-6})			
	H_2	CO	CH_4	H_2O
Granulites	5.8	55	32	10
Gneisses	1.3	170	12	2,500
Amphibolites	1	32	1.2	2,100
Granites (isofacial)	1.6	450	-	560

In palyngenic granitoids, in comparison with gneisses, the amount of H_2O decreases. Maximum amounts of H_2 and CH_4 were found in granulites. The buffering influence of rocks on the gas composition at elevated temp., ascertained by the authors, is the most interesting phenomenon: the method permits a close approach to the conditions of rock origin, when their composition influences the composition of fluid by redox reactions. Especially it shifts the equilibrium in the system CO_2 - CO toward the formation of CO during T increase. Then, together with general tendency for decrease of partial P_{H_2O} and P_{CO_2}, and increase in the role of H_2, CH_4, and CO during increase of temp. and depth of development of metamorphism, the general composition of each layer has great significance, as the last control on individual reactions.

Development of palyngenic phenomena, leading to origin of great masses of granitoid magmas, promotes formation of homogenous media in which the phase composition of the products of crystallization in significant degree depend on the fluid composition of flowing transmagmatic solutions. This results in a uniform composition of G-L inclusions in the granitoid massif, as opposed to the metamorphic rock masses. (Authors' abstract).

LEUNG, I.S., 1974, An X-ray study of diopside inclusions in natural diamonds: Geol. Soc. Amer. Abstracts with Programs, v. 6, no. 7, p. 842-843. Author at Department of Geology and Geography, Herbert H. Lehman College of the City University of New York, Bronx, New York 10468.

LEUNG, I.S., and MANSON, D.V., 1974, Orientations of olivine inclusions in natural diamonds (abst.): Amer. Geophy. Union Trans. EOS, v. 55, no. 4, p. 481-482. First author at Dept. of Geol. and Geog., City Univ. of New York, Bronx, N.Y. 10468.

LEVINSON, A.A., 1974, Introduction to Exploration Geochemistry: Calgary, Applied Publishing, Ltd., 612 pp.

Includes a two-page summary (p. 342-343) of applications of fluid inclusions to exploration. (ER)

LEVITSKIY, Yu. F. and ORLOVA, Zh. V., 1973, Inclusions of derivatives of magma in feldspars as the cause of their pseudopelitization: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 244-245 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at VSEGEI, Leningrad .

Mesozoic hypabyssal intrusives and volcanics of W. Transbaikal'ye characteristically have turbid to opaque K-spar, usually named "pelitized

K-spar". Such feldspars often are filled more than 50% by minute (less than 0.001 mm) gas-solid. gaseous, and liquid-gaseous inclusions. Shape of vacuoles and their arrangement are crystallographically controlled. Saturation of K-spars by fluid inclusions may be uniform, zonal, polyzonal, non-uniform, along edges of crystals and along edges of crystals and along fractures cutting some neighbouring crystals. Similar inclusions fill plagioclases to a lesser degree, mainly their inner cores and transitional zones. In quartz the vacuoles are larger (0.05-0.1 mm), the earliest ones either are scattered or form cloud-like aggregates. Among them individual vacuoles are filled with an isotropic phase with an uneven surface and one or some bubbles (gas-solid inclusions); their shape is irregular, amoeboid. Other inclusions are gaseous, with drop-like or partly faceted shape (F = 0 to 10% to 30 to 40%). Latest G-L inclusions have F = 60 to 80% (...). In addition, rare G-L inclusions with a third (L_{CO_2}) phase occur (G 20 to 25%, L_{CO_2} 5 to 10%, remainder - L_{H_2O}). Basing on F values and decrepitometry, one may compare inclusions in feldspars and in quartz. T_D of plagioclase 500°C, of K-spars 400-500°C, of quartz 420-440°C.

The major composition of the inclusions is not now clear, but visual observations supported by DTA analysis exclude the presence of pelitic substance in the feldspars. Appearance of an exothermic peak at 400°C on thermograms of individual samples and the formation of a brown distillate on the walls of the tube of the decrepitometer at T interval 400-500°C suggests the occurrence of organic substances in the samples. Chemical determinations proved a positive correlation between the amount of Cl in feldspar and its turbidity.

(...) 1/ These phenomena are typical for the Mesozoic stage of magmatic activity at W. Transbaikal'ye, connected with strong development of fracture tectonics; 2/ it occurs either with or without association with postmagmatic processes, but before the earliest metasomatic alteration of the rocks; 3/ for facies occurring inside the contact of hypabyssal intrusions, the zonal and polyzonal types of occurrence of inclusions in feldspars are characteristic, and zones of K-spars saturated by inclusions are more disordered than "clean" zones.

This pseudopelitization can be discussed as the result of processes immediately connected with the magmatic stage of formation of rocks and depends on quick crystallization of melt against a background of uneven decrease of P and T. This leads to supersaturation of the melt by volatiles, with their partial separation and subsequent trapping under condition of temporary coexistence of gas and solid phase in the crystallizing system. (Authors' abstract, with abbreviations by A.K.)

LIPMAN, P.W. and FRIEDMAN, Irving, 1974, Oxygen-isotope variations in phenocrysts from compositionally zoned ash-flow sheets, southern Nevada (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 6, p. 207. Authors' at U.S. Geological Survey, Denver Federal Center, Colorado.

Closely related compositionally zoned ash-flow sheets and cogentic lava flows, erupted from the late Miocene Timber Mountain-Oasis Valley caldera complex, show systematic oxygen-isotope variations (90 analyses) among all major phenocryst phases (quartz, sanidine, plagioclase, biotite, augite, and magnetite) from glassy rocks; oxygen-isotope compositions of each phenocryst phase become lighter in O^{18} with decreasing age and are interpreted as indicating major interaction between meteoric ground water and batholithic-size bodies of silicic magma prior to eruption. Each of the ash-flow sheets is compositionally zoned from silicic and phenocryst-poor at the base to more mafic and phenocryst-rich at the top, representing in inverse order the original compositional zonation in the magma chamber, and the isotopic fractionations between phenocrysts also reflect varying crystallization temperatures of phenocrysts that were originally distributed over several kilometers vertically in the differentiated magma. Post-eruption oxidation and cooling effects have not significantly modified oxygen-isotope compositions of phenocrysts from glassy rocks. (Authors' abstract)

LISITSYN, A.Ye, and MALINKO, S.V., 1969, Physicochemical conditions for development of borosilicates and borates in lime skarn formation: Geol. Rudn. Mestor., 1969, no. 4, p. 34-45 (in Russian; translated in Int. Geol. Rev., v. 13, no. 12 p. 1773-1780; abstract in Econ. Geol., v. 69, 1974, p. 574.)

The boro-silicate type of lime skarn is represented by danburite, datolite, and axinite. The borate type of lime skarn is represented by calciborite, sibirskite*, hydrous metaborates of calcium, and nordenskiöldine.** Both types of skarn usually do not occur together, but both types of boron skarns indicate hypabyssal conditions. Data on the study of gaseous-liquid incs. and on the synthesis of boro-silicates and borates indicate that danburite, axinite, tourmaline, and nordenskiöldine formed at temperatures of 300° to 500°C. The calcium metaborates formed at 100° to 350°C, while datolite and calciborite were formed at 250° to 500°C. (These are T_D values; ed.). Activities of Si, Ca, B, and H control the specific mineralogy. (Abbreviated from E.G. abstract)

* $CaHBO_3$; ** $CaSnB_2O_6$

LITVIN, B.N., TARASENKOVA, O.L. and BELOV, N.V., 1974, Synthesis and crystallochemical peculiarities of compounds in system $Na_2O - ZnO_2 - SiO_2 - H_2O$ formed at 400-500°C: in Contrib. to Physico-Chem. Petrology, V.A. Zharikov, et al., eds.: Moscow, "Nauka" Pub. House, v. 4, pp. 89-101 (in Russian).

LITVINOV, V.L., LYAKHOV, Yu.V., and POPIVNYAK, I.V., 1970, Paleotemperature zoning of the Kariyskoye gold deposit: Geol. Rudnykh Mestor., v. 12, no. 3, p. 96-101 (in Russian; abstract in Econ. Geol., v. 69, 1974, p. 728).

The Kariyskoye gold deposit is in the eastern Transbaikal region. Gold is in quartz-actinolite-magnetite, and in quartz sulfide veins. The country rocks are gabbro-diorite, diorite, and granodiorite of presumably Paleozoic or early Mesozoic age. Upper Jurassic granitic rocks outcrop at a distance of 1 km from the ore deposit. The ore veins are closely associated with dikes of porphyry lamprophyre and grorudite. The paleotemperature studies revealed the following stages of ore deposition: (A) the pneumatolytic-hydrothermal stage, which consisted of: (1) the quartz-tourmaline substage (535°-380°C) and (2) the quartz-magnetite substage (520°-280°C); and (B) the hydrothermal stage in a proper sense, which in turn consisted of (3) the gold-polymetallic substage (335°-230°C) and (4) the quartz-carbonate substage (170°-50°C). The vertical zoning is characterized by an increase in gas content in liquid-gaseous inclusions and by an increase in temperature of homogenization with an increase in depth. On the other hand, the temperature of homogenization and the content of gas in inclusions decrease from the northeast to the southeast of the deposit. This fact suggests that the direction of flow of mineralizing solutions along the fractured zones was from the northwest to the southeast. (See also the English translation in Internat. Geol. Review, v. 14, no. 9, p. 972, p. 1966-1970).

LOFGREN, Gary, DONALDSON, C.H., WILLIAMS, R.J., MULLINS, Oscar, Jr., and USSELMAN, T.M., 1974, Experimentally reproduced textures and mineral chemistry of Apollo 15 quartz normative basalts, in Fifth Lunar Sci. Conf. Proc., Geochim. Cosmo. Acta Suppl. 5, v. 1, p. 549-567. First author at NASA Johnson Space Center, Houston, Texas 77058.

An analog of the Apollo 15 quartz-normative basalts (also called pyroxene-phyric basalts) has been experimentally crystallized at a variety of linear cooling rates between 1250 and 1°C/hr at one atmosphere total pressure and oxygen fugacities close to those ascribed to lunar rocks. The charges show a variety of mineral chemical and textural features which are systematically related to cooling rate and which replicate many features of the quartz-normative basalts. In particular, the major and minor element zoning trends in pyroxene phenocrysts, the compositional discontinuity of the spinel series, and the nonstoichiometry in plagioclases have been reproduced. Charges have a porphyritic texture at linear cooling rates less than 60°/hr. The porphyritic texture is attributed to an abrupt increase in the pyroxene supersaturation, caused by a decrease in the slope of the equilibrium liquidus when plagioclase joins pyroxene as a liquidus phase. Comparison between dynamic and equilibrium experiments suggest that igneous reactions and textures can be studied experimentally even in systems of high chemical complexity. (Authors' abstract)

LOGINOV, V.P., 1974, Endogenic zoning of pyritic deposits: in: Zonality of hydrothermal ore deposits, G.A. Sokolov, ed.: Moscow, Izdat. "Nauka," v. 2, p. 7-85 (in Russian; abstract courtesy A. Kozlowski).

Author gives some T_D of sulfides, mainly literature citations, and two new determinations of T_D from Sibay Deposit (S. Ural): pyrite 290-315°C and pyrrhotite 350-395°C.

LORTIE, R. B., and CLARK, A. H., 1974, Stratabound fumarolic copper deposits in rhyolitic lavas and ash-flow tuffs, Copiapo district, Atacama, Chile (abst.): Internat. Assoc. on the Genesis of Ore Deposits, Fourth Symposium, Varna, Sept. 1974, Abstracts of Papers: Sofia, IAGOD, p. 154-155 (in English). Authors at Dept. of Geol. Sci., Queen's Univ., Kingston, Ontario.

Field and laboratory studies of two stratabound copper deposits (Amolanas and Jardin) associated with unmetamorphosed rhyolitic flows extruded in a single Paleocene eruptive episode of regional extent have provided convincing evidence that mineralization resulted from fumarolic activity in a continental environment.

Fluid inc. T_H and sulphur isotope fractionations between coexisting sulphate and sulphide mins. in these deps. do not provide unambiguous evidence of the source of the ore-forming constituents, but it is considered probable that the metals were scavenged from the rhyolites by circulating, heated, meteoric waters, and were conc. in local traps of different types at some distance from the eruptive centers. (From the authors' abstract.)

LU, Huan-Chang, SHIH, Chi-Shi, and YU, Tzu-Mei, 1974, Determination of the temperature of ore formation and diagenesis of a deposit from southern China: Geochimica (China), 1974, no. 3, p. 145-156 (in Chinese with English abstract).

Formation temperatures have been determined on quartz of biotite granite (640°C), two-mica granite (550°C), muscovite granite (526°C), and on the feldspar-quartz zone (503°C) and quartz zone (445°C) of pegmatoid by homogenization runs made on fluid inclusions in quartz from a deposit in Southern China. The temperatures of microclinization, wolframite and carbonate mineralization of wolframite-quartz veins are 293°C, 260-287°C, and 129°C respectively. In considering the information about the geological setting, petrochemical composition, characteristics of mineralization and fluid inclusion as well as formation temperatures, it is apparent that biotite granite, two-mica granite and muscovite granite in this district are comagmatic products at different stages during the differenciation process. The pegmatoid, which may serve as a good indicator of rare-element-bearing granites, formed in the late period of magmatic differentiation, and the wolframite-quartz veins proved to be postmagmatic high-temperature hydrothermal ore deposits. (Authors' abstract)

LYAKHOV, Yu. V., POPIVNYAK, I.V. and PIVOVAROV, Yu. V., 1973, Physico-chemical conditions and stages of forming of Irokindinskoe deposit (N. Buryatya): Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov, Univ. Press, p. 53 (in Russian; translation provided through the courtesy of A. Kozlowski). First author at L'vov Univ.

The Irokindinskoe deposit is of pneumatolytic-hydrothermal origin, formed in the temp. range 500-100°C, at pressures from 900-1000 to 400-500 atm. The mineral-forming role of gases were revealed mainly at early stages in the ore-forming process; the main part of vein filling formed under hydrothermal conditions. Gases in the solutions have the following composition: CO_2 50-95 vol. %; C_nH_{2n+2} 4 - 16 vol.%; N_2 3 - 22 vol.%.

Uneven changes of phase composition, chemical composition and solution temp. as well as the determined cycles in mineral crystallization prove the pulsating inflow of ore-forming solutions and permit establishment of the following scheme of ore process: pneumatolytic-hydrothermal stage 1) quartz-tourmaline (500-350°C), 2) pyrite-quartz (460-310°C), hydrothermal stage 3) gold-sphalerite-galena (300-195°C), 4) quartz-carbonate (160-100°C). The following cycles of mineral paragenesis reflect the evolution of pH of solutions, testifying to its relative increase in the end of each stage. (Authors' abstract).

LYASHENKO, A.N., 1974, Rock-forming minerals of deposits in the Kanilovskaya series at Gorynya Basin: in Mineralogy of sedimentary deposits, v. 1, 1974, Kiev, p. 118-125. (in Russian; abstract courtesy A. Kozlowski). Author at Institute of Geological Sci., Acad. Sci. of Ukrainian SSR, Kiev.

Quartz grains from sandstones bear fluid incs., but not in the regenerated rims (photo given). Occurrence of fluid incs. is also noted in clastic apatite.

LYASHKEVICH, Z.M., 1973, Physico-chemical peculiarities of metasomatic processes of E. Priazov'ye: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 246-247 (in Russian; translation provided through the courtesy of A. Kozlowski).

Studies of metasomatic processes at E. Priazov'ye were made in 3 directions: 1) analysis of natural formations and processes, statement of stable mineral parageneses and directions of replacement reactions in metasomatites; 2) studies on geochemistry of rare and dispersed elements in connection with processes of high-temp. metasomatism; 3) studies of inclusions of mineral-forming media in minerals of metasomatic facies to obtain quantitative values of T, P and pH of solutions.

Activity of high-temp. solutions may be divided into 3 stages, in agreement with 3 stages of geological development of the region (see Table). The Archean stage is least known. Probably progressive platy metasomatism of primary sedimentary-effusive rocks was the main process. For stages 2 and 3 under platform conditions, various facies of metasomatic rocks were distinguished and studied. Magmatism and activity of high-temp. solutions were then limited to zones of deep faults. Statistical calculation of 2500 quantitative spectral analyses proved that high-temp. alterations of rocks were accompanied by accumulation of a number of rare and dispersed elements. (Author's abstract)

Table. Scheme of development of magmatic and metasomatic processes of E. Priazov'ye

Age	Stage	Magmatic rocks	Types of metasomatic processes	Type of solutions	T of solutions °C	pH of solutions
Upper Paleozoic	Platform	Andesites dacites				
		Nepheline rocks, pyroxenites, andesite-basalts, orthophyres	Gumbeisation *, K-spathization, fluoritization	postmagmatic	300-200	acid alkaline
Proterozoic	Platform	Basic dikes, diabases				
		Kamennye Mogily-type granites, alkaline and nepheline syenites, granosyenites	fenitization Na-metasomatosis of dissolution zones, mariupolitization, quartz-feldspathic metasomatism, greisenization, albitization, fluoritization	magmatic post-magmatic	800-900 700-200	alkaline alkaline (pH=10) acid (pH=5.5) late alkaline (pH=7-8)
Archean	Geosynclinal	Anadolian granites,				
		Granites, granodiorites	Migmatization, granitization	trans-magmatic	850	acid
		Metabasites, ultrabasites				

* Gumbeisation - a type of propyllitization, consisting of orthoclase, ankerite, etc.

LYGINA, V.V., and KOTOV, N.V., 1973, Trace inclusions of sillimanite and gaseous and liquid media in quartz of metamorphic rocks in the Khintala-Kuznechnoe region in the western Lake Ladoga area: Vestn. Leningrad. Univ., Geol., Geogr., 1973, no. 4, p. 160-163 (in Russian). C.A. v. 81, no. 11, 138480K.

Quartz grains with incs. from garnet-cordierite-biotite gneisses and quartz-cordierite veins syngenetic with them were studied. The results show the syngenesis of the basic minerals of gneisses. The substitution of biotite by fibrous spicular crystals of sillimanite is a typical process for the rocks. Since the formation of magnetite or independent Fe-Mg-contg. phases during decompn. of biotite was not obsd., it may be supposed that Fe, Mg, and Ti (along with K, Na, Ca) were transferred in soln. during sillimanite formation from biotite to an intergranular steam phase. Three types of incs. were identified: (1) gas-liq. type which forms 10% of all incs., ≤0.01 mm; (2) monophase gas incs. (mainly CO_2) forming 30%, diam. 0.02-0.05 mm; (3) high-temp. type (60%) composed of liq. and cryst. phases (liq. + sillimanite), ∿0.005 mm. No changes in (the latter?) incs. were obsd. at 600-900° and for ∿10 min. at ≤1200-1300°.

LYSAKOV, V.S., SEREBRYANNIKOV, A.I., and SHARAPOV, V.N., 1972, Application of thermoluminescent method for studies of quartz vein filling: Acad. Sci. USSR, Inst. of Geol. and Geophysics, of Siberian Branch, Trans. v. 114, Physical and physical chemical development of magmatogenic and ore systems, p. 308-317: Moscow, "Nauka" (in Russian).

T_H of incs. in quartz at Nura-Taldy and Taishek deps. ranges from 200 to 270°C. (A.K.)

MAALØE, S., and WYLLIE, P.J., 1974, An experimental investigation of the water content of a granitic magma (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 6, no. 7, p. 852. Authors at Department of the Geophysical Sciences, University of Chicago, Chicago, Illinois 60637.

The liquidus temperatures of dry granitic magmas vary with their composition, and for water-deficient magmas it is especially sensitive to the water content. Similarly, the crystallization sequence of a granitic magma depends on its water content. Comparison of the deduced crystallization sequence of a natural granite with experimentally determined crystallization sequences of the same rock with various water contents permits an estimate of the water content of the magma. From a study of the textural relationships a Pre-cambrian granite followed the crystallization sequence: plagioclase-alkali feldspar-quartz-biotite. The crystallization sequence of the granite was investigated at different water contents in the range 0-20% water, at 2 kb using a NNO buffer. The oxygen fugacity of a granitic magma is estimated to be close to that of the NNO buffer. The crystallization sequence observed in the rock was reproduced experimentally only for compositions containing less than 1.4 weight percent water. The rock itself contains 0.45% water, and therefore, the water content is estimated to be between 0.45 and 1.4%. At 2 kb total pressure the sequence of equilibrium crystallization for the magma with 1.4% water is plagioclase (1095°C), alkalifeldspar (950°C), quartz (870°C), biotite (870°C) and the solidus temperature is 705°C. The granite thus crystallized at strictly water-deficient conditions. The presence of CO_2 should modify the temperatures of crystallization and the evolution of a vapor phase, but little else. (Author's abstract)

McBIRNEY, A.R., and NAKAMURA, Y., 1974, Differentiation of the Skaergaard intrusion (abst.): Amer. Geophy. Union Trans., EOS, v. 55, no. 4, p. 459. First author at Center for Volcanology, Univ. of Oregon, Eugene, Oregon 97403.

The acid and transitional granophyres cannot be derived in any substantial part from the differentiated gabbro but must be mainly the products of melting of the basement gneiss. Similarly, a separation of two immiscible liquids, one rich in silica and the other in iron, can now be ruled out. The revised data also give better estimates of temperature, pressure, and oxygen fugacity as well as several quantitative aspects of the differentiation mechanism. (From the authors' abstract. See next item.)

McBIRNEY, A.R. and NAKAMURA, Yasuo, 1974, Immiscibility in late-stage magmas of the Skaergaard intrusion: Carnegie Institution of Washington Yearbook 73, p. 348-352, (pub. 1974).

The authors have shown by petrography and experimental studies on synthetic mixtures that immiscibility was involved in the evolution of the Upper Zone and granophyre of the Skaergaard intrusion.

MacGREGOR, I.D., 1974, First Kimberlite Conference, Republic of South Africa: Geology, v. 2, no. 3, p. 151-152. Author at Department of Geology, University of California, Davis, Davis, California 95616.

A short review of an important conference that included several discussions of the silicate melt inclusions in diamond (picrite high in CO_2 and H_2O?). Some of the more pertinent abstracts will be found in this volume. (ER)

MACHAIRAS, Georges, 1973, A new occurrence of cleavable quartz at Cassongue, Angola: Soc. fr. Mineral. Cristal., Bull., v. 96, no. 6, p. 395-397 (in French).

Includes a brief description of CO_2-H_2O inclusions. (ER)

MacLEAN, W.H., 1974, Base metal partitioning in sulfide-silicate liquids (abst.): Econ. Geol., v. 69, p. 1183. Author at Department of Geological Sciences, McGill University, Montreal H3C 3G1, Canada.

Partitioning of Zn, Pb, Co, Cu, and Ni between iron sulfide and iron silicate liquids at 1150°C was determined and applied to the Sudbury ores(ER).

MacQUEEN, R.W., and TAYLOR, G.C., 1974, Facies changes, dolomitization, and zinc-lead mineralization in Devonian rocks of Peace River area, Rocky Mountains, Northeastern British Columbia (abst.): Geol. Assoc. Can. - Mineral. Assoc. Can. Meeting, Newfoundland, p. 57-58. Authors at Geol. Survey Canada, Calgary, Alberta, Canada.

MAGARITZ, Mordeckai, and TAYLOR, H.P., Jr., 1974, Oxygen and hydrogen isotope studies of serpentinization in the Troodos ophiolite complex, Cyprus: Earth and Plan. Sci. Letters, v. 23, p. 8-14. Authors at Div. of Geol. and Plan. Sci. Cal. Inst. Tech., Pasadena, Calif., USA.

Oxygen and hydrogen isotopic compositions were measured on 12 serpentine and 2 actinolite samples from the Troodos ophiolite complex, Cyprus. The Troodos lizardite-chrysotile samples cannot have formed by reaction with heated ocean waters, but instead must have formed in contact with large amounts of some type of meteoric, metamorphic, or formation water, either (1) at very low temperatures in a near-surface environment, or (2) at about 100°C from waters that were abnormally enriched in ^{18}O ($\delta^{18}O \approx +4$ to $+8$). The latter possibility seems most plausible inasmuch as extensive evaporites were deposited throughout the Mediterranean Sea during the late Miocene, and this would have been accompanied by strong ^{18}O enrichments of the local meteoric waters. Heated ocean waters, however, probably were responsible for the formation of the actinolitic amphiboles. (Authors' abstract, abbrev.)

MAISKII, Yu. G., 1972, Thermobaric studies of carbonates from several hydrothermal manifestations of the exposed Donets Basin: Mineral.-Geokhim. Issled. Sev. Kavkaze Donbasse, 1972, p. 178-182, I.A. Shamrai, ed.: Rostov-on-Don, Izdat. Rostov Univ. (in Russian), C.A. v. 81, no. 1, 138608h.

Thermovacuum, x-ray, and microchem. studies of fluid incs. in carbonates from hydrothermal deposits of the exposed Donets Basin showed that the crystn. of the carbonates took place in a few stages from low- and medium-temp. hydrothermal solns. after their heterogenization accompanied by removal of H_2CO_3 and a sharp pressure drop. Crystn. occurred at a relatively high speed, which resulted in the formation of a great no. of small fluid incs. and the appearance of a block-mosaic structure in the carbonate crystals. Minerals of the siderite-ankerite-dolomite series were found as satellites of sulfide-complex ores whereas calcite occurred mostly in paragenesis with fluorite, cinnabar, and clay minerals. Histograms of thermovacuum analyses gave information about T_D of fluid incs. (Author's abstract)

MAISKY, Yu. G., **1973a**, Thermodynamic conditions of hydrothermal mineralization in Central Donbas: L'vov. Mineral. Sborn., v. 27, no. 2, p. 138-146 (in Russian).

Gas-liquid incs. in the minerals of the hydrothermal lodes of the Central Donbas have been studied. It has been determined that the crystallization of quartz which forms the lode rock of the majority of the familiar ore occurrences originated from heterogeneous solutions under subisothermal conditions. The change of the content of CO_2 in the solutions resulted in the intermittent character of mineral deposition. The existence of thermodynamic barriers is supposed during the mass crystallization of quartz, carbonates, galena, sphalerite and other minerals. (Author's abstract).

MAISKIY, Yu. G., **1973b**, Problems and perspectives of vacuum decrepitometry of minerals: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 290-291 (in Russian; translation provided through the courtesy of A. Kozlowski). Author at Rostov Univ.

The main useful features of vacuum decrepitometry are as follows: high sensitivity of the recording apparatus, possibility of recording inclusion breakage occurring without acoustic phenomena (by release of the fluid phase along fractures or during opening of minute inclusions releasing little energy) quantitative evaluation of the mass of the trapped fluids (a function of the degree of equilibrium between mineral and parent solution (sic.)) and qualitative characterization of the fluids by the addition of a gas analyser or mass-spectrometer.

The following improvements in the technique of vacuum decrepitometry are possible by way of standardization of the conditions of the experiment: wide application of statistical methods, determination of mineral stability under conditions of low pressures for exact interpretation of decrepigraphs, perfection of decrepitometer construction to relate changes of pressure (simple and differential mode) with kinetic or acoustic energy of breaking.

It is now time to extend the decrepitation method to provide typomorphic characteristics of minerals by: 1) investigation of products of sublimation and decomposition: 2) dynamics of phase and polymorph inversions; 3) changes of surface of mineral grains after thermovacuum treatment; 4) processes of dehydration; 5) determination of degree of order/disorder in the structure of minerals, etc.

In the paper individual examples are given of the solution of geological and applied questions on the basis of an 8-year period of work on vaccum decrepitometry. (Author's abstract, with abbreviation by A.K.)

MAISKIY, Yu.G., 1974, Certain typomorphic peculiarities of quartz from hydrothermal rocks of Central Donbass, in Typomorphism of Ukrainian Quartz, edited by Ye. K. Lazarenko, Acad. Sci. Ukr. SSR: Kiev, Naukova Dumka Pub. House, p. 82-86 (in Russian; translation courtesy A. Kozlowski). Author at State Univ. in Rostov-on-Don.

Parallel prismatic quartz bears G/L PS incs. with T_H 160-170 and 320-330°C, T_D 220-300 and 360-400°C (vacuum method). Fibrous quartz contains solid (organic coal-like matter) and G/L incs., T_D 220-280 and 320-400°C. Quartz with opalescence bears 1×10^6 incs. per mm^3, T_D 80-120, 220-260 and 340-380°C. Grained quartz gave T_H 220-310°C and T_D 200-300°C; some incs. bear liquid CO_2. Transparent "heads" of idiomorphic quartz from voids has incs. with T_H 160-170°C. Sponge-like quartz gave T_D 260-360°C. Probable mechanism of pption. of silica and forming of quartz, partly from gel or colloid forms of SiO_2, is given (A.K.).

MAKAGON, V.M., 1973, Crystallization temperatures of lithium-bearing minerals in East-Siberian rare-metal pegmatites: Ezheg., Inst. Geokhim., Sib. Otd., Akad. Nauk SSSR, 1972, (Pub. 1973), p. 133-138 (in Russian); C.A., v. 81, no. 12, 1974, 155696c.

The crystn. temps. were obtained from gas-liq. incs. in spodumene, elbaite, montebrasite, and petalite. T_H of gas-liq. incs. is: spodumene 220-440, elbaite 270-585 (elbaites from pegmatites without spodumene 440-600), rubellite 270-330, petalite 310-430, and montebrasite 350-470°. These Li-bearing minerals crystd. from the liq. phase at 270-600°. (Author's abstract).

MAKAGON, V.M., 1974, Peculiarities of physico-chemical conditions of formation of muscovite and rare metal pegmatites of E. Siberia (Data from gaseous-liquid inclusions and other geothermometers) (abst.): Internat. Assoc. on the Genesis of Ore Deposits, Fourth Symposium, Varna, Sept., 1974, Abstracts of Papers: Sofia, IAGOD, p. 258-259 (in Russian; translation courtesy A. Kozlowski). Author at Institute of Geochemistry, Irkutsk, USSR.

1. Origin of pegs. is connected with meta. of wall rocks: mica-bearing pegs. - under amphibolite facies of kyanite-sillimanite type, T = 500-650°C, P = 5-7 Kbars; RM-bearing pegs. - amph., epidote-amph. + greenschist facies of andalusite-sillimanite type, T = 350-650°C, P up to 5 Kbars.

2. Fluid incs. in mins. of pegs. show xliz. from liquid phase (sol. or melt); gas incs. occur only in some mins. of spodumene-bearing RM pegs.

3. Muscovite pegs. formed from fluids rich in CO_2, facilitating boiling phenomena under high P and hydrolysis of feldspars to form commercial mica zones; T = 650 to 350°C, P = 7 to 1.4-2 Kbars.

4. RM form 2 types: a. with spodumene, b. with lepidolite + amblygonite. Spodumene type has weak or no zoning, and xlized. during sharp decrease of P from 4-4.5 Kbars at T = 550°C, and decrease of CO_2 amount being one of the main volatiles at the beginning of process. Final T = 270-290°C. (...)

5. Lepidolite-amblygonite type has good zoning. It was formed at T<700 to 270°C and P much lower than spodumene type. Albite-bearing

parageneses formed from fluids rich in fluorine. (Author's abstract, abbreviated by A.K.)

MAKAGON, V. M., and KUZMINA, T. M., 1974, Peculiarities of physical-chemical conditions of beryl forming in Siberian muscovite and rare-metal pegmatites: Yearbook, 1973, Inst. of Geochemistry, "Nauka" Pub. House, Novosibirsk, p. 135-138 (in Russian with English abstract).

Beryl of muscovite pegs. belongs to the Na- and non-alkali beryl type. In the rare-metal pegs. there are beryl types of (1) the Na and nonalkali beryls, (2) the Li-Na type and (3) the Na-Li one with Cs.

The investigation of fluid incs. in beryl xls. shows that (1) beryl of the muscovite pegs. formed at high P and low T and (2) beryls of the rare-metal pegs. formed at a relatively low P xlized at T up to 600-700°C. (Authors' abstract.)

MAKAGON, V.M., and MAKRYGINA, V.A., 1973, Liquid inclusions in minerals of metamorphic rocks and metamorphic veins: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 237-239 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Inst. of Geochemistry, Siberian Branch Acad. Sci. of USSR, Irkutsk.

At the Baykalo-Patomskiy submountainous region the kyanite-sillimanite type zonation is developed. Quartz-carbonate and quartz-feldspar veins are connected with greenschist and epidote-amphibolite facies as well as with the staurolite-almandine zone of the amphibolite facies. In rocks of kyanite-almandine subfacies of amphibolite facies, plagiomigmatization was observed with formation of veins of plagioclase pegmatites, altered later into granite-like pegmatites by K-feldspathic replacement.

Fluid inclusions were investigated in quartz, calcite, garnet, kyanite, and K-spar. Presence of CO_2 is the main peculiarity of inclusions. The varieties found are as follows: 1) one-phase L_{CO_2}; 2) two-phase L_{H_2O} plus L_{CO_2}; 3) three-phase L_{H_2O} plus L_{CO_2} plus G_{CO_2}; and 4) polyphase, with solids, L_{H_2O} plus L_{CO_2} plus S. Inclusions homogenize either in L_{H_2O} or in L_{CO_2}, proving the liquid state of mineral-forming solutions.

Greenschist metamorphism took place at T 300-450°C; T_H of inclusions in quartz from veins = 270-310°C, P liquid CO_2 method) ∿ 2 kbars, i.e., veins have formed in the beginning of retrograde metamorphism. In the lowest-temp. zone of the amphibolitic facies (staurolite-almandine) veins have formed, as indicated by fluid inclusions, at T = 330-390°C and P ∿4 kbars.

T of metamorphism of kyanite-almandite subfacies was determined, by use of various geothermeters, as 500-650°C. In kyanite and garnet of this zone, inclusions of liquid CO_2 were found (density of 1.06-1.02), corresponding P = 5-7 kbars; plagiomigmatites occurring in this zone formed under similar conditions.

T of origin of granite-like pegmatites with K-spar is equal 650-700°C, liquid CO_2 inclusions occurring in quartz of this rock have a density of 1.05 - 1.00, P = 6-8 kbars. (...) (Author's abstract abbreviations by A.K.).

MALIN, M.C., 1974, Salt weathering on Mars: J. Geoph. Research, v. 79, p. 3888-3894. Author at Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, California 91109.

Although this concerns another subject entirely, data are given here on the low-temperature stable and metastable P-T relationships of strong ionic solutions that are pertinent to freezing studies of fluid inclusions. (ER)

MALININ, S.D., 1974, Questions concerning the thermodynamics of the H_2O-CO_2 system: Geokhimiya, 1974, no. 10, p. 1523-1549 (in Russian).

MALYUK, G.A., and ARTEMCHUK, V.G., 1974, The D/H and $^{18}O/^{16}O$ ratios in ground water as an indicator of the water-rock interaction (abst.): Internat. Symp. on Water-Rock Interaction, Czechoslovakia, Sept. 9-17, 1974, Abstracts: Prague, Geological Survey, p. 14-15 (in English). (Authors at Institut fizicheskoi khimii im. L.V. Pisarzhevskogo, AN USSR, Kiev, USSR.

MAMCHUR, G.P., MATVIYENKO, A.D., and YARYNYCH, O.A., 1974, On conditions of formation of quartz in Volhynian pegmatites, on the basis of isotopic composition of carbon of CO_2 from inclusions, in Typomorphism of Ukrainian Quartz, edited by Ye. K. Lazarenko, Acad. Sci. Ukr. SSR: Kiev, Naukova Dumka Pub. House, p. 45-48 (in Russian; translation courtesy A. Kozlowski). Authors at Inst. of Geol. and Geochemistry of Fuels of Acad. Sci. Ukr. SSR, L'vov.

The method of det. of isotopic comp. of C by mass-spectrometry, with absolute error ±0.05%, is described, using as a standard PDB. Isotopic comp. of C of CO_2 from granites varied irregularly in ranges δC^{13} = -2.33 to -3.43%. In peg. the carbon is heavier (-0.93 to -1.92%); the later mins. have CO_2 richer in C^{13}. Decrease of T of quartz form. from 600 to 250°C is accompanied by change of δC^{13} from -1.9 to -1.5%. Because other cpds. of C can be practically excluded (CH_4 is present in incs. in several %), the differentiation of isotopic comp. of C by way of fractionation is rather impossible. Hence the heavy isotope probably comes into the peg. system from the upper mantle. Quartz is char. by relatively uniform values of δC^{13} in comparison with granites and peg. rocks. Periods of time when the influx of probable "mantle" CO_2 was interrupted were established for peg. bodies. "Heavy" CO_2 forms haloes around pegs. Isotopic comp. of C in granites is similar to that of organic matter and the influence of organic cpds. from sed. rocks on the volatiles in granites is possible (A.K.). (Ed. note - These are % data, not ‰)

MANKOV, Sl., and ANDREEVA, L., 1974, Tungsten-molybdenum mineralizations connected with Tertiary magmatism of the Bulgarian-Yugoslav border region (extended abst.), in Metallization associated with acid magmatism, v. 1, p. 53-58, ed. M. Stemprok: Prague, Geological Survey (a volume of papers presented at the MAWAM Symposium, Karlovy Vary, Czechoslovakia, Oct. 1974) (in English).

According to mineral-thermometric investigations (presumably inc. T_H), the initial T of the ore-bearing solutions was 360-330°C. (From the authors' abstract.)

MANUCHARYANTS, B.O. & FEDORCHUK, V.P., 1973, Thermobaric peculiarities in the formation of telethermal deposits: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press,

p. 97-99 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Inst. of Mineralogy and Geochemistry of Rare Elements-IMGRE, Moscow.

The following mercury deposits of the dolomite type were investigated: Karasu (Middle Asia), Van'shan, (China), Elenovskiy and Dolomitovyi quarries (Priazov'e).

1. Inclusions in cinnabar, quartz, barite, dolomite, and calcite were of three types: $G + L_{H_2O} + L_{CO_2}$, and L_{CO_2}.

2. Salt concentrations in the mineral-forming solutions were low, a few grams per liter; temperatures ranged from 250-90°C. T_H in early quartz (pre-ore recrystallization of dolomites), 250-200°C, In minerals of ore-stage: cinnabar, antimonite, quartz II, dolomite II, barite, 220-150°C. Late-ore and post-ore minerals, mainly dolomite III and calcite - 150-90°C.

3. Narrow temperature ranges of ore stage formation and coarse-crystalline idiomorphic minerals prove that the mineral-forming solutions acted for a long time.

4. Pressures ranged from 850 to 1000 atm and they were higher than lithostatic pressure.

5. Mineral-forming solutions were acid and rich in CO_2, from 10 to 100g per 1000g H_2O.

6. Formation of ores was the result of neutralization and alkalization of solutions by the carbonate wall rocks and by separation of CO_2 to form the gas phase.

Analogous data were obtained for stratiform Pb-Zn deposits of the Mediterranean zone. (Authors' abstract)

MARAKUSHEV, A.A., and PERCHUK, L.L., 1974, Thermodynamic model of fluid regime of the Earth: in Contrib. to Physico-Chem. Petrology, V.A. Zharikov, et al., eds.: Moscow, "Nauka" Pub. House, v. 4, pp. 102-130 (in Russian; abstract courtesy of A. Kozlowski).

Devel. of magmatism and meta. was studied in connection with regime of degassing of deep parts of Earth; thdy. calcs. of min. equil. and cpds. were made for T and P values characteristic for various regions in the Earth. Sources of heat during magmatic and meta. phenomena were discussed. Paper is the extended version of the authors' report at Int. Geochem. Congress in Moscow, 1971. (Authors' abstract).

MARCHENKO, E. Ya, PONOMAREVA, R.G., SLYSH, R.A., 1974, Iron, manganese, and magnesium carbonates from Precambrian granitelike metasomatites in the Ukraine: Dopov. Akad. Nauk Ukr. RSR, Ser. B 1974, v. 36, no. 2, p. 124-126 (in Ukrainian), C.A., v. 81, no. 9, 1974, 108561 v. Authors at Inst. Miner. Resour., Simferopol, U.S.S.R.

The granite-like metasomatites of Ukraine contain manganosiderite (MnO 33.34, FeO 28.50%) ferrorhodochrosite (FeO 34.99, MnO 23.60%), and metamorphosed dolomite with Mg carbonate (20.52% MgO). The carbonates of Fe and Mn are explored near the tectonic fault while dolomite is found in the peripheral zones. T_H of the gas-liq. incs. of the ore samples 190-285°. This temp. corresponds to the temp. of the hydrothermal fluids which produced these Precambrian metasomatic formations. (Authors' abstract)

MARTIN, R., 1974a, Morphology and inclusions of the quartzes of the Orpierre region: Soc. Ital. Mineral. Petrol., Italy, v. 30, p. 435-440 (in Italian). See next abstract.

MARTIN, Roger, 1974b, Fluid inclusions in quartz crystals from Orpierre (Hautes Alpes, France) and Remuzat (Drôme, France)-Color film (abst.): Internat. Mineral. Assoc. Ninth Gen. Meeting, West Berlin and Regensburg, W. Germany, Collected Abstracts: West Berlin, German Mineralog. Soc., p. 25 (in English). Author at Nyon, Switzerland.

Calcareous concretions in the Oxford marls have undergone low grade anchimetamorphic metamorphism, accompanied by tectonic deformation.

During this deformation the concretions have been flattened, and their open cracks (or perhaps even diagenetic origin) gave way to growth of quartz crystals of a very peculiar morphology which is probably due to the presence of hydrocarbons (MARTIN 1973). The quartz crystals are very rich in P fluid incs., which all contain gaseous, liquid or solid hydrocarbons in addition to water. Some clear yellow or red-brown oil contains small drops of denser oils or even organic particles. In the quartz crystals of Orpierre water may be completely absent, and inclusions are composed essentially by "oily" and gaseous substances.

The film shows the complicated behaviour of the incs. during heating, cooling or rotation of the samples. Between 18° - 50°C the following are observed: eddies, viscosity changes, convection currents, homogenization of phases, unmixing of phases with retro-boiling, and attraction or repultion of particles. (Modified by ER from author's abstract).

MATHEZ, E.A. and YEATS, R.S., 1974, Magmatic sulfides in basalt glass from the Nazca plate, DSDP Leg 34 (abst.): Amer. Geophys. Union Trans. EOS, v. 56, no. 12, p. 1198. First author at Department of Geological Sciences, University of Washington, Seattle, WA.

Basalt glasses collected from the Nazca plate at sites 319A and 320 contain Ni- and Cu-rich sulfide globules up to 48 μm in diameter and have vesicles with well-developed sulfide spherules lining their walls. The glasses are petrographically and chemically typical of other low-K abyssal tholeiites, containing <10% plagioclase and olivine phenocrysts, having been quenched at near-liquidus T. They are probably pillow selvages. Paragenetic relations show that an immiscible sulfide liquid existed in the magma prior to its eruption (T~1190°C). Hence, sulfides may have separated in a pre-eruption chamber, and the present sulfur concentrations of 1200-1500 ppm in these glasses are below juvenile values. Microprobe investigations reveal that two sulfide phases (compositions given below) usually coexist within individual globules. This means that the sulfides have undergone relatively low T (<700°C) subsolidus re-equilibration, even in rapidly quenched rocks. Many melts generated beneath mid-ocean ridges may be sulfur-saturated, resulting in sulfide concentrations at magma chamber floors. (Authors' abstract).

	Ni-rich phase	Cu-rich phase	Estimated bulk composition
S	37.4	35.1	37.0
Fe	50.8	37.0	49.0
Ni	9.1	3.3	8.3
Cu	1.1	23.1	4.1
Co	0.28	0.11	0.26
Mn	0.03	0.05	0.03
Zn	0	0.10	0.02
Total	98.7	98.8	98.7

MATKOVSKY, O.I., 1973, Thermodynamic conditions for the metamorphic mineral formation in the crystalline base of the Ukrainian Carpathians: L'vov. Mineral. Sbornik., v. 27, no. 1, p. 10-25 (in Russian).

Thermodynamic conditions for the metamorphic mineral formation in the crystalline base of the Ukrainian Carpathians are discussed. These are based on the quantitative evaluation of the temperature and pressure on different thermometers and barometers, the results of a study of incs. in quartz with due regard for the experimental data on the rigidity of separate minerals. (Author's abstract)

MATSUBAYA, O., TSURUMAKI, M., and SAKAI, H., 1974, Stable isotopic and chemical features of saline brines at Arima and related areas of Japan (abst.): Internat. Symp. on Water-Rock Interaction, Czechoslovakia, Sept. 9-17, 1974, Abstracts: Prague, Geological Survey, p. 14 (in English). First author at Institute for Thermal Spring Research, Okayama University, Misasa, Tottori-Ken 682-02, Japan.

MATSUI, Eiichi, SALATI, Eeneas, and MARINI, O.J., 1974, D/H and $^{18}O/^{16}O$ ratios in waters contained in geodes from the basaltic province of Rio Grande do Sul, Brazil: Geol. Soc. Amer. Bull., v. 85, p. 577-580. First author at Centro de Energia Nuclear na Agricultura, Caixa Postal 96.13.400 Piracicaba, S.P. Brasil.

Anal. of the ^{18}O and deuterium (D) concs. in water contained in chalcedony and quartz geodes of Salto do Jacui, in Rio Grande do Sul, Brazil, indicate small variation in the isotopic concs. of fluid, avg. $\sim -5.0^o/_{oo}$ (per mille) for $\delta^{18}O$ and $-27^o/_{oo}$ or δD relative to Standard Mean Ocean Water (SMOW). The geodes studied were collected in primary or sed. clay soil resulting from the decomp. of Cretaceous basalt. Comparisons with postulated juvenile and meteoric waters are made in an attempt to obtain further information on the genesis of the studied geodes. The isotopic concs. indicate that the waters contained in these geodes are meteoric. (Authors' abstract)

MATSUO, Sadao, SUZUOKI, Tetsuro, KUSAKABE, Minoru, WADA, Hiroaki, and SUZUKI, Masaru, 1974, Isotopic and chemical compositions of volcanic gases from Satsuma-Iwojima, Japan: Geochem. Jour. (Japan), v. 8, p. 165-173 (in English). First author at Dept. Chem., Tokyo Inst. Tech., O-okayama, Megur. ku, Tokyo 152.

D/H and $^{18}O/^{16}O$ ratios of fumarolic condensate, hot spring water and surface water collected from a volcanic island, Satsuma-Iwojima were det. together with some chem. components.

δD and $\delta^{18}O$ of fumarolic condensates range from -27 to $-17^o/_{oo}$ (SMOW) and from $+7.3$ to $+9.5^o/_{oo}$ (SMOW), respectively. The high value of ^{18}O was concluded to be the result of thorough oxygen isotope exchange with ambient andesitic rocks. δD values are also higher than that of the local surface water, but we could not find a positive evidence that supports the assumption of mixing of the local surface water and sea water.

On the basis of the relationship between the conc. of chem. components and isotope ratios of fumarolic condensates, it was concluded that water vapor and chem. components behave independently in an individual fumarole. (Authors' abstract)

MAYSKAYA, Z.V., MAYSKIY, Yu.G, USHAK, A.T., TRUFANOV, V.N., SINITSYN, I.V., POZDNEV, Yu.D., and GOVOROV, Yu.I., 1973, Decrepitation activity of foundry sands and its significance in metallurgical production: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov

Univ. Press, p. 278-279 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Rostov Univ., and "Rostelsel'-mash" Works.

Foundry quartz sands from 22 deposits of the European part of USSR, were divided into four groups, based on genetic studies of inclusions of mineral-forming media: a) those bearing only secondary, low-temp. liquid inclusions; b) those bearing mainly melt inclusions; c) those bearing G-L inclusions with various degrees of filling; d) those bearing inclusions of several genetic types.

Vacuum-decrepitometric sampling of foundry sands proves their variable content of gas, depending on which of the above groups and on differences in the dynamics of escape of volatiles during heating to 1000°C. The first group gives a weak maximum gas escape during decrepitation at 60-100°C; the second hardly gives any decrepitation effects; the third and fourth group have higher activity in a wide T interval, from 40 to 650°C.

Decrepitation of inclusions aids in the destruction of quartz grains, causing a significant change in the physico-chemical features of foundry mixtures, and having an influence on the quality of resultant metallurgical parts. (Authors' abstract)

MEL'NIKOV, F.P., 1973, Inclusions of hydrocarbons, petroleum and bitumens in endogenetic minerals: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 16-18 (in Russian; translation provided through the courtesy of A. Kozlowski). Author at Moscow University.

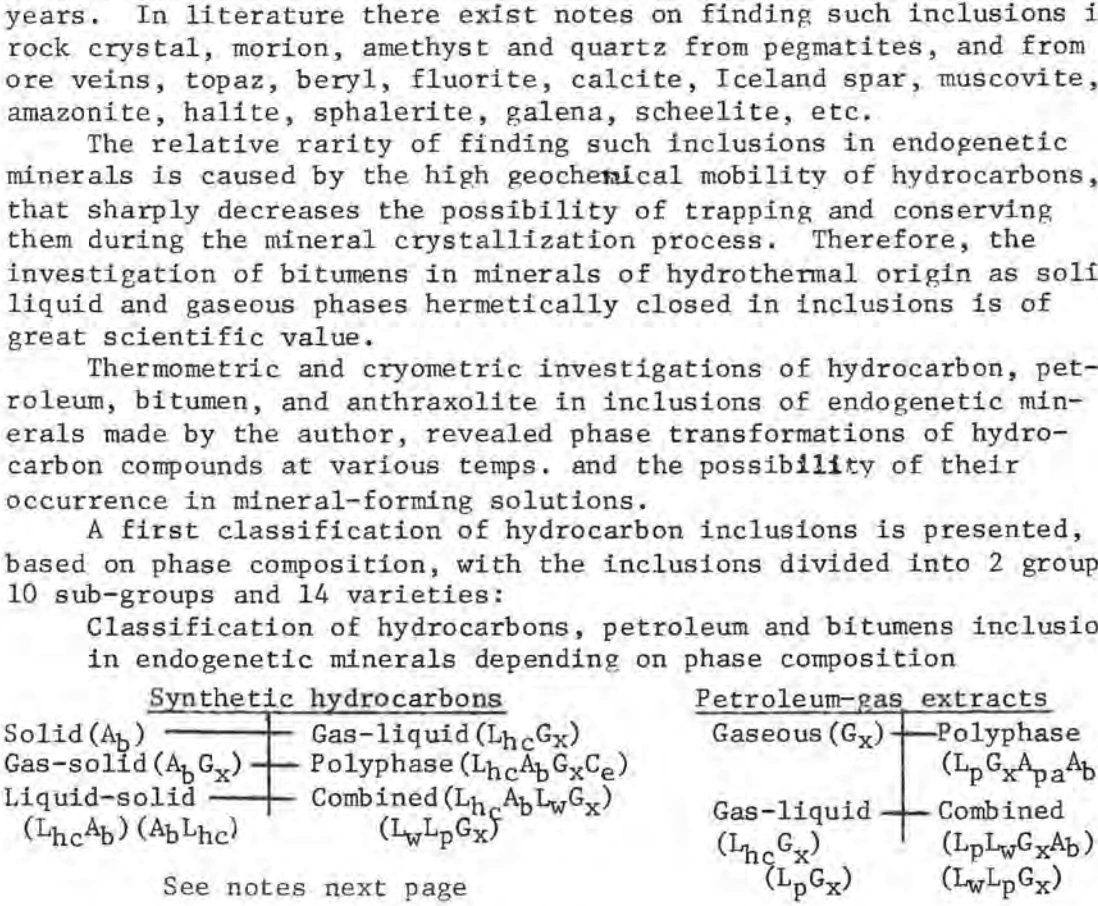
Hydrocarbon inclusions in natural crystals are known for over 100 years. In literature there exist notes on finding such inclusions in rock crystal, morion, amethyst and quartz from pegmatites, and from ore veins, topaz, beryl, fluorite, calcite, Iceland spar, muscovite, amazonite, halite, sphalerite, galena, scheelite, etc.

The relative rarity of finding such inclusions in endogenetic minerals is caused by the high geochemical mobility of hydrocarbons, that sharply decreases the possibility of trapping and conserving them during the mineral crystallization process. Therefore, the investigation of bitumens in minerals of hydrothermal origin as solid, liquid and gaseous phases hermetically closed in inclusions is of great scientific value.

Thermometric and cryometric investigations of hydrocarbon, petroleum, bitumen, and anthraxolite in inclusions of endogenetic minerals made by the author, revealed phase transformations of hydrocarbon compounds at various temps. and the possibility of their occurrence in mineral-forming solutions.

A first classification of hydrocarbon inclusions is presented, based on phase composition, with the inclusions divided into 2 groups, 10 sub-groups and 14 varieties:

Classification of hydrocarbons, petroleum and bitumens inclusions in endogenetic minerals depending on phase composition



See notes next page

Note: A - amorphous, L - liquid, C - crystal, p - petroleum, b - bitumens, hc - hydrocarbons, w - water phase, pa - paraffin, x - gas mixture, e - easily soluble. (Author's abstract).

MEL'NIKOV, F.P., 1974, Inclusions of oil and bitumens in rock crystal from Aldan (abst.): Internat. Assoc. on the Genesis of Ore Deposits, Fourth Symposium, Varna, Sept., 1974, Abstracts of Papers: Sofia, IAGOD, p. 260-261 (in Russian; translation courtesy A. Kozlowski). Author at Moscow State Univ., Moscow, USSR.

Dep. of rock crystal is connected with Archean quartzites. Quartz crystal (10cm long x 4cm diam.) had P bitumen incs. $\leq$0.1 mm, parallel to prism faces, with elongated, flattened or isometric shape. Phase characteristics: (number of phases in parentheses)

1. Light-brown liquid + gas (2); 2. Light-brown liquid + dark-brown solid + gas (3); 3. Colorless liquid + dark solids with angular shape; 4. Aqueous sol. + spherical droplets of light-brown liquid; 5. Colorless liquid + ligth-brown liquid + dark-brown liquid + gas, phase boundaries distinct; 6. Aqueous sol. + easily-soluble salt + droplets of oil + brown solid + gas (polyphase); 7. Dark or brown granular substance.

Oil-like substance has blue luminescence. In zone of bituminous ins. solid incs of specularite were found. Throughout the volume of crystal numerous P. and PS. incs. were found, and thermometric and cryometric studies made. (Author's abstract modified by A.K.)

MEL'NIKOV, F.P., and POLYANSKIY, Ye.V., 1973, Temperature zoning of tungsten deposits in Transbaikal'ye: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 268-269 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Moscow Univ.

Authors discuss T-zoning by analogy with well-known mineralization zoning classification of V.I. Smirnov, using the tungsten deposits of Transbaikal'ye as examples.

In rare-metal zone of Transbaikal'ye, occurring in all regions from SW to NE, the following types of deposits are known: quartz greisen, complex quartz-molybdenite-wolframite, and quartz-wolframite-sulfide. For all types a relatively narrow T interval of origin of W mineralization (350-280°C) is characteristic. Greisen deposits have the highest T of origin and vein deposits the lowest.

T-zoning of the rare metal zone is characterized by similar values in all regions. T-zoning varies from district to district. In one case (Khangilay-Shilinskiy) no T differences are seen in the regular change of mineral associations from parent intrusion to outside. In others (Dzhida, Bom-Gorkhon) distinct changes in T may be seen with change of associations. Most distinct is the T-zoning of the ore bodies (here exemplified by Bom-Gorkhon deposit). The main ore body of this deposit is a quartz-hübnerite-sulfide vein of uneven thickness, known for 2.6 km on the surface and 0.7 km down dip. Formation of the ore took place in one period of mineralization, divided into 3 stages: quartz-pyrite-hübnerite (T_H 380-290, T_D 480-520°C for quartz), quartz-sulfide (T_H 254-170, T_D 400-460°C) and barren quartz (T_H 178-112, T_D 260-320°C). The one period of mineralization is expressed by a continuous sequence of T_H of inclusions in various minerals at T 380-100°C. Horizontal T-zoning of the body is expressed by regular changes of T_H and T_D of inclusions in minerals of each of three stages of mineralization. Distribution of ore minerals follows the same sequence. Vertical T-zoning at the deposit is not distinct, although with increasing depth the role of minerals of the middle stage increases significantly.

T-zoning is distinct within the thickness of the vein; the outer parts of the vein have T_H significantly lower than in the central part. (Authors' abstract, abbreviated by A.K.)

MEL'NIKOV, F.P., and POLYANSKII, E.V., 1974, Genetic relations between rare-metal ore formations and acid intrusive magmatism within Bom-Gorkhon ore field (Transbaikalia), determined by thermo-baro-geochemical techniques (extended abst.), in Metallization associated with acid magmatism, v. 1, p. 275-277, ed. M. Stemprok: Prague, Geological Survey (a volume of papers presented at the MAWAM Symposium, Karlovy Vary, Czechoslovakia, Oct. 1974) (in English). Authors at Moscow Univ., Moscow, USSR.

Solidified melt incs. in the first-stage rocks have T_H between 1020 and 930°C, and P 1.5-1.3 kbars. Newly-formed microcline contains two-phase fluid incs. only, with T estimated to be 400-320°C, at the same P. The source of these solutions was determined by decrep. studies of the rocks of the massif and the neighboring Paleozoic granitoids. This study revealed a circular aureole around the leucocratic granite body, with decrep. activity decreasing outward.

The second-phase granites have solidified melt incs., with T_H 1050-950°C. Dikes at this stage have 3 types of incs. in addition to melt incs.: crystal-fluid incs. (850-500°C), polyphase liquid incs. of highly concentrated solutions (420-350°C,) and two-phase fluid incs. (50-60% vapor; T_H 380-300°C). H_2O-CO_2 incs. from the dikes show P 0.95 to 1.1 kbars.

The first assoc. of quartz-pyrite-hübnerite formed at 395-255°C and 0.96-0.86 kbars, with hübnerite crystallizing at 295-255°C. Then the quartz-sulphide (>20 minerals) formed at 270-185°C and 0.6-0.3 kbars. Last, fluorite-calcite crystallized at 0.1 kbars and 180 to 100°C. (Modified by ER from the authors' abstract.)

MELTON, C.E., and GIARDINI, A.A., 1974, The composition and significance of gas released from natural diamonds from Africa and Brazil: Amer. Mineral., v. 59, p. 775-782. First author at Department of Chemistry, University of Georgia, Athens, Georgia 30602.

Anal. of the comp. of G incs. in ten samples of natural diamonds have been made by mass spectrometric techniques. The P of S nature of the incs. was not det. with certainty. Anal. were made by crushing the diamonds in the high vacuum inlet system of a research mass spectrometer. The gases observed were comp. of C, H, O, N, and Ar atoms. Water was the most abundant gas, followed in decreasing abundance by H, CO_2, CH_4, CO, N, Ar, ethylene, ethyl alcohol, butene, and O. By generalizing from the results and assuming the incs. to be P, some suggestions are made which specify conds. under which natural diamonds may have been formed. A model consisting of reactions of H-C-O atoms is given as a possible explanation for the observed gas. (Authors' abstract)

MICHEELSEN, Harry, 1974, In situ measurements of the refractive indices of liquid and gaseous inclusions in minerals (abst.): Internat. Mineral. Assoc. Ninth Gen. Meeting, West Berlin and Regensburg, W. Germany, Collected Abstracts: West Berlin, German Mineralog. Soc., p. 31 (in English). Author at Copenhagen, Denmark.

The refractive indices of the gas, liquid and mineral contents of incs. in minerals can often be measured in situ by a conoscopic method on the ordinary polarizing microscope using a slightly modified condenser. The principle of the method is that a narrow beam of light can be totally reflected on the surface of an inclusion. This can be observed by means of the Bertrand lens. The incident beam is tilted away from the microscope axis until the limiting angle of total reflection is reached; if the angle of tilt becomes too large the reflection will disappear. The tilt is obtained by manual movement of a pinhole plate placed just on top of the fully opened aperture iris-diaphragm of the condenser. Some degree of training is needed to get reproducible determinations of the limiting angle. The angles of tilt of the incident beam and of the reflected beam are measured by means of a graduated ocular.

The ratio between the refractive index of the inc. and that of the host mineral is calculated from the two angles of tilt. Large single incs. with approximately plane surfaces give better results (± .002 to .012 depending on $\underline{n}$) than groups of small incs. (± .01 to .05). Solid-solid grain boundaries can also be measured in petrographic thin sections, but care is needed to distinguish between refraction and reflection.

Incs. in rock crystal from a quartz vein in alkali granite from the Ilimaussaq intrusion, South Greenland, show in this way the presence of several phases, here given as $\underline{n}_D$- values and a tentative identification:

$\underline{n}$ = 0.99 - air
$\underline{n}$ = 1.19 - liquid CO_2
$\underline{n}$ = 1.24 - light hydrocarbon liquid
$\underline{n}$ = 1.34 - cryolite
$\underline{n}$ = 1.367 - NaCl solution
$\underline{n}$ = 1.398 - mirabilite
$\underline{n}$ = 1.432 - fluorite
$\underline{n}$ = 1.452 - ?
$\underline{n}$ = 1.478 - 1.500 natrolite
$\underline{n}$ = 1.517 - immersion oil
$\underline{n}$ = 1.534 - albite
$\underline{n}$ = 1.543 - halite

(Author's abstract).

MIDDLEMOST, E.A.K., 1974, Petrogenetic model for the origin of carbonatites: Lithos, v. 7, p. 275-278. Author at Dept. Geol. and Geophy., Univ. of Sydney, Sydney. 2006, N.S.W., Australia.

The petrological significance and distribution of igneous carbonatites is discussed, and in particular the relationship that exists between carbonatites and volcanism in East Africa. Using a simple model of a carbonatite-nephelinite-ijolite volcanic complex it was discovered that all the peralkaline and carbonatitic rocks found in such a complex could be derived from a single primary nephelinitic magma. The origin of such a primary magma, and the subsequent evolution of carbonatitic submagmas, is examined. (Author's abstract)

MILLHOLLEN, G.L., 1974, Synthesis of scapolite under magmatic conditions: Amer. Mineral., v. 59, p. 618-620. Author at Dept. Geol., Univ. of S. Carolina, Columbia, S. Carolina 29208.

Scapolite was synthesized from a calcite-bearing nepheline syenite in the presence of H_2O-rich and CO_2-rich aqueous vapor phases in the melting interval at P 3-6 kbar. Electron-microprobe anal. of a scapolite formed at about 6 kbar and 900°C in the presence of a CO_2-rich aqueous vapor phase gives a structural formula of $NaCa_3Al_5Si_7O_{24}(CO_3)$($CO_3$ assigned arbitrarily). This formula is equivalent to 3 plagioclase (An_{67}) + 1 calcite. (Author's abstract)

MINČEVA-STEFANOVA, J., and PENCHEVA, E. N., 1974, A sphalerite-smithsonite paragenesis (abst.): Internat. Assoc. on the Genesis of Ore Deposits, Fourth Symposium, Varna, Sept. 1974, Abstracts of Papers: Sofia, IAGOD, p. 307-308 (in English). Authors at Geol. Institute, Sofia.

The Sedmochislenitsi deposit, containing Pb-Zn mineralization with bravoite, in calcareous Middle Triassic sediments, formed under near-surface conditions at low T. T_H of fluid incs. in quartz from the paragenesis is 70°C. (From the authors' abstract.)

MIRONOVA, O.F., NAUMOV, G.B, and FROLOV Ye.V., 1973, New possibilities of chromatographic determination of concentration of gas components in 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. 297-298 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Vernadskiy Inst. of Geochemistry and Analytical Chemistry of Acad. Sci. of USSR.

1. Existing methods of analysis of the gas components of gas-liquid inclusions unusally gives the ratios between the gases or their amount compared with the weight of mineral. It does not give information about the concentration of gases in primary mineral-forming solutions and does not permit evaluation of their concentration in time and space, i.e. to ascertain most completely the physico-chemistry of natural processes. Then, in addition to analysis of gases in inclusions, a similar determination of water (the main solvent) from the same portion of mineral is necessary.

2. Gas chromatography solves this problem by the use of the new polymer sorbent - "Polisorb: as filling of the chromatographic columns.

3. A method of opening of inclusions in glass ampoules was developed, as well as the methods of inserting the released gases into the chromatographic column by use of a especially constructed apparatus for breaking the ampoules.

4. A method of gas chromatography analysis was proposed. The method permits determination, from one portion of the mineral (about 0.5g) methane, CO_2, and water with sensivity 10^{-7}g, 2.4×10^{-6}g and 2.5×10^{-6}g respectively and with a relative error close to 5%.

5. New analyses of inclusions in quartz from Pamir are given, with a concentration of CH_4 of 0.14 mol/kg H_2O. The redox potential of the mineral-forming solution was calculated, based on these results. (Authors' abstract).

MIRONOVA, O.F., NAUMOV, V.B., and SALAZKIN, A.N., 1973, Investigations of gaseous-liquid inclusions bearing H_2S in quartz from E. Zabaikal'ye: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 177-178 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Vernadskiy Inst. of Geochemistry and Analytical Chemistry, Moscow.

1. During crushing of quartz from monomineral quartz veins of Klichkinskoe ore field, E. Zabaikal'ye, a strong smell of H_2S was noted.

2. Inclusions in quartz are very numerous: during decrepitation of 1g of quartz to 600°C, 70,000 of impulses were recorded. The main type of inclusion is the three-phase variety bearing 2 liquid phases and 1 gaseous phase. Disappearance of gas was noted at 20.5 - 51.8°C (±0.1°C), and the melting temp. was -56 to -67°C (±2°C). These data prove that the second liquid phase is the mixture of CO_2 with

H_2S (critical temp. of CO_2 = +31.04°C, and of H_2S +100.4°C; melting temps. -56.6 and -85.6°C respectively, full solubility of each in the other). T_H 236-325°C, at pressures 1150-1550 bars.

3. Chromatography was used for simultaneous determination of CH_4, H_2S, CO_2 and H_2O; the sensivity of method for H_2S was 2.5×10^{-6}g. Gas composition for investigated quartzes is as follows: N_2 and O_2, CH_4, CO_2, H_2S and H_2O, in calculated amounts of gases per 1000 g of H_2O: 880g of CO_2, 11g of CH_4, 9g of H_2S. Thermodynamic calculations from these data yield the partial pressures of the respective gases: 1350 atm of CO_2, 280 atm of CH_4, 7 atm of H_2S (and calculated partial pressure of H_2 = 0.2 atm).

4. On the basis of above data on CH_4 and CO_2 the equation for redox potential dependence on pH is as follows:

$$Eh = 0.0197 - 0.1137pH.$$

Graphic analysis proved that the solution is in an equilibrium state with pyrite at given T and real values of pH. (Authors' abstract, abbreviated by A.K.).

MITSYUK, V.M., 1974, Mechanism of transport and crystallization of silica under hydrothermal conditions, in Typomorphism of Ukrainian Quartz, edited by Ye. K. Lazarenko, Acad. Sci. Ukr. SSR: Kiev, Naukova Dumka Pub. House, p. 11-18 (in Russian; translation courtesy A. Kozlowski). Author at Inst. of Geochemistry and Physics of Minerals, Kiev, USSR.

The mechanism of dissolving of silica-bearing mins., transport of silica, pption. and xliz. of silica mins. is presented. Special attention was paid to intermediate forms (SiO_2-X_1, SiO_2-X_2, SiO_2-X_3, SiO_2-X_4, SiO_2-Y) and complexes (A.K.).

MOHAMMED, Lydie, and TOURET, Jacques, 1973, The granulite of Valjok (Northern Norway) (abst.): Sci. de la Terre, Réunion Annuelle, Paris 1973, p. 304 (in French; translation courtesy Chris Eastoe). Authors at Univ. de Nancy I, C.O. n°. 140, 54037 - Nancy-Cedex, France.

The cordierite-calcite assoc. in the granulites of Valjok, Lapland (Northern Norway) is a secondary meta. feature. The form. of the assoc. required a large quantity of CO_2 which was derived from the CO_2 -bearing fluid phase characteristic of the granulite facies. The CO_2 contained notable quantities of hydrocarbons. In addition to the usual granulite facies incs., two-phase (fluid + solid) incs. were observed; their comp. is unknown and their behaviour is exceptional.

The blasto-mylonitic texture of the quartz from the granulites arises from the superposition of a late-stage deformation onto a phase of migmatization which had already reached granulite facies conditions. (Authors' abstract considerably shortened)

MOORE, J.N., and KERRICK, D.M., 1974, Mixed-volatile equilibria in calcareous rocks of two contact aureoles in the western U.S. (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 6, no. 7, p 875. Authors at Department of Geosciences, The Pennsylvania State University, University Park, Pennsylvania 16802.

Progressive metamorphism of siliceous dolomites in the aureole of the Alta Stock, Utah, has resulted in the successive appearance of talc, tremolite, diopside, fosterite, and periclase. Isobarically univariant assemblages are common, suggesting that the composition of the fluid phase was buffered by the reactions. Reactions resulted in an overall increase in X_{CO_2} through the forsterite zone. Abrupt increase in X_{H_2O} upon entering the periclase zone probably reflects influx of H_2O from the pluton - the presence of the metasomatic phases ludwigite and vesuvianite within the periclase zone is compatible with this conclusion. Electron probe analysis of major phases indicates equilibria can be considered within the system $CaO-MgO-SiO_2-H_2O-CO_2-F$, the molar F/F+OH ratio in tremolite ranging from .1-.4. $T-X_{CO_2}$ topologies at 2kb., corrected for the reduced activity of OH-tremolite, indicate approximate temperatures of 450°C for the tremolite isograd, 500°C for the diopside isograd, and a maximum of 540°C for the fosterite isograd.

Assemblages in interbedded calcareous pelite and impure limestone in the aureole of the Granite Peak stock, Montana, are interpreted with mixed-volatile equilibria in the system: $CaO-MgO-K_2O-FeO-SiO_2-Al_2O_3-CO_2-H_2O$. The common occurrence of K-feldspar + clinozoisite in both lithologies implies the presence of a H_2O-rich fluid, conflicting with Melson's (1966) conclusion regarding fluid composition. Furthermore, electron probe analysis shows significant solid solution of iron components in diopside and tremolite, requiring modification of $T-X_{CO_2}$ equilibria involving these phases in the system $CaO-MgO-SiO_2-CO_2-H_2O$ (cf. Melson, 1966). (Authors' abstract)

MOORE, W.J., and NASH, J.T., 1974a,(Hydrothermal biotite, fluid inclusions and sericitic alteration at porphyry copper deposit in Utah (abst.)): Geol. Survey Research 1974, U.S. Geol. Sur. Prof. Paper 900, p. 1. See next item

MOORE, W.J., and NASH, J.T., 1974b,Alteration and fluid inclusion studies of the porphyry copper ore body at Bingham, Utah: Econ. Geol., v. 69, p. 631-645. First author at U.S. Geol. Survey, Menlo Park, Calif.

Distribution patterns for biotitic alteration, sericitic alteration, and distinctive fluid-inc. types in igneous host rocks of the porphyry copper ore body at Bingham, Utah, have been det. by petrographic exam. of ∿300 samples. These patterns are related to differences in original rock comp., variations in physical-chem. conds. during periods of intrusion and min., and spatial position within the ore body.

The distribution of biotitic (K-silicate) alt. assemb. and high-salinity fluid incs. generally follows the crudely triangular form of the disseminated copper ore zone. Variations in abundance of hydrothermal biotite are attributed to differences in original mafic min. content of the igneous host rocks. Biotitic alt. and initial copper min. were accomplished by high-salinity fluids conc. during final xliz. of the monzonitic parent magma; genetic continuity between magmatic and hydrothermal stages is indicated.

Pervasive sericitic alt. of plagioclase is confined to rocks in the northern one-third of the Bingham stock; a subzone of argillic alteration in the north-central part of the ore body occurs within the broader area of sericitic alt. Fluids responsible for sericitic and argillic alt. were channeled by a broad zone of NE-trending fractures.

Hydrothermal mins. and high-salinity fluid incs. occur within a large volume of shattered rock. Boiling of fluids during xliz. of the aplitic porphyry may account for the shattering. Sericitic (and argillic) alt. were apparently superimposed on the earlier biotitic assemb. as the hydrothermal system cooled. Cooling and hydrolytic alt. were promoted by progressive introduction of meteoric waters. The many generations of incs. trapped from boiling fluids in the T range 400° to 600°C suggest that the system was recharged repeatedly during the period of min.

Estimated fluid of ~800 bars in the early stages of min. correspond to a lithostatic load of about 3 km; Ps were even lower (<200 bars) in the later stages and were probably controlled by hydrostatic conditions. (Authors' abstract)

MOROZOV, S.A., ALIDODOV, B.A., AND ISHAN-SHO, G.A.,1973, Physicochemical conditions of origin of rare metal deposits in Tadzhikistan: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 69-71 (in Russian, translation through the courtesy of A. Kozlowski) Authors at Geological Inst. of Academy of Sciences of Tadzhikistan SSR.

1. In Tadzhikistan the following rare metal (RM) ores are known: Au, Ag, Mo, W, Sn, Sb, and Hg. Those metals occur in complex deposits and for that reason the ascertaining of the thermodynamic parameters of ores formation is of great value.

2. Native gold formation took place from hydrothermal solutions of 3 geological ages: Middle Carboniferous (N Tadzhikistan), Permo-Triassic (N and Central Tadzhikistan) and Alpine (Pamir). In N Tadzhikistan gold is connected with quartz-carbonate and quartz-sulfide veins, formed at temp. of 400-360-300°C. In Central Tadzhikistan gold is associated with products of 2 mineralization stages: earlier-pyrite-arsenopyrite and later-tetrahedrite-chalcopyrite (T = 380-250°C, P = 1000-800 atm). At Pamir the sulfide-Au-Ag mineralization formed at T = 250-160°C and P = 500 atm, and less. It overlaps siderite-ankerite bodies and carbonate-quartz veins under high-temp. and high-pressure conditions (T = 450-400°C, P = 2000-1500 atm.).

3. Scheelite-molybdenite deposits of N Tadzhikistan are connected with infiltration Ca-skarns. True skarn minerals formed at 650-500°C from supercritical gas solutions. W and Mo ores formed at temp. range 480-210°C and 750-350 atm from liquid F-Cl-Si solutions, with Ca, Na, W, Mo, Fe and the gases H_2, CO_2, and H_2.

Sn-W and Sn ore mineralizations in Central Tadzhikistan formed at 450-300°C and P lower than 750 atm by HCO_3^--F-Cl solutions with the following cations: Ca, Na, W, and Sn.

4. Hg-Sb ores in Tadzhikistan formed in Permo-Triassic (Central Tadzhikistan) and Alpine periods (Pamir). In both regions the mineralization occurred in 3 stages under the following conditions: pre-ore 360-250°C and 700-300 atm, 1st ore-bearing 250-150°C and 500-100 atm. 2nd ore-bearing 150-50°C and 250-100 atm. The main ore state formed at 250-150°C. Ore-forming solutions were acid and rich in F and Cl. (Authors' abstract).

MOROZOV, S.A., MOGAROVSKIY, V.V., AVER'YANOV, G.S. and FAYZIEV, A.R., 1974, Thermobarogeochemical studies of Alpine age mineralization of Pamir, Afgano-Tadzhikskaya depression and S. Tyan' Shan' (Tadzhikistan) (abst.): Internat. Assoc. on the Genesis of Ore Deposits, Fourth Symposium, Varna, Sept., 1974, Abstracts of Papers: Sofia, IAGOD, p. 262-263 (in Russian; translation courtesy A. Kozlowski). Authors at Geol. Inst. of Acad. Sci. of Tadzh. SSR, Dushanbe.

1. (...)

2. Sn ore deps. have been formed at T = 400-250°C and P = 1.0-0.8 Kbar, cassiterite always xlized. at 400-300°C and other mins. (including sulfides) at 300-250°C. Arsenopyrite-scheelite-gold deposits - at 400-300°C and 1.5-0.8 Kbar, fluorite-sulfide-gold + Ag - at 250-150°C and $P \leqslant 0.5$ Kbar, quartz-molybdenite - 350-300°C -

anhydrite-sulfide - 370-280°C and P = 1 Kbar, polymetallic (pyrargyrite, freibergite, argentite) - at T = 300-220°C, tetrahedrite + Ag and fluorite-hematite + Ag forms. - at T = 250-180°C and P <0.2 Kbar; Pb-Zn + Tl deps. - at 150-80°C, Hg-Sb deps. - at 270-110°C, Sb-Hg-tetrahedrite, Sb-Hg-polymetallic and Sb depos. - essentially at T = 270-200°C, Hg form. - at T = 180-100°C.

3. Hydrothermal deps. of rock xl. formed at T = 400-100°C and P = 1.0-0.3 Kbar; boron-silicate min. (axinite-datolite-danburite) formed at 400-250°C and ores (calcite veins bearing chalcopyrite and sphalerite) at T = 220-180°C; celestite, sulfide-celestite and quartz-celestite-calcite veins and lenses inside Palaeogene limestones - at T = 200-100°C and P = 0.8-0.3 Kbar; fluorite deposits - at T = 230-60°C, but for fluorite at Sn, Au and other deposits T = 380-220°C and P = 0.7-0.3 Kbars are characteristic.

4. Min.-form. sols. bear in addition to ore elements, Na, K, Ca, Mg, Cl, SO_4, F, B, CO_2 (the latter sometimes in major amounts).

5. At the studied area deps. having non-magmatic sources of ore substance and not connected with subcrustal magmatism give T ≤250-200°C and P = 0.4-0.1 Kbar. Deps. of Pamir connected with granitoid magmas formed at higher P and T: 1.0-0.5 Kbar and 400-200°C. (Authors' abstract, shortened by A.K.)

TEMPERATURES OF ENDOGENIC DEPOSITS IN TADZIKISTAN

Main products	Early ore (pre-ore) assoc.		Late ore assoc.	
	Main mins.	T of form. (°C)	Main mins.	T of form. (°C)
Rock crystal	Quartz (in veins)	450-350	Rock crystal	300-200
Celestite	---	---	Celestite (quartz, sulphides Pb, Zn, Fe)	200-100
Fluorite	---	---	Fluorite, sulphides, barite, calcite, quartz	250-50
Sn	Cassiterite, tourmaline, quartz	450-300	---	---
W, Sn (Cu, Zn)*	Scheelite, cassiterite	450-300	Pyrrhotite, chalcopyrite, sphalerite	300-200
W*	Scheelite, calcite, andradite	350-250	Scheelite, scapolite, albite, sulphides	250-200
Au, Cu, As*	Pyrite, arsenopyrite, with gold, quartz	450-300	Chalcopyrite, pyrrhotite, tetrahedrite, bismuthinite	300-250
Hg, Sb (As, Au)	Arsenopyrite with gold, chalcopyrite	400-300	Stibnite, cinnabar, calcite, fluorite	250-50
Sb, Hg (Zeravshan-Hissar)	---	---	Cinnabar, stibnite, calcite, fluorite, quartz	250-50
Hg, Sb (Pamirs)	---	---	Cinnabar, stibnite, carbonates, quartz (sulphides Pb, Zn, Cu)	200-50

* Pre-ore skarn assoc. is neglected. (cont.)

Au, Ag	Quartz, siderite, ankerite	450-400	Native gold, pyrargyrite, fluorite	250-150
Pb, Zn	Sphalerite, galenite, chalcopyrite	500-350	Sphalerite, galenite, marcasite	350-80

MOROZOV, S.A., MOGAROVSKII, V.V., AVER'YANOV, G.S., and FAIZIEV, A.R., 1974, Thermodynamic and chemical conditions of formation of endogenic deposits in southern Tien Shan and Pamirs (Tadzhikistan): Akad. Nauk SSSR Doklady, v. 217, no. 2, p. 449-451 (in Russian; see Translations). Authors at Inst. of Geology, Dushanbe, USSR.

MOTTL, M.J., CORR, R.F., and HOLLAND, H.D., 1974, Chemical exchange between sea water and mid-ocean ridge basalt during hydrothermal alteration: An experimental study (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 6, no. 7, p. 879-880. Authors at Department of Geological Sciences, Harvard University, Cambridge, Mass. 02138.

Powdered fresh mid-ocean ridge basalt of varying crystallinity has been reacted with sea water at 200-500°C and 500-1000 bars in sealed gold capsules for 5 to 20 months. Rock/sea water wt. ratios of 1:1 to 1:3 were used. On quenching the solutions were analyzed for Na, Mg, Ca, K, Sr, Fe, Mn, SiO_2, CO_2, and Cl, and for minor elements (by emission spectography) and Cl by titration. These results set limits on the volume of sea water which can circulate convectively through the crust at mid-ocean ridge crests, and indicate that chemical exchange between heated sea water and basalt during hydrothermal alteration within the crust may contribute significantly to the geochemical budgets of several elements for the oceans.

Hydrothermal leaching of transition metals from basalt can account in major part for the layer of metal-rich sediment which overlies basalt over much of the ocean floor. (Authors' abstract, abbreviated)

MUEHLENBACHS, K. and KUSHIRO, I., 1974, Oxygen isotope exchange and equilibrium of silicates with CO_2 or O_2: Carnegie Institution of Washington Yearbook 73, p. 232-240, (pub. 1974).

MUFFLER, L.J.P., and BARGAR, K.E., 1974, Hydrothermal alteration of rhyolitic ash-flow tuff in the geothermal system at Mud Volcano, Yellowstone National Park, USA (abst.): Internat. Symp. on Water-Rock Interaction, Czechoslovakia, Sept. 9-17, 1974, Abstracts: Prague, Geological Survey, p. 52 (in English). Authors at U.S. Geol. Surv., Menlo Park, Cal. 94025, USA.

MUNOZ, J.L., 1974, Measurement of quenched fluoride in synthetic hydrothermal fluids (abs.): Geol. Soc. Amer. Abstracts with Programs, v. 6, no. 7, p. 882. Author at Department of Geological Sciences, University of Colorado, Boulder, Colorado 80302.

Aqueous solutions equilibrated with the anorthite-fluorite-sillimanite-quartz fluorine buffer between 300° and 700° and at pressures of 1 and 2 kb have been investigated using microanalytical methods.

At 700°C, measured fluoride values are in approximate agreement with calculated molalities obtained assuming HF is the only fluoride species, but they deviate increasingly toward higher values at lower temperatures. This behavior suggests that Al-F complexing is negligible at high temperature but becomes increasingly important at lower temperatures. Aluminum in solution ranges from 40 to 1,500 ppm (increasing with temperature); these values are 5 to 10 times greater than those measured in the fluorite-free anorthite-sillimanite-quartz-fluid assemblage.

These experiments can be used to model the behavior of fluorine in high-temperature aqueous fluids and to set limits on the fluorine contents of fluids that equilibrated with fluorite. (Author's abstract, abbreviated).

MURR, L.E., 1974, Ordered lattice defects in colored fluorite: direct observations: Science, v. 183, p. 206-208. Author at Dept. Metal. and Mat. Eng., New Mexico Inst. Min. and Tech., Socorro 87801

Ordered arrays of defect aggregates in the (111) planes of natural fluorite have been observed by transmission electron microscopy. The intense blue coloration observed in corresponding sample areas after 200-kilovolt electron microscopy confirms the conclusion that these are color-center aggregates and, conversely, that color centers are primarily responsible for fluorite coloration. (Author's abstract)

MURRAY, D.P., 1974, Formation of epidote in calc-silicates from east of the Canopus Valley fault, Reading Prong, New York (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 6, no. 7, Author at Department of Geology, Amherst College, Amherst, Massachusetts 01002.

The environment of formation is interpreted in terms of X_{CO_2} of the adjacent fluid. Epidote compositions indicate that T_{max} attained during metamorphism in this area was 625°C. (ER)

MUSHENKO, L.V., and RAZMAKHNINA, E.M., 1974, On the formation of quartz-greisen and silicate-sulphide tin deposits in Sikhote-Alin, Primore, USSR (extended abst.), in Metallization associated with acid magmatism, v. 1, p. 338-341, ed. M. Stemprok: Prague, Geological Survey (a volume of papers presented at the MAWAM Symposium, Karlovy Vary, Czechoslovakia, Oct. 1974) (in English). First author at Far-East Sci. Center, Acad. Sci., Vladivostok, USSR.

T_H of incs. in quartz of granodiorite, and other geothermometers, show early biotitization and recrystallization of biotite (biotite 2M) + deanortitization of plagioclases at 700-550°C, then K-feldspathization at 600-520°C, and silicification at 450-400°C. In tectonically active zones, granitized rocks of the described massifs were affected by albitization, late biotitization (biotite IM), K-feldspathization, muscovitization and silicification which took place at 400° to 100°C. (Modified by ER from authors' abstract.)

MYAZ', N.I., and KORNILOV, V.F., 1973, On prospecting possibilities of decrepitometry (exemplified by pegmatites of Volhyn); Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 255-257 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at L'vov Univ.

1. Determination of decrepitation background of varieties of granite. For each chosen variety the average decrepitation was determined in T interval 100-600°C (γ_1 - 14.3, γ_2 - 17.9, γ_3 -36.0 impulses, the latter variety is characterized on basis of a small number of samples), although decrepitation varies in a wide range of 2-188 impulses. Use of Student's criterion showed the lack of significant differences in the average decrepitation of all var-

ieties of granite. By application of Kolmogorov's-Smirnov's criterion, functions of distribution of impulse number in intervals of 100°C were compared. Varieties of granites, among them γ_1 and γ_2, the contact zone between which controls the localization of pegmatites (V.T. Klochkov and others, 1968), did not differ at a significance level of 0.05, thus does not permit application of decrepitometry for mapping of granite varieties.

2. Decrepitometric mapping of one part of the deposit. Samples were taken at some levels of boreholes, drilled in a net 20 x 25 m and 40 x 50 m, and the number of impulses from 2 to 2000 determined (heating to 600°C). Average value of background - 18 impulses, minimal value of anomaly - 62 impulses. Isolines for each 20 impulses were drawn on maps (...). For better distinction of anomalies connected with pegmatites, from anomalies due to later hydrothermal alteration of granites, maps were made in various T intervals, e.g. 400-600, 100-400°C, etc. Known pegmatites are characterized by distinct anomalies. By comparison, possible regions for finding of blind pegmatitic bodies were chosen.

3. Investigation of aureoles of impregnation of pegmatites was made by sampling of boreholes in areas of mining and detailed prospecting (samples taken each 5 m). Aureoles of impregnation around chamber pegmatites, established on the basis of minimal anomalous decrepitation activity, have irregular, ellipse-like shape, depending on size, morphology and, seemingly, on mineral composition of pegmatitic bodies.

As indicated by preliminary data, size of aureoles above pegmatite ranges from 15 to 30 m, and around it (in horizontal plane) - 7-25 m. Inside the aureole inner and outer zones of high decrepitation activity are interrupted by a zone of lowered activity (in some cases the zonality is poorly expressed). Additional investigations of impregnation around pegmatites of various industrial productivity will provide prospecting-evaluation criteria for blind (hidden) pegmatitic bodies. (Author's abstract).

MYSEN, B.O. and SEITZ, M.G., 1974, Solubility of CO_2 in DI-CO_2 and AB-CO_2-H_2O-Xe liquids at high P and T (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 6, no. 7, p. 884-885. Author at Geophysical Laboratory, 2801 Upton St., N.W., Washington, D.C. 20008.

Fission tracks from C^{14} are used to measure CO_2 solubility in silicate systems. The solubility of CO_2 in diopside melt increases linearly from 1.4 to 4.8 wt% between 5 and 30 kb at 1625°C. The solubility increases with increasing temperature at 20 kb. This effect is less pronounced at lower pressure. The solubility of CO_2 is less in albite than in diopside liquid. The solubility decreases with addition of Xe and increases with addition of H_2O to the vapor. (Authors' abstract, abbreviated).

MYSEN, B.O., SEITZ, M.G., and FRANTZ, J.D., 1974, Measurements of the solubility of carbon dioxide in silicate melts utilizing maps of carbon-14 beta activity: Carnegie Institution of Washington Yearbook 73, p. 224-226, (pub. 1974).

NABOKO, S.I., 1974, Criteria of the origin of hydrothermal solutions and propylitization in regions of active volcanism (abst.): Internat. Symp. on Water-Rock Interaction, Czechoslovakia, Sept. 9-17, 1974, Abstracts: Prague, Geological Survey, p. 9 (in English). Author at Institut vulkanologii AN SSSR, Petropavlovsk - Kamchatskii, USSR.

NAIBORODIN, V.I. and GONCHAROV, V.I., 1970, Temperature during the formation of Agatovskoye gold-silver deposit: Geol. Rudnykh Mestor., v. 12, no. 6, p. 46-51 (in Russian; abstract in Econ. Geol., v. 69, 1974, p. 730). Note — a brief abstract was given in Fluid Inclusion Research - Proc. of COFFI, v. 3, 1970, p. 48.

The deposit of Agatovskoye is of the gold-sphalerite-galena type and belongs to the volcanic class of hydrothermal deposits. It is an area underlain by volcanic rocks of Cretaceous and Paleogene age, which are associated with the linear Maltano-Ol'skaya depression in the southern part of the Okhotsk-Chukot volcanic belt. The mineralization is in veins controlled by tear faults striking northwest and northsouth. The ore minerals are represented by galena, sphalerite, chalcopyrite, pyrite, and marcasite. Pyrrhotite, arsenopyrite, tetrahedrite, cubanite, argentite, pyrargyite, and gold (electrum of 520-550 fineness) are also present. The main gangue minerals are quartz, calcite, and dolomite. Siderite, rhodochrosite, kutnahorite, hydromica, chlorite, adularia, and barite are of lesser importance. The average ratio of gold to silver in ore is 0.2. The average content of sulfides in the veins is 10 to 15 percent. The veins are of four types: (1) quartz, (2) carbonate-quartz, (3) sulfide-carbonate-quartz, and (4) sulfide-carbonate. Five stages of mineralization are distinguished: (1) metacolloidal quartz stage, (2) gold-sphalerite-galena-quartz stage, (3) gold-marcasite-calcite stage, (4) sulfide-carbonate stage, and (5) barite-opal-chalcedony stage. The study of gaseous-liquid incs. indicates that the Agatovskoye deposit formed within a temperature range of 365° to as low as 50°C. The deposition of ore minerals took place between 300° and 200°C. Native gold was deposited between 250° and 230°C. The temperature changed sharply during the process of mineralization. It was accompanied by temperature inversions of 100° to 150°C between the stages. These conditions are explained by internal changes of thermodynamic conditions, mixing of high temperature fluids with meteoric water, and by the effect of the temperature field of subvolcanic intrusions.

NAIBORODIN, V.I. and SIDOROV, A.A., 1973, Some properties of the dynamics of the mineral-forming process in volcanic Au-Ag deposits: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 49-50 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at NE Commission of Scientific-Research Institute of Far-East Scientific Center of Academy of Sciences USSR, Magadan.

Au-Ag deposits occur in structures of the Okhotsk-Chukotka volcanic zone, accompanied by various metasomatites of subvolcanic depth facies. Most of the deposits are connected paragenetically with zones of hydrothermal quartzites and hydromica-quartz rocks. Multiple (rhythmic) deposition of low-sulfide, adularia-quartz ore vein mineral associations, forming the fine-grain thin-layered aggregates, is characteristic. Widespread development of collomorphic and metacolloidal as well as deformation structures testifies to structurally opened system at low depths.

Au-Ag veins were formed mainly at moderate and high temp. (up to 450°C), and temps. lower than 170-150°C are not characteristic. Sharp pulsations occurred, even during one stage, with ranges as wide as 100-200°C and more. Productive mineral associations (bearing electrum, Sb-sulfides of silver, tetrahedrites etc.) have crystallized at 250-170°C.

According to experimental data (A.N. Dudarev, V.D. Pampura and others) the formation of hydrothermal quartzites is associated with significant exothermal effect, resulting in formation of a long-lasting thermal anomaly (up to 400-500°C), the intensity and duration of which is supported also by a strong thermal stream, usual in paleovolcanic regions. The thermal field of metasomatites surrounding the ores (pre-ore metasomatities) promoted the existence for long periods of the high-temperature hydrothermal solutions forming Au-Ag ores. The essential factor causing precipitation of relatively low-temperature productive associations was not temperature decrease of the solutions, as in plutonic deposits (cf. L.N. Ovchinnikov, etc.), but pressure decrease as the result of periodically repeating formation of fractures. In some deposits variations of pressure in the range 200 - 20 atm were ascertained by thermobarogeochemical methods. That process was accompanied by intensive boiling of superheated hydrothermal solutions with formation of coagulating colloidal systems. Temperature drop only follows the adiabatic expansion of ore-forming hydrothermal system. Analogous decreases of temp. were ascertained in the hydrothermal systems of recent volcanic areas (S.I. Naboko). Increase of solution temp. under stabilized conditions (after each impulse of fracture forming) is caused by heat exchange with heated wall rocks and was accompanied by partial dissolution and redeposition of mineral aggregations, forming numerous thin veinlets. (Authors' abstract).

NAKAMURA, Yasuo, 1974a, The system Fe_2SiO_4-$KAlSi_2O_6$-SiO_2 at 15 kbar: Carnegie Institution of Washington Yearbook 73, p. 352-354 (pub. 1974).

Pressure expands the field of silica at the expense of fayalite and the field of immiscibility, if any, is greatly reduced at 15 kbar.

NAKAMURA, Yasuo, 1974b, Nature of H_2O-rich fluid in the systems SiO_2-H_2O-H_2 and Mg_2SiO_4-SiO_2-H_2O at 15 kb (abst): Geol. Soc. Amer. Abstracts with Programs, v. 6, no. 7, p. 885. Author at Geophysical Laboratory, Carnegie Institution of Washington 2801 Upton Street, N.W., Washington, D.C. 20008.

The melting temperature of quartz in the system SiO_2-H_2O varies continuously with H_2O content because of the supercritical nature of the SiO_2-H_2O fluid at 15 kb. Fluids with 86, 63, and 22 wt % H_2O coexist with quartz at 900, 1000, and 1100°C, respectively. Adding H_2 to the system by the use of highly reducing oxygen buffer results in the separation of gas and liquid phases. Quartz melts at 1090°C in the presence of the H_2O-H_2 gas mixture controlled by IW buffer. The SiO_2 contents of the liquid at 1090°C is 76 wt %. The compositions of gas phase in the system Mg_2SiO_4-SiO_2-H_2O were determined from isothermal sections on the basis of phase assemblages. The SiO_2 contents of the gas phase coexisting with forsterite and enstatite are 18 and 21 wt % at 1280 and 1310°C, respectively. Those of the gas phase coexisting with enstatite and liquid are 38 and 28 wt % at 1280 and 1310°C, respectively. The determined SiO_2 contents in the gas phase raise a possibility that the upward gaseous transportation of SiO_2 contributed to the mantle-crust differentiation to some extent. As the H_2 content in the gas phase increases (fO_2 decreases), the SiO_2 content in the gas phase will be reduced. The possible upward gaseous transportation of SiO_2 in the mantle may thus be more effective under high fO_2 than under low fO_2. In addition, production of quartz-normative magmas upon partial melting of hydrous mantle peridotite may be less favorable under low fO_2. (Author's abstract)

NASH, J.T., and COX, D.P., 1974, (Fluid inclusion petrography of quartz from a porphyry copper zone in Puerto Rico) (abst.)): Geol. Survey Research 1974, U.S. Geol. Sur. Prof. Paper 900, p. 1.

Study of thin sections showed fluid incs. in quartz coincides with areas of higher grade disseminated copper min. at Sapo Alegre, Puerto Rico. The halite-bearing incs. are most abundant in a biotite-chlorite zone of alt. in quartz diorite porphyry. Lateritic weathering hampers recognition of the original lithology and hydrothermal alt. in most areas, but fluid incs. can be readily studied in residual quartz in soils. In Puerto Rico, a study of residual quartz may lead to recognition of disseminated copper ore bodies not detectable at the surface by standard geologic and geochemical methods. (Author's abstract)

NASH, J.T. and CUNNINGHAM, C.G. Jr., 1974, Fluid-inclusion studies of the porphyry copper deposit at Bagdad, Arizona: Jour. Research U.S. Geol. Survey, v. 2, no. 1, p. 31-34. Authors at U.S. Geol. Survey, Denver, Colorado 80225

Quartz in chalcopyrite- and molybdenite-bearing veins at Bagdad contains two predominant types of fluid inclusions: one has moderate salinity (about 8 percent) and filling temperatures in the range from 302° to 373°C; the other has high salinity (30-35 percent) and filling temperatures of 223° to 310°C. Sparse gas-rich inclusions indicate brief periods of boiling. Fluid pressures deduced from fluid-inclusion data are approximately 150 bars; emplacement under about 6,000 ft of cover is suggested. Temperatures and salinities of ore fluids at Bagdad were significantly lower than in other studied porphyry copper deposits, indicating that chemically and physically diverse fluids affect mineralization in these deposits. (Authors' abstract.)

NAUGHTON, J.J., LEWIS, V.A., HAMMOND, Dale and NISHIMOTO, Daniel, 1974, The chemistry of sublimates collected directly from lava fountains at Kilauea Volcano, Hawaii: Geoch. Cosmo. Acta, v. 38, p. 1679-1690. First author at University of Hawaii, Honolulu, Hawaii 96822, U.S.A.

During 1970, it was occasionally feasible to collect sublimate from directly above the lava fountain in the crater of Mauna Ulu. The main components in the sublimate were, in order of decreasing concentration for the best sample, Na, Ca, Al, Fe, Mg, K, B, Si, Ti, Zn, H^+, NH_4^+, Cu, Ni in the form of sulfates, chlorides and fluorides. The thermodynamic data on such gas phases are reviewed. (ER)

NAUMOV, V.B., KHAKIMOV, A.Kh., and KHODAKOVSKY, I.L., 1974, On the solubility of carbon dioxide in concentrated chloride solutions at high temperatures and pressures: Geokhimiya, 1974, no. 1, p. 45-55 (in Russian). Authors at V.I. Vernadsky Inst. of Geochemistry and Analytical Chemistry, U.S.S.R. Academy of Sciences, Moscow and Moscow State University.

In quartz crystals from rock-crystal bearing veins of the Western Pamir singular multiphase incs. have been studied in which liquid CO_2 as well as some daughter minerals are found. Carbon dioxide concentration is equal to 80-140 g/1000 g H_2O, the concentration of chlorides 450-1400 g/1000 g H_2O. T_H is high (490-410°C) and pressures (2850-800 bar). A thermodynamical analysis of the reaction of CO_2 dissolution in pure water and aqueous solutions of sodium chloride has been carried out and values of carbon dioxide solubility in these solutions in a wide range of temperatures, pressures and ionic strength have been obtained. These data explain the high CO_2 solubility in concentrated chloride solutions.

(Authors' abstract)

NAUMOV, G.B., and KHODAKOVSKIY, I.L., 1972, Thermodynamic analysis of mineral formation factors for hydrothermal deposits: Geokhimiya, 1972, no. 12, p. 1561-1568 (in Russian; translated in Geochem. Internat., v , p. 1051-1056, 1973. Authors at Vernadskiy Inst. of Geochem. and Anal. Chem., Acad. Sci. USSR, Moscow.

A discussion of the theoretical bases for various ore depositional models. (ER)

NAUMOV, V.B. and POLYAKOV, A.I., 1974, Thermometric investigation of mineral inclusions of the basalt-rhyolite rock series of the Iceland rift zone: Geokhimiya, 1974, no. 5, p. 701-707 (in Russian). Authors at V.I. Vernadsky Inst. of Geochemistry and Analytical Chemistry, USSR Academy of Sciences, Moscow.

Thermometric investigations of primary incs. in phenocrysts of the Iceland magmatic rocks have been carried out. T_H is 1320-1170°C for plagioclase and clinopyroxene from basalts and 1200-900°C for K-Na feldspar and quartz from rhyolites and granophyres. The causes of the differences between the eutectic temperatures of the artifical systems and T_H are discussed. A conclusion about the volatile depletion of natural melts of acid composition is drawn. (Authors' abstract)

NAUMOV, V.B. and SALAZKIN, A.N., 1973, Thermometric investigation of melt inclusions in quartz phenocrysts of acid effusives from E. Transbaikal'ye: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 200 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Vernadskiy Inst. of Geochemistry and Analytical Chemistry, Moscow.

Over 500 primary melt inclusions in quartz phenocrysts were investigated from Upper Jurassic acid effusives of Tulukuevskaya Caldera (E. Transbaikal'ye). Quartz phenocrysts often are corroded and cataclased, hence quartz is a very early mineral. Dimensions of inclusions are 2 to 120 µm, and the phase composition is gas + glass or gas + glass + one or several crystals.

Thermometric investigations were made in a Pt-wound furnace using the quenching method. T of beginning of glass melting (T_B) = 470 - 700°C. Positive correlation between T_B and T_H was ascertained (...). Maximum T_H = 1260°C, minimum T_H = 910°C. The results obtained are as follows ($T_H \pm 10°C$; no. of incs. homog.): 1260-1180 (182), 1180-1100 (29), 1100-980 (216), 980-900 (37). (Authors' abstract, abbr. by AK).

NEKRASOV, I.Ya., 1973, Experimental studies of system MgO - CaO - B_2O_3-H_2O under hydrothermal conditions: *in* Contrib. to Physico-Chem. Petrology, V.A. Zharikov, et al., eds.: Moscow, "Nauka" Pub. House, v. 3, pp. 46-71 (in Russian; abstract courtesy A. Kozlowski).

High-T. part of system MgO-CaO-B_2O_3-H_2O and its two branches: MgO-B_2O_3-H_2O and CaO-B_2O_3-H_2O were invest. exper. at T = 200-700°C and B_2O_3 conc. in equil. sols. of 0.1-45 wt. %. In system MgO-B_2O_3-H_2O (ampule method) the fields of stability of periclase, brucite, cotoite $Mg_3(BO_3)_2$, suanite $Mg_2B_2O_5$, szaibelyite $Mg(OH)BO_2$ (= ascharite), boracite and tetraborates. Qual. P-M and qual. T - $C_{B_2O_3}$ diagrams were constructed, and curves of dehydration of szaibelyite and brucite at P = 0.5 - 2.5 kbar were presented. In system $MgO-CaO-B_2O_3-H_2O$ the equil. of kurchatovite ($CaMgB_2O_5$) with other borates of Ca and Mg were found. Qual. $T - C_{B_2O_3}$ diagram for T = 200-700°C and concs. of B_2O_3 in equil. sols. = 0.1-10% were constructed. Interpretation of exper. data was made to explain genesis of borates in endogenic deps. (Author's abstract)

NEKRASOV, I.Ya., and BORTNIKOV, N.S., 1974, The system $Pb-Sn-Sb-S-H_2O$ at 300-500°C and the genesis of the ores of "Bolivian" type (extended abst.), in Metallization associated with acid magmatism, v. 1, p. 280-283, ed. M. Stemprok: Prague, Geological Survey (a volume of papers presented at the MAWAM Symposium, Karlovy Vary, Czechoslovakia, Oct. 1974) (in English). Authors at Inst. Exper. Mineral., Moscow, USSR.

A study of Pb-Sn-Sb-S in chloride solutions with pH values ranging from 1 to 10 at T = 300-500°C. (ER)

NEKRASOV, I. Ya., and SIPAVINA, L.V., 1974, Phase relations of sulfides and oxides of tin and iron at 300-600°C: in Contrib. to Physico-Chem. Petrology, V.A. Zharikov, et al., eds.: Moscow, "Nauka" Pub. House, v. 4, pp. 146-161 (in Russian; abstract courtesy A. Kozlowski).

Exper. studies of system $Fe-Sn-S-H_2O$ in chloride sols. were made. For isobaric-isothermal sections of the system at T = 400°C, P = 1000 atm, with various mass ratios of solid components (m_k) and constant sol. vol. (= 9.2 cm^3), the one-, two-, and three-phase areas of xliz. were delineated for cassiterite, herzenbergite (SnS), ottemanite (Sn_2S_3), berndtite (SnS_2), magnetite, pyrite, pyrrhotite, and ortho-rhombic sulfur. Ranges of solub. of oxides and sulfides of Sn and Fe are also stated. (Authors' abstract shortened by A.K.).

NEVSKIY, V.A., TUROVSKIY, S.D., KOZLOVA, P.S., KIM, V.F., and TURCHINSKIY, V.P., 1974, Example of hypogenic zoning of ore mineralization at a rare-metal-polymetallic deposit: in: Zonality of hydrothermal ore deposits, G.A. Sokolov, ed.: Moscow, Izdat. "Nauka," v. 1, p. 267-275 (in Russian; abstract courtesy A. Kozlowski).

The deposit, containing Th, Be, TR, Pb and Zn, occurs in pre-Riphean gneisses, mica schists, and epidote-actinolite schists, cut by dikes of late Variscan diorites and fissure intrusives of subalkaline granite, and later by dikes of early aplites, small bodies of porphyritic or aplitic subalkaline granites, granophyres, late aplites, dikes of syenite-aplites and syenites, and the latest dikes of diabasic and dioritic porphyrites and lamprophyres. T_H and T_D for minerals of distinguished stages were determined as follows:

	Stage	Typical minerals	T, °C
I	Pegmatoid quartz	Quartz, cyrtolite, microcline, albite	500-600
	Quartz-muscovite-sericite	Quartz II, muscovite, sericite, pyrite, fluorite, monazite, ferrithorite, cassiterite	---
	Columbite-cyrtolite-albite	Albite, columbite, cyrtolite, beryl, microcline II, quartz III, fluorite III, ferrithorite III, cassiterite II	320-400: ab 350-380 c, ft, b 310-370, fl 325, qz 310-320
	Biotite-monazite	Biotite, monazite, orthoclase, molybdenite, quartz IV, fluorite IV, ferrithorite IV.	310-320

II	Ferrithorite-orthoclase	Biotite, orthoclase, ferrithorite, cassiterite, phenacite, malacon, rare earth carbonates, yttrium-fluorite, molybdenite, quartz V, fluorite V, tourmaline IV, xenotime II, arseno-pyrite III, pyrite IV (No min. specified)	270-280
	Sulfide-quartz	Quartz VI, galenite, sphalerite, chalcopyrite, pyrite, fluorite VI, malacon III, fluocerite II, yttrium-fluorite II	240-250
	Fluorite-calcite-quartz	Quartz VII, calcite II, fluorite VII	qz 190 ca 120-140

Note: I - associations formed before intrusion of subalkaline granites; II - associations formed after the intrusion; minerals used for determination of T_D or T_H are underlined.

NEWTON, R.C. and GOLDSMITH, J.R., 1974, Stability of the scapolite meionite ($3CaAl_2Si_2O_8 \cdot CaCO_3$) at high pressures (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 6, no. 7, p. 889. Authors at Department of the Geophysical Sciences, The University of Chicago, Chicago, Illinois 60637.

A study of the stability of meionite (to >1500°C at 20 kbar), from which it is concluded that CO_2 coming from the earth's interior will be captured by reaction with plagioclase and clinopyroxene. Scapolite has been noted in basic granulite inclusions from basaltic pipes in 3 continents. It seems probable that scapolite acts as a major storage site for CO_2 in the deep crust. (Authors' abstract, abbreviated.)

NIKITINA, Ye.I., SOTNIKOV, V.I., PROSKURYAKOV, A.A., ARKHIPENKO, D.K., and KRIVOPUTSKAYA, L.M., 1974, Maghemite from explosive breccias of Obkorondinskoe molybdenum deposit (E. Transbaikal'ye), in Minerals and parageneses of minerals of hydrothermal deposits: Leningrad, "Nauka" Publishing House, p. 61-67 (in Russian).

T_H of incs. in quartz proves that maghemite has been formed at 260-330°C. (A.K.)

NIKOLAEVA, O.V., and GERMANOV, A.I., 1973, Equilibria in system C - S - H_2O under hydrothermal conditions: Geol. Rudn. Mest., v. 15, no. 4, p. 51-60 (in Russian). Authors at Moscow State Univ. and All-Union Scientific-Research Inst. of Hydrogeology and Applied Geol., Moscow.

Redox potential of natural system C - S - H_2O is det. by comp. of carbon, among which graphite is an Eh buffer. Hydrothermal geochem. of sulfur depends on geochem. of carbon. (Authors' abstract, translated by A.K.)

NISTERENKO, G.V., LOSERT, J., CHARES, L., and NAUMOV, V.B., 1974, Temperatures and pressures of formation of some copper deposits of Chile: Rev. Geol. Chile, 1974, no. 1, p. 74-80 (in Spanish).

Covers same material given earlier in Russian, under authors Naumov, et al., 1973; see Fluid Inclusion Research - Proc. of COFFI, v. 6, p. 111, 1973. (ER)

NORONHA, F., 1974, Study of fluid inclusions in the quartz of veins in the tungsten deposit of Borralha (North Portugal): Museu e Laborat. Mineral. e Geolog. Fac. Ciencias do Porto, v. 85, 4th series, p. 7-32 plus 4 plates (in French with Portugese abstract).

The paragenesis is detailed; quartz formed with early tungsten and later As, Mo, Zn, Cu, Bi and Ag sulfides. Much liquid CO_2 is present in some. T_{Frz} and T_H data on many inclusions show a range from 1.5 to 17.6% NaCl equiv. and T_H from 90 (metastable) to 328°C. Eight anal. for Na, K, Ca, and Mg are given. Estim. conds. of form. - 280-350°C and 1000 atm. (ER)

NORMAN, D.I., 1974a, Fluid inclusion study of the Tribag mine, Batchawana Bay, Ontario: Inst. Lake Superior Geol., Abstracts and Field Guides, no. 20, p. 23-24. Author at Univ. Minn., Minneapolis, MN, 55455.

The Tribag property consists of five, closely spaced, Keweenawan-age breccia pipes located along major fracture zones in Archean metavolcanics and granite. Anal. of fluid incs. in quartz and calcite from the three mineralized pipes, along with paragenesis, suggest five stages in the brecciation, void filling and min. of the Tribag breccias.

1. Boiling fluids above 400°C, containing salts 8-9 eq. wt. % NaCl, and supersaturated with CO_2 dep. the finely disseminated Cu and Mo sulphides in the East breccia. Similar waters were responsible for the emplacement of the quartz-Mo veins which cut the general area preceding the form. of the other breccias.

2. Subsequent to and possibly during the form. of the Breton breccia, the void spaces were nearly filled with quartz from boiling sols 350-400°C, salinity 7-8% and saturated with CO_2. Calcite dep. followed from 325°C fluids.

3. Boiling hydrothermal water 300-320°C, salinity 1-5%, with little CO_2 dep. the quartz, which makes up almost the entire matrix of the West breccia.

4. The major sulphide dep. in the Breton breccia and surrounding granite plus the West breccia resulted from hydrothermal fluids 250-300°C, salinity varying between 7 and 17%, and with considerable CO_2.

5. Waters with T decreasing to 140°C, salinity oscillating between 5 and 12% were responsible for the late stage galena, quartz and calcite.

Two general observations may be made. Brecciation was accompanied or subsequently followed by superheated waters, boiling perhaps vigorously. The main sulphide min. in the Breton and West breccias followed from cooler waters of varying salinity.

The high Ts, CO_2 content, and salinity suggest a nearby magmatic source. Time-related changes in the character of the hydrothermal fluids may be attributed to the mixing of saline, CO_2-rich magmatic water with local ground water. (Author's abstract)

NORMAN, D.I., 1974b, Fluid inclusion study of Precambrian breccia pipes, Tribag, Ontario (abst.): Econ. Geol., v. 69, p. 1184-1185. Author at Department of Geology and Geophysics, University of Minnesota, Minneapolis, Minnesota 55455.

At Tribag five closely spaced, Keweenawan-age breccia pipes are located along major fracture zones in Archean metavolcanics and granite. Three of the pipes contain ore grade mineralization.

The East Breccia contains finely disseminated Cu and Mo sulfides both within the breccia matrix and cross cutting veinlets. Fluid inc. data from the quartz in the associated qtz-epidote-calcite gangue indicate mineralization by boiling, CO_2-rich, aqueous fluids (405°-380°C) containing 8-9 eq. wt. % NaCl.

The Breton Breccia is partially cemented by quartz and calcite deposited by boiling solutions from 360°-325°C, containing 7-8 wt. % salt. The Cu-Fe sulfide mineralization present in the pipe was formed from fluids of lower temperature (310°-265°C) and varying salinity (7-17 eq.

wt. % NaCl).

Fluid inc. data from quartz in the matrix of the West Breccia indicate quartz and associated calcite and laumontite deposition within the temperature range of 325°-300°C by low salinity (1-5%) fluids. The copper-bearing orebody occurs as a linear quartz-rich zone in the breccia. The associated large euhedral quartz crystals were deposited from hot (390°-370°C) boiling solutions of relatively high salinity (13-14% NaCl).

In many aspects, these Precambrian breccia pipes resemble those found in Tertiary Cordilleran mountain belts, but were apparently generated in a markedly different tectonic setting. (Author's abstract).

NORTON, D., and CATHLES, L., 1974, Convective fluid flow in plutonic environments: implications in predicting water-rock interactions (abst.): Internat. Symp. on Water-Rock Interaction, Czechoslovakia, Sept. 9-17, 1974, Abstracts: Prague, Geological Survey, p. 6 (in English). First author at Dept. of Geol., Univ. of Arizona, Tucson, Ariz., USA. (See Cathles and Norton, 1974, this volume.)

OBOLENSKIY, A.A., BORISENKO, A.S. AND VASIL'YEV, V.I., 1973, Physico-chemical conditions of formation of mercury deposits from data on gas-liquid inclusions: Abstracts of papers from the Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30, Sept., 1973: Rostov, Rostov Univ. Press, pp. 149-151 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Inst. of Geology and Geophysics of Siberian Branch of Acad. Sci. USSR, Novosibirsk.

1. T_h, composition of the solutions and the gas phase of individual inclusions were determined for minerals earlier than cinnabar and for those crystallizing together with it; quartz, ankerite, calcite, fluorite, and in cinnabar as well as in post-cinnabar calcite, occurring at various epithermal mercury deposits in the Altay-Sayany folded area, Yakutia and Chukotka. All these deposits belong to the mercuric ore type (Kuznetsov, Obolenskiy and Vasil'yev, 1964; Kuznetsov 1972). Probable temperatures of mineral formation did not exceed 250°C.

2. Cryometric analyses revealed the main salts to be NaCl and Na_2CO_3, with minor KCl and $MgCl_2$; gas analyses show the main gases to be CO_2 and H_2S.

3. Inclusions were divided into two groups: 1) inclusions with supersaturated and highly concentrated solutions, 2) inclusions with low salt concentration. The concentration of salts in the inclusions ranges from 36.9 to 1.5-0.5%. High temp. inclusions have an H_2S-CO_2 type gas phase, and inclusions with low concentrations of salts have a CO_2-O_2-type gas. Inclusions with highly saline solutions occur in pre-cinnabar minerals, and cinnabar and minerals paragenetic with it bear moderately saline solutions. Post-cinnabar minerals contain low-saline solutions in their inclusions. (. . .)

4. Composition of salts, especially the presence of Na_2CO_3, indicates that early solutions were highly saline alkaline ones, with concentration of sulfide sulfur reaching 4560 pp. As indicated by calculated and experimental data, in such solutions, the ore elements occur as bisulfide and

sulfide complexes: $HHgS_2^-$, $HAsS_2^-$ (sic.; $HAsS_3^-$ meant? A.K.) $HSb_2S_4^-$, HgS_2^{2-}, AsS_2^-, and SbS_2^-.

5. The cause of ore formation (decomposition of complexes) may be as follows: a) decrease of sulfide sulfur concentration in solution as a result of oxidation of sulfide ion, b) increase of acidity (pH decrease) accompanied by temp. decrease from 250 to 50°C and pressure decrease from 1500 to 1 atm, c) dilution by descending meteroric waters. All these factors probably are strictly connected. (Authors' abstract)

OHMOTO, Hiroshi and RYE, R.O., 1974, Hydrogen and oxygen isotopic compositions of fluid inclusions in the Kuroko deposits, Japan: Econ. Geol., v. 69, p. 947-953. First author at Penn State University, University Park, Pennsylvania.

Initial data on the hydrogen and oxygen isotopic compositions of water in fluid incs. in pyrite and chalcopyrite from some of the Kuroko deposits in the Hokuroku district of Japan fall within a narrow range: $\delta D = -26$ to -18 per mil and $\delta^{18}O = -1.6$ to -0.3 per mil, relative to SMOW.

These data together with geologic and other geochemical data indicate that the Kuroko ore fluids were predominantly of sea-water origin. A small proportion (less than 25 percent) of magmatic and/or meteoric water may have been mixed in the ore fluids.

A model for the formation of the ores by convective circulation of sea-water through high-temperature volcanic rocks is presented. (Authors' abstract)

OHMOTO, Hiroshi, and SHETTEL, D.L., 1974, Effect of f_{O_2} on the hydrogen and oxygen isotopic compositions of minerals at high temperatures and pressures (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 6, no. 7, p. 898. Authors at the Department of Geosciences, The Pennsylvania State University, University Park, Pennsylvania 16802.

δD and δ^{18} values of minerals formed during fluid-rock interactions (e.g., metamorphism, ore-formation) are affected by equilibrium temperature, and by δD and $\delta^{18}O$ values of H_2O in the hydrothermal fluid. δD and $\delta^{18}O$ values of H_2O are controlled by: (1) source of the hydrothermal fluid (e.g., magmatic, meteoric); (2) isotopic exchange history of the fluid (e.g., ^{18}O shift); and (3) the physico-chemical state of the fluid. δD and $\delta^{18}O$ values of H_2O are dependent on (3) because any change in T, P_{fluid}, f_{O_2}, or C/H/O can alter both the relative proportions of fluid species (e.g., H_2O, H_2, CH_4, CO_2, CO), and the isotopic equilibria among these species.

Using the available PVT data and the isotopic fractionation factors for various fluid species, effects of changes in T, P_{fluid}, f_{O_2}, and C/H/O ratios of various fluid systems on isotopic equilibria among fluid species have been evaluated. Within a geologically important f_{O_2} region (i.e., the f_{O_2} region bounded by the mineral buffers W-M, and M-H), a slight change in the redox state can cause large changes in δD and/or $\delta^{18}O$ values of H_2O and of minerals formed from the fluid. For example, at T = 500°C and $P_{fluid} = 2$ Kb, δD and $\delta^{18}O$ values of minerals formed from solutions of the same origin can differ by more than 30% and 5%, respectively, depending upon the redox state of the fluid. This implies that it is difficult to determine the origin of fluids from δD and $\delta^{18}O$ values of minerals unless all the above physico-chemical parameters that prevailed during fluid-rock interaction can be estimated. (Authors'abstract)

ŌKI, Yasue, HIRANO, Tomio, and SUZUKI, Takao, 1974, Hydrothermal metamorphism and vein minerals of the Yugawara geothermal area, Japan (abst.): Internat. Symp. on Water-Rock Interaction, Czechoslovakia, Sept. 9-17, 1974, Abstracts: Prague, Geological Survey, p. 54 (in English). Authors at Hot Spring Research Institute of Kanagawa Prefecture, Hakone, Kanagawa, Japan 250-03.

O'NEIL, J.R., and KHARAKA, Y.K., 1974, Hydrogen and oxygen isotope exchange between clays and water (abst.): Internat. Symp. on Water-Rock Interaction, Czechoslovakia, Sept. 9-17, 1974, Abstracts: Prague, Geological Survey, p. 11-12 (in English). First author at U.S. Geol. Surv., Menlo Park, Cal., USA.

O'NEIL, J.R., and SIBERMAN, M.L., 1974a, (Epithermal gold-silver deposits (abst.)): Geol. Survey Research 1974, U.S. Geol. Sur. Prof. Paper 900, p. 142-143.

The oxygen-isotope ratios of hydro. mins. from 22 Tertiary epithermal gold-silver vein deps., mainly in the Great Basin, Nev. have been measured. Most of the samples have relatively light $\delta^{18}O$ values, indicating a meteoric-water component to the ore fluid; however, $\delta^{18}O$ values of samples from a few deps. are relatively heavy. Deuterium anals. of fluid incs. in quartz and adularia from 15 deps., including those with ^{18}O-rich mins., are uniformly isotopically light with a δD range of -90 to -139, virtually identical to the range of δD observed for modern spring waters in the Great Basin. The deuterium meas. clearly demonstrate the dominance and probable exclusivity of meteoric water in the hydro. fluids of such deps.

Knowledge of the age, location, and isotopic comp. of meteoric waters allows possible reconstruction of ancient topographies and climates. These initial meas. indicate that such reconstructions are quite feasible for the Great Basin in Tertiary time.

The results of isotopic anal. of a sample of quartz in bonanza silver ore from the 1200-foot level of the Con Virginia mine of the Comstock Lode district are unique in this study. The δD of inc. water from this sample is -68.5, implying that ~80% of the water in the ore fluid as magmatically derived. (Authors' abstract) (See also next entry)

O'NEIL, J.R., and SILBERMAN, M.L., 1974b, Stable isotope relations in epithermal Au-Ag deposits: Econ. Geol., v. 69, p. 902-909.

This is the full paper corresponding to the previous abstract.

ONTOEV, D.O., 1974a, Stages of mineralization and zoning of deposits of Zabaykal'ie: Moscow, "Nauka", Press. Abstract courtesy A. Kozlowski.

Author uses literature T_H and T_D of incs. in minerals from studied W-Sn-sulfide deposits as well as own determinations. At Inkura deposit following T vertical zonality was found: depth 100m - T_H in quartz 324-292°C, 253m - 410-380°C; another borehole depth 150m - T_H in quartz 390-320°C (there are several misprints in these data in the Russian text; they have been changed to the probably correct values. A.K.); 514m - 440-410°C. Sequence of ore mineralization of deposits of molybdenite-sulfide-wolframite formation (exemplified by Bom-Gorkhon deposit) is as follow: stage I (pre-ore, accompanied by microclinization) - T_H of incs. in quartz 430-240°C; stage II (molybdenite, accompanied by microclinization and later by greisenization) - T_H for quartz 320-210°C; stage III - (sulfobismuthite-hübnerite with greisenization) substage quartz-hübnerite - T_H for quartz 400-200°C, substage sulfobismuthite-hübnerite-quartz - T_H for quartz 300-190°C. In individual quartz-ore veins of Bom-Gorkhon deposit the zoning was found: external part of veins consists of coarse-crystalline gray and smoky quartz with hübnerite, pyrite, sphalerite and bismuthite (T_H of incs. in quartz 320-340°C and 230-240°C); internal part bears white and light-gray coarse crystalline quartz (T_H = 290-270°C) with giant aggregates of hübnerite (up to 0.5 m long), sulfides and sulfosalts (cosalite). At Dzhida deposit, the same formation, following stages were distinguished (T_H of incs. in quartz in °C): I (pre-ore) (albitization and microclinization) - 440-245, injection of dikes, II - molybdenite, substages microcline-molybdenite with microclinization - 470-170 and quartz-muscovite-molybdenite with greisenization - 324-165, injections of dikes, III - sulfobismuthite-hübnerite, substages quartz-microcline (microclinization) - 320-190 and quartz-hübnerite (greisenization) - 300-170, IV - quartz-sulfide-hübnerite (greisenization), substages quartz-hübnerite - 420-235, sulfide-hübnerite - 320-180 and fluorite-quartz - 300-180, V - stage of chalcedony-like quartz - ? (argillitization).

Deposits of silicate-sulfide-cassiterite formation, Khapcheranginskoe deposit (T_H of incs. in quartz, °C) - stage I - pre-ore (microclinization and biotitization), stage II - greisen substages quartz-topaz-muscovite - 430-270, III - quartz-cassiterite-arsenopyrite - 310-220, IV - sulfide-cassiterite-chlorite - 285-218, V - carbonate-sphalerite-galena - 250-200. Sherlovaya Gora deposit, same formation, stage I, greisen substages 520-305 and 440-300°C, II - quartz-cassiterite-tourmaline 300-200°C, III - sulfide-cassiterite-chlorite about 250°C, V - carbonate-sphalerite-galena.

Author gives changes of composition of gas component of incs. in quartz. Paleotemperature gradient, calculated from T_H values, equals 18°C/100m of depth at Inkura deposit and 22°C/100m at Sherlovaya Gora deposit. Zoning of T of origin of quartz-ore veins is as follows: external zones 438-235°C, internal zones 340-200°C, latest quartz 300-200°C; sometimes zoning in veins is asymmetric. Mineral-forming solutions contained Na, K, Ca, Mg; either HCO_3 prevails over Cl or Cl strongly prevails over other ions. Amount of liquid CO_2 reaches 10-20% of inc. vacuole volume.

ONTOEV, D.O., 1974b, Conditions and main factors of origin of zoning at hydrothermal deposits: <u>in</u>: Zonality of hydrothermal ore deposits, G.A. Sokolov, ed.: Moscow, Izdat. "Nauka," v. 2, p. 123-163 (in Russian; abstract courtesy A. Kozlowski).

Author uses literature data on T_D and T_H of inclusions in minerals.

PAČES, Tomáš, 1974a, Effect of CO_2 on Na - K - Ca geothermometer for natural waters (abst.): Internat. Symp. on Water-Rock Interaction, Czechoslovakia, Sept. 9-17, 1974, Abstracts: Prague, Geological Survey, p. 61 (in English). Author at Geological Survey of Prague, Czechoslovakia.

PAČES, Tomáš, **1974b**, Springs of carbon-dioxide water in northwestern Bohemia: Prague, Geological Survey, 83 pp. (in English).

An excellent English summary of the geochemistry of the famous hot springs of Bohemia, prepared as a field-trip guide in connection with the Internat. Symp. on Water-Rock Interaction, Prague, 1974. (ER)

PAGEL, Maurice and POTY, Bernard, 1974, Fluid inclusions in rocks from the Charlevoix cryptoexplosion structure (Quebec - Canada) (abst.): Internat. Mineral. Assoc. Ninth Gen. Meeting, West Berlin and Regensburg, W. Germany, Collected Abstracts: West Berlin, German Mineralog. Soc., p. 33 (in English).

Authors at Nancy, France.

Two main kinds of fluid incs. related to the genesis of the cryptoexplosion structure have been recognized in Charlevoix area: 1) Numerous minute fluid incs. which are located in planar deformation structures. The fluid phase of these incs. is essentially aqueous, with a highly variable L-V ratio. Many contain only vapor, and considerable necking down has occurred. Salinity, estimated from microthermometry measurements, varies from 1 weight percent equivalent NaCl to saturation at room T. 2) Incs. occurring as clusters, mainly in quartz of breccias, in quartz relicts from rocks which are almost entirely recrystallized and also in milky quartz from "Mont des Eboulements". These incs. contain H_2O vapor, though a few show also low salinity aqueous solution.

Besides these, older aqueous or CO_2-rich incs. (CO_2-rich from high grade metamorphic rocks and anorthosites) have undergone morphological, physical and chemical changes related to the cryptoexplosion. The modifications are due mainly to microfracturing of quartz but also to decrep., followed by healing, at high T. The great extent of low-density, water-bearing incs. indicated high T and low P during formation. In addition, lack of CO_2 associated with the cryptoexplosion, as confirmed by microthermometry, crushing and gas chromatography, contraindicates a volcanic process. Necking down in planar decorated features indicates that T decreased during healing after the shock. Heterogeneous chemical composition of the aqueous solutions shows a complex history of mixing. Finally the decreasing abundance of transformed and gas incs. towards the margin of the structure gives us new and supplementary criteria to the meteoritic hypothesis retained for this structure (Rondot, 1968). (Modified by ER from authors' abstract).

PANINA, L.I. and KOSTYUK, V.P., 1973, On crystallization temperatures of minerals in some ultrabasic - alkaline complexes of Siberian Platform: Abstracts of papers at fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 212-213 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Inst. of Geol. and Geophysics, Siberian Branch, Acad. Sci. of USSR, Novosibirsk.

T_H of primary melt and highly concentrated saline inclusions in the minerals of ultrabasites, alkaline rocks and carbonatites of composite complexes from Maymecha-Kotuy Province were as follows:

Massif	Rock	T_H of inclusions in minerals, °C					
		Forsterite	Pyroxene	Nepheline	Apatite	Calcite	Dolomite
Gulya	Meymechite	1450 ± 30					
	Biotite-nephelinite peridotite		1100- -1230	950 -1080			
	Melteigite-ijolite		1040 -1150	870 1100			
	Carbonatized melteigite		1040 -1130	830 -1050			
	Carbonatite					270- -450	600- -750
Odikhincha	Olivinite	1340- -1360 ± 20					

	Well-crystallized melteigite-ijolite		1230-1260 ±20	1170-1210 ± 20			
	Dike of melteigite		1220--1260				
Essey	Jacupirankite-melteigite		1100-1210 ± 20	1150-1170			
	Magnetite-apatite rock				1140--1170		
	Forsterite-magnetite-apatite rock	1280 ±20			1140--1170		

(Authors' abstract. See also next two items)

PANINA, L.I., and KOSTYUK, V.P., 1974, Some data on temperature of formation of minerals in carbonatite complexes of Maymecha - Kotuyskaya Province, in Mineralogy of endogenetic deposits, Yu. A. Dolgov and V. S. Sobolev, eds.: Novosibirsk, Acad. Sci. USSR, Sib. Branch, Inst. Geol. and Geophys., p. 75-90 (in Russian; abstract courtesy A. Kozlowski).

In rock-forming minerals of the named province two types of inclusions occurred: melt inclusions (M), and melt-solution inclusions (M-S) (gas-liquid-crystal) with 90-95 vol. % of solid phases usually as an aggregate. Some secondary gas-liquid and liquid-gaseous inclusions occur also. Temperature data are as follows: (See also next item)

Massif	Mineral	Inclusion type	T_H, °C	Rock type
Gulinskiy	Forsterite	M	1450±30	meimechite
	Pyroxene	M	1230-1170	meimechite
		M	1230-1100	biotite-nepheline peridotite
		M-S	1150-1040	melteigite-ijolite
		M-S	1130-1040	carbonate-bearing melteigite
	Nepheline	M-S	1080-950	biotite-nepheline peridotite
		M-S	1100-870	melteigite-ijolite
		M-S	1050-830	carbonate-bearing melteigite
	Dolomite	M-S	750-690	dolomitic carbonatite
Odikhincha	Forsterite	M	1360-1340	olivinite
	Pyroxene	M	1260-1230	holocrystalline melteigite-ijolite
		M	1260-1220	melteigite from dike
	Nepheline	M	1210-1170	holocrystalline melteigite-ijolite
Essey	Forsterite	M	1280±20	forsterite-magnetite-apatite rock
	Pyroxene	M	1210-1100	jacupirangite-melteigite
	Nepheline	M	1170-1150	jacupirangite-melteigite
	Apatite	M	1170-1140	magnetite-apatite and forsterite-magnetite-apatite rock

PANINA, L.I., and SHATSKIY, V.S., 1973a, Inclusions of melt in magnetite-apatite rock of the Yessey carbonatite intrusion: Akad. Nauk SSSR Dokl., v. 209, no. 2, p. 455-457 (in Russian; trans. in Doklady Acad. Sci. USSR, v. 209, p. 149-151 (1974); English abst. in Internat. Geol. Rev., v. 15 no. 5, p. 619 (1973)). Authors at Inst. Geol. and Geophy., Siberian Div., USSR Acad. Sci. Novosibirsk.

T_H of incs. in apatite (ap.) and olivine (ol.) from magnetite (mt.)-ap. and ol.-mt.-ap. rocks of the Yessey carbonatite intrusion, situated in the south of the Meymecha-Rozhuiskaya ultrabasic-alkaline province, were studied. Two groups of incs. were found in ap.: P melt incs., and S-L/G incs. Magmatic incs. had T_H at 1140-1170°C. S incs., (two-phase and three-phase types), were abundant. The latter had T_H at 200-520° (for incs. with transparent facetted solid phase) and 730-740° for incs. with a dark-brown solid phase). T_H is 80-380° for two-phase S incs. in ap. Ol. has two generations of melt incs: 1) glassy one-phase ("quenched" glass) and two-phase (glass and gas); and 2) partly xlized. melt incs. The first have T_H 1280 ± 20°, but T_H could not be detd. for the second group because of explosion at high T. The authors conclude that mt.-ap. and ol.-mt.-ap. rocks formed from a melt and suggest the existence of natural carbonatite magma. Such hypothetical mt.-ap. melt may have formed by immiscibility, either from a carbonatitic or an ultrabasic melt. (Abstract courtesy of T.M. Sushchevskaya) (See previous two items)

PARK, Hi In and CHOI, Suck Won, 1974, A study on the fluid inclusions in the minerals from the Dae Hwa tungsten-molybdenum deposits: Korean Inst. Mining Geol., Jour., v. 7, no. 2, p. 63-78 (in Korean with English abstract).

Daehwa tungsten-molybdenum deposits are fissure filled quartz veins occurring in Precambrian granite gneiss adjacent to the contact with Mesozoic biotite granite mass. Essential ore minerals are molybdenite and wolframite, accompaning scheelite, cassiterite, chalcopyrite, pyrrhotite, pyrite and bismuthinite. Gangue minerals are quartz and little muscovite, fluorite, beryl and carbonate minerals. Fluid incs. in fluorite, beryl, scheelite and calcite have T_H ranges of 170-353°C. Numerous incs. with DMs or CO_2 are illustrated. Studies of mineral paragenesis and T_H indicate that main tungsten and molybdenum mineralization have taken place in the range 205 to 353°C. Liquid CO_2-bearing fluid incs. are characteristic in the quartz and early fluorite of tungsten and tungsten-bearing molybdenum veins but hardly recognized from molybdenum veins. Estimated CO_2 concentration, according to diagram proposed by Takenouchi, ranges from 10 to 20 wt. %. These facts suggest that tungsten mineralization may be related to the CO_2 content of the hydrothermal solution during the mineralizing period. (Authors' abstract modified by ER.)

PARK, H.I., PARK, N.Y., and LEE, M.W., 1974, A study of the temperature of formation of fluorite deposits in Korea: Korean Ministry of Science and Technology Report R-74-49, 54 pp. (in Korean (?) with English summary).

Forty deps. were studied, which varied widely in terms of inc. data. In the Hwacheon district, ore-fluids were comparatively dilute brine and low CO_2 content. T_H = 104°C to 170°C. In the Chuncheonshinpo mine, salinity ranges 0.5∿2.2 wt. % NaCl and T_H is between 116°C and 143°C. In the Hwanggangrni district, ore fluids were complex and T_H varies widely. In contact metasomatic fluorite deps. ore fluids were NaCl-rich brines with moderate CO_2 content and T_H from 285°C to >360°C. Fluids of tungsten and sulfide mineral-bearing fluorite veins show high CO_2 ($\leqslant$31 wt. %). T_H ranges from 101°C to 310°C. Fluids of mainly fluorite-bearing veins were more dilute and had low CO_2 contents. T_H ranges from 95°C to 312°C. T_H of fluid incs. of Keumsan district are between 95°C and 237°C. Fluorite mineralization in Hwacheon district occurred at low T from dilute brines with low CO_2 contents. In Hwanggangrni district, fluorite mineralization proceeded by several pulses of chemically distinct ore fluids and formed the mineralogically different type of deposits around cooling granite plutons which were emplaced at shallow depth. (From the authors abstract).

PAVLOV, A.L., and OBOLENSKIY, A.A., 1972, Role of interaction of hydrothermal solutions and wall-rocks in formation of mercury deposits: Acad. Sci. USSR, Inst. Geol. and Geophysics of Siberian Branch, Trans. v. 114, Physical and physical chemical development of magmatogenic and ore systems, p. 158-197: Moscow, "Nauka" (in Russian).

By way of thdy. calcs. the stability of sulfide, chloride, sulfate and oxide compounds, ions and metallic mercury in water is evaluated at 25 and 250°C and 1 atm of total P, activity of dissolved S = 10^{-1}. and Cl = 10^{-1}. (From authors' abstract, translated by A.K.)

PAVLOV, A.L., and SHARAPOV, V.N., 1972, Elements of physics and physical chemistry of processes of forming of rare-metal deposits of vein-greisen type: Acad. Sci., USSR, Inst. Geol. and Geophysics of Siberian Branch, Trans. v. 114, Physical and physical chemical development of magmatogenic and ore systems, p. 73-136; Moscow, "Nauka" (in Russian; translation courtesy A. Kozlowski).

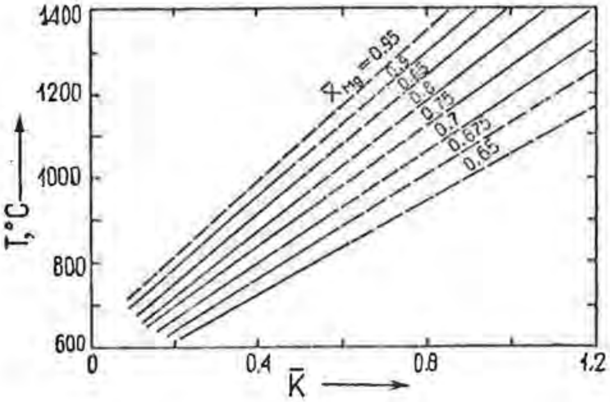
Peculiarities of formation of individual types of deps. are related to the existence of three sub-systems with various hydrodynamics in the hyd. system. Changes of T and P (from fluid incs.) are given for mins. from Nura-Taldy dep. (Central Kazakhstan). Pption. occurred from 180 to 400°C (T_H). Zonality of vein filling is connected with cooling of sols. and interaction of gases dissolved in intergranular water with the sols., causing sharp changes of pH; pH during filtration through the granitic rocks varies from 4 to 9, in those ranges in which mins. of granites are stable. Distinct pH change in the zone of ore pption. is indicated by alt. of S^{2-} into $SO_4{}^{2-}$ with increase of P_{S_2}.(Authors' abstract)

PERCHUK, L.L., 1973, Equilibria of Ca-clinopyroxene with ortho-pyroxene in deep rocks; in Contrib. to Physico-Chem. Petrology, V.A. Zharikov, et al., eds.: Moscow, "Nauka" Pub. House, v. 3, p. 3-11 (in Russian; abstract courtesy A. Kozlowski).

On the basis of studies of natural mins. and experimental data the distribution of Fe and Mg between Ca-Cpx and Opx was investigated in equation: $CaMgSi_2O_6 + Fe_2Si_2O_6 = Mg_2Si_2O_6 + CaFeSi_2O_6$;
When T increases, reaction goes to form Mg and CaFe pyroxenes; influence of P is insignificant. Results permitted construction of diagram suitable for determination of T (Fig. 3, see below):

$$\bar{x}_{Mg} = 0.5/X_{Mg}^{Opx} + X_{Mg}^{Cpx}/; \ \bar{K} = FeO^{Cpx}/FeO^{Opx} \text{ in wt \%.}$$

T values for nodules in basalts and kimberlites, and for meteorites are given (810 - 1180°C). (Of pertinence to the many silicate melt T_H measurements on such materials.) (ER)



PERCHUK, L.L. and FED'KIN, V.V., 1974, Calculations of P-T diagrams for equilibria of minerals of unstable composition: in Contrib. to Physico-Chem. Petrology, V.A. Zharikov, et al., eds.: Moscow, "Nauka" Pub. House, v. 4, pp. 162-175 (in Russian).

PERCHUK, L.L. and SUVOROVA, V.A., 1973: Thermodynamic calculations of fugacity of CO and CO_2 in the area of phase inversion graphite-diamond, in Contrib. to Physico - Chem. Petrology, V.A. Zharikov, et al., eds.: Moscow, "Nauka" Pub. House, v. 3, pp. 15-18 (in Russian; abstract courtesy A. Kozlowski).

On the basis of thdy. constants of carbon and its gaseous oxides, fugacities of CO and CO_2 were calc. in reactions: diamond + $\frac{1}{2}$ O_2 = CO; graphite + $\frac{1}{2}$ O_2 = CO. Diagrams P-T for conditions $f_{O_2} = 10^{-20}$ and 10^{-40} bar are given. (Authors' abstract).

PERTSEV, N.N., 1974, Evolution of postmagmatic fluids and solutions related to chemical activity of CO_2: Geol. Rudn. Mest., v. 16, no. 1, p. 34-42 (in Russian. Author at Inst. of Geol. of Ore Deps., Petrog., Min. and Geochem. of Acad. Sci. USSR, Moscow.

Comparison of continuous alt. of carbonate parageneses under postmagmatic conds. at contact-metasomatic and contact-metamorphic deps. establishes a decrease of molar conc. of CO_2 with T decrease. The author discusses the possible reasons for varying CO_2 concs. in fluids of magmatic and postmagmatic stage, and the influence of CO_2 on the genesis of brucite marbles is evaluated. (Author's abstract, translated by A.K.)

PETRICHENKO, O.I., 1973, Methods of study of inclusions in minerals of saline deposits: Kiev, "Naukova Dumka" Pub. House, 92 pp., plus 58 photographs (in Ukrainian).

This little book, with a total printing of only 350 copies, at 66 kopecks, brings together much of Dr. Petrichenko's careful work on the origin, chemistry, and significance of fluid inclusions in saline minerals, including what are probably the only experimentally determined values for Eh in inclusions. (ER)

PETRICHENKO, O.I., KOVALEVICH, V.M. and CHALYI, V.N., 1974, Geochemical conditions of salt origin in Tortonian evaporite basin at NW Predkarpat'ye: Geologiya i geokhimiya goryuchikh iskopaemykh, v. 41, p. 74-80 (in Russian; abstract courtesy A. Kozlowski). Authors at Inst. of Geology and Geochemistry of Fuels of Acad. Sci. of Ukrainian SSR, L'vov; L'vov Geological Expedition.

The investigated rocks consist of halite, anhydrite and detrital minerals. On basis of inc. studies, two varieties of halite were distinguished, sedimentary and recrystallized, illustrated with photos of typical inclusions. Halite bears one- and two-phase incs., sometimes with gas bubbles (or with solid phases). Data on inc. fillings (all in g/l of inc. solution, made on individual incs., unless otherwise noted): a) sedimentary halite: K^+ - avg. of 66 dets. 12.4 (3-45); Mg^{2+} avg. of 36 dets. 26.8 (6-45); Ca^{2+} avg. of 14 dets. 0.5; SO_4^{2-} avg. of 40 dets. 31.0 (10-55); Br^- 0.3-1 (6 dets); Cl^- avg. 170; Fe 5-10 mg/l (Fe^{2+} + Fe^{3+}); BO_3^{3-} $\leq$50 mg/l; Cu found; Eh avg. of 11 dets. + 408 mV (+340 to +515mV); pH 5.3-6.4 (4 dets.); general conc. 260-280 g/l; d=1.230 to 1.260g/cm^3; gases not found, no phase changes on cooling to -20°C; P in incs. ∿ 1 atm. b) recrystallized halite: K^+ avg. of 25 dets. 13.9; Mg^{2+} avg. of 21 dets. 26.9; Ca^{2+} avg. of 10 dets., 1.9 (0.5-13); SO_4^{2-} avg. of

28 dets. 27.0; Br and Cl as in a); Eh avg. + 308mV; pH 5.3 to 6.0; general concentration 260 to 280; d=1.250 to 1.280 g/cm^3; gases rarely occur under P 1 to 15 atm; F of incs. bearing gases 90 to 99%, proving the external origin of the gases.

PETRICHENKO, O.I., and SLIVKO, E.P., **1973a**, On the conditions of formation of Permian salt deposits of Donbass: L'vov. Mineral. Sborn., v. 27, no. 3, p. 201-214 (in Russian; abstract courtesy T.M. Sushchevskaya).

Chem. comp. of liquid incs. in halite was studied. Three stages were found for the process of halite formation: sedimentary, syngenetic and diagenetic. Study of incs. in sedimentary halite show that brines from which halite crystallized were of sulphate type with high potassium. Average content of Mg in inc. sol. is 43 g/l, of K - 19.5 g/l and of SO_4 - 28 g/l. Conc. of these varies considerably and increases in incs. in halite formed during the late stages of precipitation. The SO_4 in incs. from the center of the crystals is higher than that from the periphery. Avg. Br/Cl ratio is $9.13 \cdot 10^{-3}$, pH - 5.4, Eh - +174 mv. Study of the incs. showed that K content in the brine increased during the formation of one of the deposits (310 years) from 6 g/l to 27 g/l: all the salt precipitated at >40°C.

Incs. in crystals that have undergone syngenetic alteration contain less SO_4, more Mg and practically the same concentration of K; pH of these sols. is almost the same as in P. incs. and Eh is about 0 mv; T of syngenetic alteration was $\leq$45°C. Incs. corresponding to the diagenetic stage are relatively large (up to 2.5 cm^3) and contain: K - 12 g/l, Mg - 16 g/l, SO_4 - 1.3 g/l, Ca - 1.28, HCO_3 - 1.68, Br - 2.06 g/l, pH - 4.5-5.6, Eh - 10 to -210 mv. T. of diagenetic alteration was ~60°, P = 11-17 atm. Chemical comp. of the incs. proves that seawater took part in this process. Data on inc. comp. from Devonian rock salt are given for comparison. These incs. contain very little K, less Mg, no SO_4 and a lot of Ca.

PETRICHENKO, O.I. and SLIVKO, E.P., **1973b**, On the mineral formation conditions during the formation of Permian salt deposits of the Donbas: L'vov Mineral. Sborn., v. 27, no. 3, p. 263-274 (in Russian).

Data on inc. pH, Eh, and compositions are combined with phase equilibrium data in salt systems to try to estimate the conditions. (ER)

PETRICHENKO, O.I., and SLIVKO, E.P., 1974, The effect of clayey material on the change in microelement content in salty solutions (abst.): Internat. Symp. on Water-Rock Interaction, Czechoslovakia, Sept. 9-17, 1974, Abstracts: Prague, Geological Survey, p. 33 (in English). Authors at Institut geologii i geokhimii goryuchiky iskopaemykh, AN SSSR, L'vov, USSR.

PETROVSKAYA, N.V., ELINSON, M.M., and NIKOLAEVA, L.A., 1973, Composition and formation conditions of gas inclusions in native gold: Mezhdunar. Geokhim. Kongr., [Dokl.], 1st 1971 (Pub. 1973), v. 2, p. 441-451 (A. P. Vinogradov, ed., Akad. Nauk SSSR, Inst. Geokhim. Anal. Khim.: Moscow, USSR; in Russian). C.A. v. 81, 1974, 94002z.

Gas incs. in native Au are very common. The dimensions of these incs. are 0.1-1.5 mm and are independent of the Au grain size. Components of gas incs. were detd. by hermetic degassing. The gas incs. contained CO_2, H_2, CH_4, CO, SO_2, and H_2S. CO_2 is the major component. Crystn. of native Au occurred at low pressures and was closely related to the CO_2 pressure. The redistribution and consolidation of gas incs. occur during metamorphic processes of Au ore.

PETROVSKAYA, N.V., TIMOFEEVSKIY, D.A., AND BORODAEVSKIY, N.I., 1974, Endogenic zoning of gold-ore fields and deposits: in: Zonality of hydrothermal ore deposits, G.A. Sokolov, ed.: Moscow, Izdat. "Nauka," v. 2, p. 86-122 (in Russian; abstract courtesy A. Kozlowski).

Authors discuss temperature zoning of gold deposits based on literature data of T_D and T_H.

PETROVSKY, V.A. and ASKHABOV, A.M., 1973, Morphology of a gas inclusion cavity as an indicator of the change of rate and the arrangement of growth centers on a crystal face in the process of a crystal growth: 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 The Institute of Geology of the Komi Branch of the USSR Academy of Sciences, Syktyvkar.

A set of experiments, modelling the process of crystal growth in a "boiling" solution, has been carried out for the study of the features of the mechanism of trapping and enclosing of gas bubbles (Ref. 1).

The experiments have ascertained that an abrupt stepwise change in temperature of solution influences the shape of inclusions cavity to the form of a sharp overclipping (sic.) by which several stages in the change of rate of crystal growth can be distinguished (Fig. 1).

These stages are: 1. The regime of rapid decrease in growth rate of the crystal; 2. The constant growth rate; 3. The regime of a gradual decrease in growth rate of the crystal.

Along with this we noted the duct bending of overgrowing inclusions of gas bubbles in the growth pyramid of the same face in contrast to the previously described case (Ref. 2), when a bending was defined by the transition of inclusions from one face to another.

Further experiments provided the explanation of these rather curious phenomena.

Our investigations have been carried out in a temperature-controlled vessel under direct observation of the overgrowing of gas bubbles under the microscope in the reflected light.

The face under observation (III) of aluminium potassium sulphate crystal is normal (perpendicular) to the vector of gravity.

As a consequence of our investigations it was ascertained that the deflection of inclusion ducts from a perpendicular line to the growing face was defined by the phenomena taking place on the face surface (by the action of growth layers, propagating from the active growth centers). The degree of deflection depends upon the cavity size and the efficiency of the activity of growth centers.

Under uniform distribution of growth centers around an overgrowing inclusion, the duct is rectilinear (Fig. 2a). In case of uneven distribution of growth centers, the duct is curved (Fig. 1).

In the process of growth, because of the change in location of actively-operating growth centers (as a result of the supression of some and appearance of others), the direction of curvature of the inclusion cavity is changed (Fig. 2b, c).

The ducts from adjacent inclusions are curved to meet one another (often merging into a single one), due to the low probability of forming powerful growth centers on the limited area between inclusions.

Under a relatively great density of inclusions of equal size on a crystal face, the effect of deflection of cavities by moving layers is slight and the cavities remain almost parallel to one another.

Thus, on the one hand, by artificially creating new growth centers, and on the other hand, destroying them, one may control the curvature of ducts of overgrowing gas inclusions in the process of crystal growth.

These facts together with the observed abrupt overclippings (sic.) of inclusions caused by fluctuation in growth rate (due to the abrupt stepwise fluctuations in temperature) may be employed with the aim of forming cavities of an appropriate shape in crystals as well as in the case of morphological analysis of inclusions for the purpose of restoring the original conditions of the formation of inclusions and crystal growth. (Authors' abstract). Note - although this is not in the printed abstract volume, it was presented orally.

PHILLIPS, R., and SMITH, F. W., 1974, Structural ore controls and paleocirculation in fluorite veins in the North Pennine orefield, England (abst.): Internat. Assoc. on the Genesis of Ore Deposits, Fourth Symposium, Varna, Sept. 1974, Abstracts of Papers: Sofia, IAGOD, p. 463-465 (in English). Authors at Dept. of Geol. Sci., Univ. of Durham, Durham, U.K.

P fluid inc. studies of fluorite indicate T_H generally 180° to 105°C. Fluorite deposition within orebody cavities was caused chiefly by convective cooling of the hydrothermal brines (20 to 26 equivalent weight % NaCl) against wall-rocks. Brine cooling gradients in orebodies indicate hydrothermal flow paths in both vertical and horizontal senses. Feeder conduits are masked as zones of high brine T and lateral orebody terminations by low brine T that tend towards background rock T known from coal rank studies. RE concs. correlate with T_H. Flow direction trends can be used to predict limits of productive ore-zones.

A theory on the paleocirculation in the district is proposed. (From the authors' abstract.)

PIZNYUR, A.V., 1973, Principles of thermobarogeochemistry. Synopsis of lectures, Pt. 2: Methods of thermobarogeochemical research. Methods of barometry: L'vov(?) 84 pp. (in Russian?). Author at Vishcha Shkola, L'vov, Ukr. SSR. C.A. v. 81, no. 4, 40070b.

PIZNYUR, A.V., 1974, The theoretical modelling of thermobarogeochemical conditions of the postmagmatic mineral-forming solution: L'vov. Mineral. Sborn., v. 28, no. 3, p. 18-31 (in Russian, with English abstract).

The contents of gas-liquid incs. have been taken as the solvent for the ore components. The possibility of the existence in one section of a cupola shaped model (i.e., a miscibility dome?) are analysed, by comparing the P-T-X diagram for CO_2-H_2O with that for CO_2-30% NaCl sol. It is confirmed by studies of gas-liquid incs. and by the corresponding exper. work. Possible homogenous and heterogenous cond. of the min.-forming fluids at specific Ts and Ps (in this section) are shown. (Author's abstract, modified by ER)

POIROT, Jean-Paul, 1974, Fluid inclusions and gemology (abst.): Internat. Mineral. Assoc. Ninth Gen. Meeting, West Berlin and Regensburg, W. Germany, Collected Abstracts: West Berlin, German Mineralog. Soc., p. 50 (in English). Author at Paris, France.

A discussion of the usefulness of incs. in gemmology. (ER)

POLYANSKIY, Ye,V. AND PONOMAREVA, I.A., 1973, Temperature regime and chemical composition of mineral-forming solutions of Bom-Gorkhon ore field: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 186-187 (in Russian; translation through the courtesy of A. Kozlowski). Authors at Moscow University.

Inside the Bom-Gorkhon granitoid massif (Zabaikal'ye)rare metal mineralization occurs, altering from center to periphery as follows: quartz-molybdenite association (ass.), complex quartz-molybdenite-hübernite ass. and quartz-hübnerite-sulfide ass.

(...) Two-phase inclusions are characteristic for two first ass. (degree of fill (F))=0.6-0.7, T_H 320-280°C, type of homog., l. Chemical composition of solutions is Na-Ca-Mg-Cl-HCO_3^- type with low concentrations; $Na^+/K^+ \sim 4.0, (K^+ + Na^+):(Ca^{2+} + Mg^{2+}) \sim 1.25$, HCO_3^-/Cl^- ~ 3.0. Quartz-hübnerite-sulfide ass. consists of numerous mineral types crystallizing during a long time, accompanied by decrease of temperature, from solutions of one inflow. Within this ass. one may ascertain 3 stages: quartz-hübnerite-pyrite, quartz-sulfide and quartz-fluorite-calcite. In vein quartz of ore bodies two-phase fluid inclusions (F = 0.5 - 0.95, T_H = 383 - 90°C) occur. Inclusions in hübernite, sphalerite, triplite, fluorite and calcite were also investigated; T_H and F fall into the above ranges. By the water leachate method, K^+, Na^+, Ca^{2+}, Mg^{2+}, Fe^{3+}, Al^{3+}, SO_4^{2-}, CO_3^{2-}, HCO_3^{2-}, Cl^-, F^- as well as CO_2 were found in inclusions in these minerals. Also the amount of H_2O was determined.

Strong differences of chemical composition within the range of each stage were not observed. Solutions are weakly mineralized, and the anion group changes from chloride-bicarbonate to bicarbonate-sulfate. Changes in cation composition are larger. During the whole stage Na prevails over K and Ca concentration decreased to the end of process. Na^+/K^+ ratio has the following values (for stages I, II and III, respectively): 0.5 - 1.0. 5.0 - 7.0, 10.0 - 12.0. Al^{3+} and Mg^{2+} were found only in inclusions of minerals of the second stage (quartz II and triplite) in small amounts. F^- occurs only in fluorite. Liquid CO_2 was found in minerals of the first stage: hübnerite (visually) and pyrite (in water leachate). Values of pH ranges from 6.7 to 7.8, except for pyrite, which is 4.4 - 4.6 (probably because of the CO_2 inclusions).

Mineralization of Bob-Gorkhon ore field was formed during two essential intervals; molybdenum ores and tungsten ores; the latter interval is divided into 3 stages. (Authors' abstract, abbreviated by A.K.)

POLYANSKY, E.V., 1973, History of formation of the Bom-Gorkhon granite intrusive and associated ores: Geol. Rudnykh Mestor., 1973, no. 3, p. 29-37 (in Russian; abstract courtesy T.M. Sushevskaya).

On the basis of petrographic and fluid inc. data the Bom-Gorkhon granite intrusive complex (western Transbaikalia) was formed during 4 stages: (1) intrusive stage (granitoid body); (2) hydrothermal stage, resulting in metasomatic alteration of granitoids; (3) intrusive (leucocratic granites); and finally (4) hydrothermal ore-forming stage.

The measured T_H for incs. in quartz (semi-xline. glass + $\leq$ 15% gas) from diorites are in range 1010-980°, in quartz from porphyritic granites - 960-980°, and from diorite-porphyrites - 950-930°C. The metasomatic alteration (microclinization) took place at 300-220°C, as is evidenced from T_H of fluid incs. in quartz and microcline. The new magmatic stage resulting in formation of leucocratic granites was characterized by T. 1050-950°C, based on T_H of P. incs. in quartz. The late portions of these melts gave rise to silexite and pegmatite bodies.

P. incs. in quartz (melt + 15-20% gas) have T_H 720-550° (pegmatite) and 650-660 (silexite). The T. range of ore mineral formation, found from T_H of P. incs. of Bom-Gorkhon W deposit, are: quartz - 380-100°, hübnerite - 235-200, quartz-sulfide assoc. - 260-170°, quartz-fluorite-calcite - 190-180°.

POLYKOVSKIY, V.S., 1973, Genetic classification of fluorite mineralization in Middle Asia in the light of knowledge about mineral-forming conditions: Abstracts of papers from the Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 117-119 (in Russian, translation through the courtesy of A. Kozlowski) Author at MINGEO Uzbek SSR.

The following genetic types of fluorite mineralization recognized were: pegmatitic, skarn, pneumatolytic-hydrothermal and hydrothermal (most common), subdivided into high-, moderate- and low-temperature subtypes (300-250°C, 250-200°C and 200-80°C respectively).

Pressures of mineral-forming solutions of fluorite deposits range from 200 to 620 atm. The gases in the inclusions change as follows: $H_2>N_2>CO_2+N_2\gg H_2>CO_2+N_2$. The composition of five solutions is presented below:

	1	2	3	4	5
Cl	49.5	63.3	50	36	25.6
F	23.9	—	—	—	—
HCO_3	33.8	11.2	45	57	33.3
SO_4	3.2	25.5	5	7	41
Na	68.9	32.5	30	21	50
K	2.48	0.6	0.6	2	10.5
Mg	—	—	—	2	—
Ca	28.4	63.2	69.2	35	39.5
NH_4	0.6	37	0.2	—	—

(Note by A.K.: Composition is probably expressed in ionic ratios. (Author's abstract, abbreviated by A.K.)

POMÂRLEANU, V.V. and FILIP, D.P., 1974, On method of thermoacoustic analysis of inclusions in minerals (abst.): Internat. Assoc. on the Genesis of Ore Deposits, Fourth Symposium, Varna, Sept., 1974, Abstracts of Papers: Sofia, IAGOD, p. 264 (in Russian; translation courtesy A. Kozlowski). Authors at Geol. Inst., Center of Techn. and Physical Investigations, Iassy, Roumania.

Thermoacoustic app. for simultaneous detection of T and frequency of acoustic vibrations during decrep. of mins. is described. Resulting diagrams are interpreted and compared with other data from references on thermoacoustic analysis of minerals. (Authors' abstract)

POPIVNYAK, I.V. AND LAZ'KO, Ye.Ye., 1973, Inclusions of mineral-forming media in minerals of kimberlites: Abstracts of papers at Fourth Regional Conference on Mineral-Forming Processes: Rostov, Rostov Univ. Press, p. 217-218 (in Russian; translation through the courtesy of A. Kozlowski). Authors at Lvov Univ.

1. In olivine and garnet from kimberlite rocks of the Udachnaya and Mir diamond-bearing pipes (Yakutia), microinclusions were found and studied. Inclusions were observed in xenocrysts from the main mass of the kimberlites as well as in minerals from xenoliths of ultrabasic rocks. Olivine from the main mass of the kimberlites is the richest in inclusions. Microinclusions were found more rarely in phenocrysts of orange-red garnet. In minerals of xenoliths of ultrabasites, microinclusions were observed in single cases only in olivine and orthopyroxene from lherzolites. Microinclusions were not found in violet garnets from xenoliths of kimberlites.

2. On the basis of composition and phase state, the investigated inclusions are magmatic (solidified) melt inclusions (Ermakov, 1972) and are divided into amorphous gas-glassy and partly crystallized inclusions, bearing gas (up to 35%), and glass (up to 25%) plus 2 or 3 crystal phases.

Amorphous inclusions can be divided into two varieties: a) glassy and b) gas-glassy. For a) the absence of one clearly expressed gas phase is typical. Gas as tiny bubbles is dispersed in whole volume of glass. Inclusions of variety b) bear one or several gas bubbles (glass 80-95%, gas up to 20%).

Partly crystallized inclusions bear a crystal aggregate plus gas plus glass plus liquid (?) with widely varying amounts. Daughter minerals are represented by 3 varieties: most common are pale-orange elongated cyrstals occupying up to 30% of the volume of the vacuole. Some inclusions bear up to 6 such crystals. Colorless cubic or prismatic crystals are rarer; an opaque dark mineral is very common, occurring as well developed cubic crystals or aggregates with irregular shape.

3. Genetically, the inclusions may be divided into 3 groups: primary (?), pseudosecondary, and secondary. Primary and pseudosecondary inclusions in garnet and in olivine are partly opened (decrepitated). Secondary inclusions are widely developed in olivines and are characteristic for garnets with kelyphite rims.

4. Presence of decrepitated inclusions indicates the sharp decrease of P in the system at a certain stage of evolution. Presence of amorphous and partly crystallized inclusions in the same grain supports such conclusions and besides it proves that olivine is the "thourgh" mineral of the kimberlites (it crystallizes at all stages of development of the magmatic chamber). Presence in inclusions of numerous other phases may be explained by somewhat increased concentration of mineralizers in the primary belt. (Authors' abstract)

POTY, B.P., LEROY, J., and CUNEY, M., 1974, Fluid inclusions in uranium ores from intragranitic deposits in Limousin and Forez (Massif Central, France): in Formation of Uranium Ore Deposits, Proceedings of a Symposium, Athens, Greece, 6-10 May 1974: Vienna, Internat. Atomic Energy Agency, p. 569-582. First author at Centre de recherches pétrographiques et géochimiques, Vandoeuvre-lès-Nancy, France.

Fluid inc. studies have been performed utilizing a variety of techniques: crushing stage, microthermometry and gas chromatography on samples from uranium deps. located in granites from Massif Central: Limousin and Forez.

In Limousin uranium is mined from veins and in hydrothermally altered pods of the Saint-Sylvestre two-mica granite. Only the second type of occurrence has been studied. Fluid incs. show that a clear relation exists between uranium grade and CO_2 conc. in the fluid, that boiling occurred at the time of trapping, and that dep. occurred at 340-350°C and P ∿ 700-800 bars. This strongly suggests transport of uranium as uranyl carbonate complexes, and dep. due to unmixing of the solution. Reduction of the uranyl ion is not fully understood. A reaction coupled with oxidation of ferrous iron does not seem adequate since hematitic alteration is not ubiquitous.

In Forez (Bois Noirs - Limouzat vein) a detailed paragenesis in six stages has been worked out. The dep. of quartz-marcasite-pitchblende and pyrite (1st stage), is followed by hematitic quartz (2nd stage). At that time pitchblende was slightly altered into coffinite and epidote + adularia grew in the surrounding rocks. Then banded smoky quartz (3rd stage), fluorite, carbonates, and whewellite (4th stage) were formed. A late generation of quartz + bismuthinite crosses most previous generations (5th stage) and supergene alteration during alpine orogeny and present time ended the evolution of this vein (6th stage).

Characteristic fluids have been isolated for the first five stages. Ts and compositions varied quite widely and suggest a complex genesis for this vein-type dep. Fluids associated with pitchblende dep. as well as those associated with bismuthinite are rich in CO_2 and suggest, as in the case of Limousin, transport of uranium through uranyl carbonate complexes. Reduction of the uranyl ion was probably controlled by a constituent of the solution. (Authors' abstract.)

POTY, B.P., STALDER, H.A., and WEISBROD, A.M., 1974, Fluid inclusion studies in quartz from fissures of Western and Central Alps: Schweiz. Min. Petr. Mitt., v. 54, no. 2/3, p. 717-752 (in English).

Fluid incs. in quartz crystals of more than 120 alpine fissues from western and central Alps (Pelvoux, Mont Blanc, Aar, Gotthard and the Pennines) have been studied.

Microthermometry (freezing and heating) gives ests. of the chem. comp. of the fluids in terms of three components: water, NaCl (for all the salts) and CO_2. Density ests. may be inferred as well. It is shown that fluids are mainly aqueous salt sols., except in the Gotthard and the Pennines, where CO_2 becomes an important component.

Chem. anal. of fluids occurring in incs. give the relative amounts of the following solute components: K, Na, Ca, Mg and to a lesser extent, Cl and SO_4. The K/Na ratio seems to be well buffered in feldspar-bearing rocks. After it has been shown that albite grew in the disordered structural state, even at rather low Ts, the equil. constants of the system adularia-high albite-KCl-NaCl aqueous sol. are calculated and used as a tentative geothermometer. Ps and depths of form. have been estimated using the densities of the fluids (calculated from microthermometry results).

Est. Ts increase from the Pelvoux massif (340°C) to the Gotthard massif (505°C). On the other hand the P (2.5 to 3 Kbar) and the overburden (9.5 to 11 km) are rather constant all over the Mont Blanc and Aar massives. (Authors' abstract) Ed. note: This abstract does not convey adequately the scope of this important paper. There are major sections on microthermometric technique, large tables of specific microthermometric results and 78 analyses of water leaches (all for K, Na, Ca, and Mg, and many for Cl and SO_4 also). (ER)

POTY, Bernard, WEISBROD , Alain, and STALDER, H.A., 1973, Temperature and pressure of quartz crystal growth in the Alpine fissures of the French and Swiss Alps (abst): Sci. de la Terre, Réunion Annuelle, Paris, 1973, p. 343 (in French; translation courtesy Chris Eastoe). First author at Centre de Recherches Pétro. et Géochim., C.o. no.1, 54500 - Vandoeuvre-les Nancy, France.

Fluid incs. in quartz xls. from 50 cavities distributed throughout external xline. massifs of the Alps, the Simplon and the Tessin have been studied.

A classical microthermometry study has established the isochore (P.T. curve) of the fluid, as well as a minimum T of trapping since the fluids were generally located in the one-phase field.

Quant. chem. anal. of the aqueous phase for K and Na in the light of exper. work by Wyart and Sabatier (1956) and Orville (1963) allows the T at which the sols. were in equil. with feldspars to be deduced, with the following results: 1) The K/Na values are not always constant for diff. cavities of a single massif, but taken together the results suggest that there was indeed equil. for the alkali exchange reaction between feldspars and sols. 2) In the sequence Pelvoux, Mont Blanc, Aar, and Simplon (and Tessin) there is a progressive increase in K/Na. This indicates a progressive increase in the T of quartz growth. When the T is known, the P may be found from the isochore. The T and P values for the four areas are as follows (°C and bars): 360-375, 2350-2500; 385-425, 2400-3000; 395-475, 3700-3750; 450-545, (no P given). A number of measurements are minimum values. The certain presence of $CO_3{}^{2-}$ and $SO_4{}^{2-}$ increases the activity of K relative to Na.

There are complex time relations between fissuring and meta. In all cases, however, high Ts and Ps are indicated, and these must be integrated into the history of the Alpine meta. (Authors' abstract, shortened) (This item was briefly abstracted in the previous volume of COFFI).

PRASOLOV, E.M. & ZAKHARCHENKO, A.I., 1974, Isotopes of noble gases as source of information on conditions of formation of pegmatites, greisens, and hydrothermal veins: Internat. Assoc. on the Genesis of Ore Deposits, Fourth Symposium, Varna, Sept., 1974, Abstracts of Papers: Sofia, IAGOD, p. 212-213 (in Russian; translation courtesy A. Kozlowski). First author at All-Union Scientific-Research Geol.-Prospecting Inst., Leningrad.

1. (...)

2. Ar and He isotopes were measured in G/L incls. in minerals from chamber rock-crystal-bearing pegs., vein mica-bearing pegs., rare metal greisen bodies, and hydrothermal quartz veins of various regions of USSR. Gas was released by crushing or heating of incls. in ∿10-gm samples.

3. The occurrences listed above show a regular $\geqslant$ 10-fold of Ar^{36} (Ar^{40}_{air}), $Ar^{40}_{air}/Ar^{40}_{radiogenic}$ & Ar^{40}_{air}/He^4. In chamber pegs. the minimum amount of Ar^{40}_{air} was = $0.07 \times 10^{-6} cm^3/g$ (less than 0.002 vol. % in gas). In mica-bearing pegmatites the amounts are somewhat higher, and greisens showed $(0.2 \text{ to } 0.8) \times 10^{-6} cm^3/g$ (less than 0.007 vol. %). Maximum values occur in hydrothermal veins - $(1 \text{ to } 2.5) \times 10^{-6} cm^3/g$ (up to 0.15 vol. %). Results prove that chamber pegs. formed mainly from deep fluids practically without influence of vadose waters and air, whereas hydrothermal ore-bearing quartz veins and especially post-ore veins are strongly enriched in atmospheric Ar, testifying to formation of these veins in more open systems.

4. He^3/He^4 ratio in chamber pegs. = $(1 \text{ to } 4) \times 10^{-7}$, being by about two orders lower than in mantle gases and an order higher than in "normal" gases in Earth's crust. These data testify to scarce role of mantle fluids during formation of chamber pegs.

5. The published paper will give data on conc. of radiogenic isotopes

of He & Ar in the samples. (Authors' abstract, shortened by A.K.)

PRICE, L.C., 1973, The solubility of hydrocarbons and petroleum in water as applied to the primary migration of petroleum: PhD dissertation, Univ. of Calif. Riverside, Calif. 298 pp. Author at U.S. Geol. Survey, Denver, Colo.

The solubs. of petroleum and petroleum-forming hydrocarbons in distilled water increase as a function of T. The increase is gradual to ∿100 C where a more drastic increase takes place. Two different solub. mechs. were found in the range 25°C to 180°C in which solub. data were collected. In a family of cpds. the aqueous solubs. of the more insol. (higher boiling) cpds. increase at a far greater rate than the solubs. of the more soluble (lower boiling) cpds. At 180°C the solubs. of all cpds. and oils are drastically increased over the 25°C values (15-400 fold).

The presence of a N(O or S) atom on a hydrocarbon molecule drastically increases the molecule's water solub. Increases in T increase the aq. solub. of the aromatic nucleus much more than that of the cycloalkane nucleus which is affected slightly more than the iso-paraffinic or paraffinic nucleus. Salinity increases cause decreases in the aq. solubs. of hydrocarbons. The salting out effect is extreme (90-95%) in saturated NaCl sols.

The solub. data collected here supports the hypothesis of primary migration by molecular sol. Published literature shows adequate amounts of water at great depths (20,000-30,000 feet) in clastic basins to account for petroleum deps. Rough mass balance calcs. also support primary migration by molecular sol. The author believes fault planes serve as the main conduits for movement of water and hydrocarbons from great depths. Decreases in T and increases in salinity are proposed exsolution mechs. Only a small percentage of the world's petroleum could have undergone primary migration by molecular sol.

The n-paraffin distribs. of some crude oils conclusively show that these oils could not have undergone primary migration by molecular sol. Further, these n-paraffin distribs. show that these oils underwent a flush type migration before full source bed maturation was reached. The n-paraffin distribs. of other crude oils support the hypothesis of primary migration by molecular sol.

The depth rule of Barton (1934) can be explained by long secondary migration with the increased influence of hydrodynamic meteoric systems with decrease in depth. Leaching of a mature petroleum by molecular sol. would result in the immature crude of Barton (1934). (Author's abstract)

PRINS, P., 1973, Apatite from African carbonatites: Lithos, v. 6, p. 133-44. Author at Geol. Dept. Univ. of Stellenbosch, Stellenbosch, C.P. South Africa.

Apatite from three African carbonatites (sövites) are of the carbonate-hydroxy-fluorapatite type with a marked similarity in composition and structural formula, but differ from that of an apatite-magnetitic dike assoc. with carbonatite, and from apatite of ign. or meta origin. (From the author's abstract) (Ed. note: of pertinence to the many studies of incs. in carbonatite apatites.)

PRZENIOSLO, Stanislaw, 1974, Zinc and lead in the Triassic carbonate rocks in the vicinity of Zawiercie: Biul., inst. Geol., Warsaw 1974,

v. 278, p. 115-199 (in Polish). Author at Inst. Geol., Warsaw, Poland. C.A. v. 83, no. 10, p. 166991n, 1975.

Two generations of ore-bearing dolmites are recognized, based on petrog. and thermoluminescent data. Decrep. studies indicate the form. T of galena (140-220°), sphalerite (170-225°), and barite (190-250°). A hydrothermal origin is suggested for ore localization.

PURTOV, V.K., and POKROVSKII, P.V., 1973, Major formation regularities of quartz veins of rock crystal and tungsten deposits of the Urals: Ezheg., Inst. Geol. Geokhim., Akad. Nauk SSSR, Ural. Nauch. Tsentr 1972 (pub. 1973), p. 163-168 (in Russian). C.A. v. 81, no. 5, 52457w.

Ratio of H_2O/CO_2 concns., CO_2 concn., and total d. were detd. for gas-liq. incs. in veined quartz and in quartz crystals on the Akmullin, Western, and Astaf'ev deps. Rock crystal-bearing quartz veins were formed from hydrothermal heterogeneous solns. of high d. (>0.7 g/cm^3). These solns. contained various amts. of salts (2-40 wt. %) and dissolved CO_2 (<16 molar %). Veined and cryst. quartz was formed under small T (10-60°) and P (170-750 torr) variations. Form. of the veins was connected with P drop, decrease of CO_2 soly. in H_2O solns., and with lowering of the d. in all deps. and with increase in the min. of solns. in the Astaf'ev dep. CO_2 sepn.-dissoln. processes compensate for P variation and keep const. both the degree of oversatn. of the soln. with SiO_2 and the rate of its xliz. Acidity of hydrothermal solns. increases with lowering T or with increase in P at const. CO_2 concn. A geol. description of the title deps. is given.

PUZANOV, L.S., 1972, Formation temperatures and temperature zoning of fluorite mineralization: Geol. Rudn. Mest., v. 14, no. 4, p. 66-75 (in Russian).

T data on 57 fluorite deps. were reviewed. Individual T_H ranged from 60° to 300°C, but the range of T_H is generally <50°C for a given deposit. (E.R.)

PUZANOV. L.S., 1973, On regional differences in the temperatures of the origin of industrial types of fluorite ores: Abstracts of papers from the Fourth Regional Conference on Thermobarogeochemistry of Mineral-forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 126-128 (in Russian; translation through the courtesy of A. Kozlowski). Author at All-Union Institute of Mineral Raw Materials, VIMS, Moscow.

1. 2. (Geological)

3. Fluorite mineralization occurs as a polystage process at temp. 300-60°C, with the major amount of fluorite cyrstallizing from low-temperature hydrotherms in narrow temp. ranges that are different for various deposits of USSR.

4. Fissure-type deposits are characterized by temp. decrease during mineralization of 10-40°C, fluorine-metasomatic-type deposits - 40-70 to 90°C.

5. The lowest-temperature deposits in USSR are known from Kazakhstan (80-150°C). Temp. decrease in ore bodies of fissure type varies from 15 to 45°C, and in metasomatic from 70 to 90°C. The whole range of all generations of fluorite changes from 60 to 270°C.

6. The highest temperature deposits occur in metasomatites of the Ukrainian cyrstalline shield. Commercial fluorite ore has precipitated in the temp. interval 145-200°C, with a temperature

drop of 50-55°C. Precipitation temp. range for all generations of fluorite ranged from 100 to 300°C.

7. Comparable temp. of origin were ascertained for deposits of Gornyi Altai. Most fluorite crystallized at 120-220°C during a temp. drop of 30-40°C for veins and 50-70°C for metasomatic bodies. All generations of fluorite crystallized in the temp. interval 80-270°C.

8. An intermediate position is occupied by vein deposits of E and W Zabaykal'ye, Tadzhikistan and Uzbekistan. Commercial fluorites crystallized in the interval 110-180°C with a temp. drop of 20-40°C, in individual cases 50°C. All generations give temp. ranges 90-260°C.

9. The large temp. decrease during metasomatic replacement of carbonate rocks by CaF_2 explains the greater amounts of fluorite ores at metasomatic deposits. (. . .). (Author's abstract, abbreviated by A.K.)

RADTKE, A. S., and DICKSON, F. W., 1974, Controls on the vertical position of fine-grained replacement-type gold deposits (abst.): Internat. Assoc. on the Genesis of Ore Depsoits, Fourth Symposium, Varna, Sept. 1974, Abstracts of Papers: Sofia, IAGOD, p. 68-69 (in English). First author at U.S. Geol. Surv., Menlo Park, Calif.

The fine-grained gold deps. of the western United States, of which the Carlin and Cortez deps. are representative, constitute a hitherto not recognized class of ore deps., which were formed by the action of ascending hot waters that penetrated to the earth's surface or to shallow depths below the surface. Conditions during dep. of ore ranged from the low T and P of the hot-spring environment to more normal epithermal conditions up to 225°C and 25 bars. These deps. were formed in part under the lowest T-P conditions for epithermal ore deps. (From the authors' abstract.)

RADTKE, A.S., DICKSON, F.W., and RYTUBA, J., 1974, Genesis of disseminated gold deposits of the Carlin type (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 6, p. 239-240. First author at U.S. Geological Survey, 345 Middlefield Road, Menlo Park, California 94025.

Similar features of 11 disseminated gold deposits of the Carlin, Nevada, type, suggest a common origin: dep. at shallow depths from hydrothermal sols. that boiled at one stage. All deps. show: exceedingly fine grained ore mins.; relatively unstable organic cpds. in or near ore; fault zones with dikes; oxidized above unoxidized rocks; fine-grained silicified rocks and surface jasperoids; and argillic alt. Visible gold and gold-bearing quartz veins are rare. As, Sb, and Hg occur with gold and in surrounding halos. Tl persistently occurs in high-As ores.

Shallow dep. from epithermal to hot-spring sols. is proposed, and the former presence of gas-boiling water interfaces is suggested by boundaries between altered and unaltered rocks and between oxidized and unoxidized rocks. Gold and the associated elements were deposited by ascending hydrothermal fluids, which also promoted some argillic alt. Oxidation and additional argillic alt. happened in waning stages, when the gas-water interface lowered itself into prevously min. rocks. (From the authors' abstract)

RAFAL'SKIY, R.P., 1973, Transportation and deposition of some metals by hydrothermal solutions: Geol. Rudn. Mest., v. 15, no. 1, p. 16-32 (in Russian).

The author generalizes the reference data on anion comp. of hyd. sols., concs. of Pb, Cu and Ag (from anal. of fluid incs.) and geochem. important complexes of these metals. Quan. role of Cl^-, HS^-- and CO_3^{2-}- complexes in hyd. process is evaluated, as well as the reasons for pption of heavy metals from hyd. sols. (Author's abstract, translated by A.K.)

RAKHMANOV, A.M., KHITAROV, D.N. and ROSSEYKIN, L.V., 1973, Geochemical and thermodynamic peculiarities of skarn-forming solutions (Central Tadzhikistan: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 145-146 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at All-Union Institute of Mineral Raw Materials, Moscow; Tadzhikistan Univ.; Office of Geology at Council of Ministers of Tadzhik SSR, Dushanbe.

1. (...) At skarn deposits of S. Hissar the following stages were distinguished: skarn, rare-metal, quartz-sulfide, quartz-carbonate (sometimes with fluorite). T_H and T_D were measured in pyrrhotite, calcite and fluorite, covering all intervals of ore formation at the investigated deposits.

Minerals	Stage	Temp. interval, °C
Pyroxenes, garnets	Skarn	600 - 400
Scheelite, cassiterite, quartz I	Rare-metal	420 - 226
Pyrrhotite, sphalerite, quartz	Quartz-sulfide	420 - 200
Quartz, carbonates, fluorite	Quartz-carbonate	200 - 180

2. P of mineral-forming solutions was determined by use of CO_2-bearing inclusions in quartz I. The majority of determinations gave values 750-650 atm, with some equal to about 800 atm.

3. Results of chemical analysis of triple water leachates from pyroxenes, garnet, scheelite, cassiterite, quartz and sphalerite of the main stages of ore-formation prove that skarn-forming solutions had a mixed bicarbonate-fluoride-chloride composition. Main cations are alkline metals: Na exceeds K. Solutions also bear Al and Mg. The composition of the solutions changed slightly during formation of the quartz-feldspar-scheelite-cassiterite association. Cassiterite precipitated from mixed fluoride-chloride-bicarbonate solutions; scheelite and quartz crystallized from essentially fluoride solutions. During formation of cassiterite and scheelite Ca was the main cation, and during crystallization of quartz Na prevailed. D During the quartz-sulfide stage, scheelite II crystallized from essentially fluoride solutions, sphalerite - from bicarbonate-sulfide and quartz - from chloride solutions. The main cations for scheelite II and sphalerite was Ca, and for quartz was Na. Quartz of the quartz-carbonate stage formed from mixed bicarbonate-Na-Ca solutions. (Authors' abstract, abbreviated by A.K.).

RANKIN, A.H., and LE BAS, M.J., 1974, Nahcolite ($NaHCO_3$) in inclusions in apatites from some E. African ijolites and carbonatites: Mineral. Magazine, v. 39, p. 564-570. Authors at Dept. Geol. Univ. of Leicester, Lei 7RH, England.

Nahcolite ($NaHCO_3$) is ident. and recorded for the first time from an igneous rock. Often associated with it is another carbonate min. tentatively ident. as kalicine ($KHCO_3$), which has not previously been recorded as a primary min. in any rock. These min. occur in incls. in apatite xls. in ijolites and carbonatites, and indicate that both ijolite and carbonatite magma must have been considerably richer in soda and potash than is indicated by the chem. anal. of the rocks. The ident. was made by a combination of microchemical, sol., xlog., and optical det. (Authors' abstract)

RASUMNY, J., 1974, Cavities and inclusions in quartz from King Solomon mines (Mene'iyeh). Some aspects of their studies under the scanning electron microscope (abst.): Internat. Mineral. Assoc. Ninth Gen. Meeting, West Berlin and Regensburg, W. Germany, Collected Abstracts: West Berlin, German Mineralog. Soc., p. 27 (in English). Author at Orsay, France.

Quartz from this copper occurrence has been studied under the scanning electron microscope at the "Museum d'Histoire Naturelle de Paris." Replicas of broken surfaces (electron fractographs) have shown, besides the intragranular incs. already described from other localities by various authors (e.g., J. Verdier et al.), intergranular cavities, and contacts between quartz and other minerals (at magnifications >20,000). Some conclusions are drawn as to the possibilities of capillary circulations of ore-forming fluids. (From the author's abstract.)

RATMAN, I.P., AREVADZE, D.V. AND GIGIADZE, G.V., 1973, Temperature conditions of formation of a gold - polymetallic deposit from Little Caucasus: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 52 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Caucasian Institute of Mineral Raw Materials - KIMS, Tbilisi.

Au-polymetallic deposits of Little Caucasus are localized in the zone of the Tezhsar-Dilizhan-Kazakh system of transverse fractures, controlling also sulfur-pyrite mineralization (with Au).

On the basis of homogenization and decrepitation of inclusions in quartz, carbonates, pyrite, chalcopyrite and sphalerite, the formation of sulfo-pyritic ores began at temp. 340-380°C, and gold-polymetallic - at 280° - 320°C.

The narrow temp. range of inclusion homogenization (in quartz 260 - 280°C, in sphalerite 275 - 285°C) and beginning of mass decrepitation (chalcopyrite 280 - 300, pyrite 280 - 320, quartz 260 - 280, carbonates 260 - 280 and 200 - 220°C) support the conclusion received from general geological data on one-stage development of ore mineralization.

In the deposits a simple vertical zonation of precipitation was ascertained, indicated by relatively large amounts of high-temp. (280-320°C) quartz-pyrite and quartz-pyrite-chalcopyrite associations in deep ore bodies, and polymetallic and Au ores occur in shallow deposits. In the same direction the role of carbonates increases and barite appears. (Authors' abstract).

REKHARSKIY, V.I., 1974, Zoning of metasomatites and ore mineralization at molybdenum deposits: in: Zonality of hydrothermal ore deposits, G.A. Sokolov, ed.: Moscow, Izdat. "Nauka," v. 1, p. 148-176 (in Russian; abstract courtesy A. Kozlowski).

Author gives the following classification of hydrothermal-metasomatic Mo ore mineralization, based on data from Russian deposits:

Hydrothermal-metasomatic formations	Mineral associations	Typical elements	T_H of inclusions in minerals, °C
I. Feldspar-quartz	1. Molybdenite	Mo, W, Cu	420-240
	2. Scheelite-molybdenite		
	3. Chalcopyrite-magnetite-molybdenite		
II. Greisen	4. Molybdenite	Mo, W, Be	380-260
	5. Wolframite-molybdenite		
	6. Wolframite-beryl-molybdenite		
III. Quartz-sericite	7. Chalcopyrite-molybdenite	Mo, Cu	320-200
	8. Pyrite-molybdenite		
IV. Berezitic and argillitic	9. Pitchblende-molybdenite	Mo, U	220-90

REKHARSKY, V.I., and PASHKOV, Yu.N., 1973, The problem of the temperature of formation of endogenic molybdenum mineralization: Geol. Rudnykh Mestoro., v. 15, no. 4, p. 19-26 (in Russian; abstract courtesy T. M. Sushchevskaya).

Systematic studies of T_H were made for different Mo deps. (particularly Sarskoye, Kadjaran, and Chorukh-Diron). T_H range 550-90°C is typical for Mo-ores connected with pegmatites and hydrothermal metasomatism. Every variety of Mo ore is characterized by definite T limits. During postmagmatic ore formation T decreases, so the T intervals for different types of deps. may overlap (see table).

T_H of mineral associations of Mo deps.:

Pegmatites and other types of ore deps.	Ore minerals and assocs.	T_H°C
Pegmatites, pegmatoids	Molybdenite	550-360
Feldspar-quartz formations	Molybdenite; $CaWO_4$ + molybd.; chalcopyrite + magnetite + molybd.	420-240
Greisen	Molybd.; wolframite + molybd.; wolframite + beryl + molybd.	380-260
Quartz-sericite formations	Chalcopyrite + molybd.; pyrite + molybdenite	320-200
Beresitized and argillized formations	Uraninite + molybd.; uraninite + jordisite + molybdenite	220-90

The presence of definite groupings indicates specific features of different ore types. P. incs. with liquid CO_2 are typical for quartz-feldspar and greisen formations; incs. with solid DMs. are typical for quartz-sericite formation; and G/L incs. are most typical for minerals from beresitized and argillized formations.

REKHARSKY, V.I., PASHKOV, Yu.N., and AVETISYAN, G.G., 1973, Fluid inclusion evidence on the environment of deposition of hydrothermal-metasomatic formations of the Kandzharan deposit: 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.88 89 (In Russian; translation provided by Dr. E.I. Dolomanova of I.G.E.M., Moscow). Authors at IGEM, USSR Academy of Sciences, Moscow, and Kandzharan Combinate.

Various hydrothermal-metasomatic formations are widespread at the Kandzharan copper-molybdenum deposit. The quartz-hornblende, quartz-tourmaline, epidote-albite, and quartz-biotite formations are early (pre-ore); the feldspar-quartz, quartz-sericite, and beresite formations belong to the period of mineralization; and the argillic formation is post-ore.

Because commercial molybdenum mineralization is associated with the feldspar-quartz formation, and the copper one with the quartz-sericite **formation**, these formations are called feldspar-quartz-molybdenite and quartz-sericite-chalcopyrite, respectively.

Gaseous and multiphase inclusions are characteristic of the early formations. Purely gaseous inclusions are abnormal in distribution, which suggests **zonation of the mineral-forming solution in some areas.** Multiphase inclusions homogenize at 440-320° to produce the liquid phase whose mineral content is equal, by freezing evidence, to 210-250 g/l. NaCl is the main component of the solution.

The metalliferous feldspar-quartz-molybdenite formation contains multiphase inclusions having liquid carbon dioxide. They homogenize into the liquid phase, at a critical point, at 360-250°. The mineral content of the solution is equal to 50-80 g/l.

Complex multiphase inclusions were found in the quartz-sericite-chalcopyrite formation, their mineral content reaching 600 g/l or more. KCl and NaCl are the principal components of the solution. The inclusions homogenize into the liquid phase at 280-180°.

In the beresite formation, quartz-sericite-pyrite metasomatites are recognized, quartz-pyrite veinlets being related to them, and quartz-sericite-carbonate metasomatites, non-commercial copper-zinc-lead mineralization being associated with them. They are characterized by fluid inclusions homogenizing into the liquid phase at 210-140° (mineral content equals 60-150 g/l) and by others homogenizing into the liquid phase at 190-110° (mineral content equals 50-80 g/l).

The investigation results indicate that the successive hydrothermal-metasomatic formations were deposited at decreasing temperature. The composition of fluid inclusions provides definite information on migration and concentration of ore components. (Authors' abstract).

REMESHILO, B.G., 1974, Typomorphic peculiarities of beryllium minerals from zanorysh pegmatites of Volhyn, paragenetic with quartz, in Typomorphism of Ukrainian Quartz, edited by Ye. K. Lazarenko, Acad. Sci. Ukr. SSR: Kiev, Naukova Dumka Pub. House, p. 61-62 (in Russian; translation courtesy A. Kozlowski). Author at Inst. of Geol. and Geochemistry of Fuels of Acad. Sci. Ukr. SSR, L'vov.

Beryl, phenakite, bertrandite, and euclase have χlized within wide T range (500-150°C), but under det. values of pH, a_K, a_{Na} and a_F. P incs. in beryl from zanorysh homog. in gas at 350-415°C and from metasomatites at 480-510°C; concs. of salts in incs. by cryometry are 5-7% of NaCl equiv.; pH in individual incs. is 8.0-8.2 ± 0.2 for zanorysh beryls and 7.2-7.5 ± 0.2 for metasomatites. Phenakite with rhombohedral habit χlized from sols. with pH 4.9-5.3 ± 0.2, T_H 370-380°C. T_H of incs. in bertrandite is 130-160°C and this mineral as well as prismatic phenakite χlized from Na-K-F sols. (A.K.).

RENFRO, A.R., 1974, Genesis of evaporite-associated stratiform metalliferous deposits - a sabkha process: Econ. Geol., v. 69, p. 33-45.

A theory of origin of stratiform deps. such as the Kupferschiefer and Roan by terrestrial form. water at low pH and high Eh picking up Cu Ag, Pb, and Zn, and ppting. it in H_2S-charged algal mat facies of coastal sabkhas. (ER)

REUTIN, J.V., PAL'MOVA, L.G., AND KHITAROV, D.N., 1973, Temperature conditions and chemistry of ore-genesis in the rare-metal deposits of the region (sic.): Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30, Sept., 1973: Rostov, Rostov Univ. Press, p. 62-64, (in Russian; translation provided through the courtesy of N.P. Ermakov). Authors at Union Institute of Mineral Resources, Moscow Ordzhonikidze Geological Prospecting Institute, U.S.S.R.

1. At present geologists of the region have at their disposal results of several studies of physico-chemical characteristics of ore-forming processes based on gas-fluid inclusion data. The researches resulted in preparing a summary on the large number of ore samples that gave an opportunity to carry out a comparable analysis of physico-chemical properties of the existing mineral formations.

2. According to the geological characteristics of different parts of the region and its deposits the following short classification can be made: (1) Rare-metal-phosphate-zirconate; (2) Rare-metal formation itself in connection with albitization; (3) Rare-metal-fluoride formation; (4) Rare-metal-molybdenite.

3. The first and the second types are wide-spread in the deposits localized in Lower Paleozoic rocks. The first and the second types appear mainly in the volcanic rocks of the Devonian.

4. Mineral associations of ore deposits have been studied by decrepitation and homogenization methods and by aqueous extraction of liquid phase of inclusions (CO_2, H_2S, HCO_3^-, F, B).

5. The first mineral type is the highest temperature formation. Typomorphic minerals of the ore-stage have relative temperatures of formation up to 350°-280° and the post-ore ones (quartz, carbonate) up to 240°-180°C. This type reveals a quite clear (sometimes genetic) relation with products of the final magmatic phases. Typically the concentrated mother liquors, with an index of common mineralization of Q 300, (show) a great role of H_2S, and prevalence of the gas phase in inclusions.

6. The second and the third formations have obvious similarity, particularly by temperatures of formation of ore and post-ore products of 310°-250°C and 240°-200°C respectively, and by mineralogic-geochemical characteristics (presence of Zr, P, Ti) with some variation of the mother liquors. The prevalent components of inclusions for the second type of formation are HCO_3^- and F in a less degree. However, F has a primary importance in the third type.

Being in different geological-structure position and rock complexes these mineral types don't demonstrate any clear relation with volcanic-plutonic formations.

7. The fourth type of ore association is found mainly in volcanic rocks in one part of the region. Typomorphic minerals of the ore-stage (Femolit, nasturine; sic.) have decrepitation temperatures 220°-180°C and 180°-80°C respectively. They are ordinary telethermal vein deposits localized either within or at the tops of volcanic piles. These deposits are distinguished by: presence of highly volatile impurity elements in the ores (As, Sb, Hg, Bi, B), the presence of highly concentrated mother liquors with considerable CO_2 and HCO_3^-, and the existence of a clearly expressed vertical temperature gradient for the ore forming solutions. (50°C/250-300m). (Authors' abstract).

REYF, F.G., **1973a**, On nature and petrogenetic significance of muscovite-bearing inclusions in quartz of granites: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 194-195 (in Russian; translation provided through the courtesy of A. Kozlowski). Author at Inst. of Geology of Buryat Division of Siberian Branch of Acad. Sci. of USSR.

Published data on the composition of solid phases in crystallized melt inclusions point to a continuous presence of feldspars among the products of crystallization. However, during investigation of shallow biotitic granites of the post-orogenic Zazinskiy Complex (Buryat Autonomic SSR) it was ascertained that in rock-forming quartz of unaltered rocks feldspar-free quarte-muscovitic inclusions are very common and that they also are microportions of melt included by the growing crystals. As a result of precipitation of quartz on the faces of vacuole in optical continuity with the host-mineral, masking the boundaries of the inclusion, at room temp. the latter are seen to be minute (5-25, rarely 80-100 μm), partly faceted individuals or aggregates of muscovite (with the plane of optical axes ± (010); Ng = 1.591 ± 0.002; - 2V = 32°) with a pressed, round or deformed gas bubble making up 3-10 vol. % of the vacuole.

During heating up to 700°C the solid phases do not transform in any visible way. At 730-750°C on the boundary of quartz and muscovite a melt appears; at 750-800°C gas dissolves in the melt; at 800-850°C muscovite itself melts and the vacuole stops enlarging. Homogenization of inclusions with a diameter ca. 10 μm usually is not achieved in less than 3-5 hours. Continuous presence of gas in the inclusions, stable phase ratios, and a narrow T interval of melting prove that these inclusions are of the crystallized melt type.

Transition of muscovite into melt without initial dehydration in sealed inclusions, and the cessation of melting and decomposition of mica in opened inclusions prove the existence, inside the inclusions of high H_2O vapor pressure (not less than 3200 bars) at the time of equilibrium of muscovite with melt. However on the basis of observed T_H, P_{H_2O} was much lower in the primary melt, and did not exceed 400 bars, according to calculations.

Analysis of the course of homogenization of quartz-muscovitic inclusions on the basis of data on silicate - H_2O systems under isochoric conditions leads to the inclusion that these relations during crystallization of water-poor granitic magmas may and ought to appear only when the melt, at the moment of trapping, was under high general pressure P_G, i.e. $P_{H_2O} < P_G > 3.2$ kbar. The minimal value of P_G is 3.2 kbar (≈ lithostatic pressure at a depth of ca. 12 km). For this reason the occurrence of quartz-muscovitic inclusions in quartz of shallow granites means that the magma has intruded under high pressure, at 1500-2000 bars. (Author's abstract)

REYF, F.G., **1973b,** 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; trans. in Doklady Acad. Sci. USSR, v. 213, (1975), p. 172-174; abstract in Internat. Geol. Rev., v. 16, no. 2, p. 241. Author at Buryat Section of the Sib. Br. the USSR Acad. Sci., Ulan-Ude. Abstract courtesy T.M. Sushchevskaya, modified by E.R.

Microscopic and T studies were made of incs. in quartz of potassium feldspar - biotite granites of the Rurbinsky and Andysky massives (several thousand km^2). The P. incs. were found to be xlized. melt type. Phase transitions in them were studied in heating stage (≤1000°) with water cooling of the objective lens. T_H was det. on 67 P incs. Crystal phases, ident. as colorless mica (possible muscovite) and quartz occupied most of the inc. volume. The volume of gas: muscovite: quartz was 10:41:49, yielding quartz -52 and muscovite -48 wt. %. During heating, full-melting of incs. ≤10μm diameter occurred in 3-5 hrs. at 800-830° for quartz from granites and at 915-935° for quartz from granite-porphyries. Incs. >10μm diameter and also about 70% of the small size incs. exploded during heating because of very high Ps. It was suggested that the obtained Ts reflected the conds. of form. of comparitively dry granite melts.

RIDGE, J.D., 1974, Note on boiling of ascending ore fluids and the position of volcanic-exhalative deposits in the modified Lindgren classification: Geology, v. 2, p. 287-288. Author at Dept. of Min. Econ. Penn. State Univ., University Park, PA 16802.

The data of Haas (1971) on the boiling curves for saline solutions are used to show that hydrothermal fluids coming out on the ocean floor can frequently be expected to boil under the pressures involved. (Of pertinence to interpretation of inclusions in some deposits such as the Kuroko type). (ER)

ROBINSON, B.W., 1974, The origin of mineralization at the Tui mine, Te Aroha, New Zealand, in the light of stable isotope studies: Econ. Geol., v. 69, p. 910-925.

The Tui mine lies within the old Hauraki Au field of the Coromandel Peninsula, 130 km NNW of the Taupo volcanic zone. Pb, Zn, Ag and Au have been recovered from quartz veins in hyd. alt. Tertiary andesites which overlie Mesozoic graywackes. The Tui mine paragenesis is divided into four stages: (1) pyrite I + chalcopyrite I + hematite + quartz; (2) galena + sphalerite + quartz, followed by minor pyrite II + chalcopyrite II; (3) minor hematite, barite, cinnabar, kaolinite, and carbonates; and (4) cerussite, smithsonite, and other supergene mins.

The fractionation of sulfur isotopes between coexisting pairs of mins. indicates T_F of 400° ± 80°C for pyrite I/chalcopyrite I and 320° ± 60°C for sphalerite/galena. Ts derived from quartz, carbonate, and barite/water oxygen isotope fractionation show a gradual decrease from about 250°C at the end of Stage 2, to about 60°C at the end of Stage 3, and about 30°C for the form. of the supergene carbonates.

$\delta^{34}S$ values of the sulfide mins. range from +5 to -3 per mil (CDT). A small systematic decrease with time is evident, but most of the variation is probably due to changes in oxidation potential of the ore fluid at pH < about 5. Some Stage 3 barite ($\delta^{34}S = +16$ per mil) is thought to have ppted when oxidized S species were dominant in the ore fluid. The $\delta^{34}S_{\Sigma S}$ of the system must thus be about +16 ± 1 per mil and the origin of the S is thought to be Jurassic sea-water sulfate leached from the graywackes. Equil. reduction of half of this sulfate to H_2S in the early stages would give $\delta^{34}S$ values of +24 per mil and +5 per mil for the sulfate and H_2S respectively. C isotope values of the vein carbonates become heavier with time and decreasing T through Stage 3, following the predicted $CaCO_3$-H_2CO_3 fractionation. They indicate a $\delta^{13}C_{\Sigma C}$ value of -6.4 ± 1 per mil (PDB) which suggests that the CO_2 is magmatic.

Present-day hot spring activity occurs at Te Aroha near to the Tui mine. The thermal water shows an O isotope shift of almost 4 per mil relative to the meteoric water ($\delta^{18}O = -5.5$ per mil SMOW, $\delta D = -30$ per mil SMOW). An anal. of P fluid incs. from vein galena gives $\delta D = -70 \pm 1$

per mil together with a calculated $\delta^{18}O$ value of 0.0 ± 1.0 per mil for the early fluid. S fluid incs. from sphalerite and Stage 2 quartz give δD values of -17 ± 1 per mil and -35 ± 1 per mil respectively. P fluid incs. from Stage 3 quartz give measured values of $\delta^{18}O = -1.0 \pm 0.2$ per mil and $\delta D = -24 \pm 1$ per mil. The initial ore fluid was possibly of magmatic origin and underwent O isotope exchange at submagmatic Ts during circulation in the graywackes. Faulting increased the rate of circulation of these fluids and prompted the onset of min. It may have also initiated a geothermal system whereby the later ore fluids were deeply circulating meteoric water. The δD values of the latter are heavier than present-day meteoric water. This is probably due to the warmer Tertiary climate.

Published Pb isotope data suggest that the Pb is derived from the graywackes. (Author's abstract)

ROBINSON, B.W. and BADHAM, J.P.N., 1974, Stable isotope geochemistry and the origin of the Great Bear Lake silver deposits, Northwest Territories, Canada: Can. J. Earth Sci., v. 11, p. 698-711. First author at Inst. of Nuc. Sci., D.S.I.R., Lower Hutt, New Zealand.

These are U-Ag-Bi-Co-Ni-As-Cu deps. The vein mineralogy is consistent with an ore fluid of high oxidation potential, low sulfur content (10^{-3} m) and low pH (∿4).

Dolomite $\delta\ ^{13}C$ and $\delta\ ^{18}O$ values of around -4‰ (PDB) and +15‰ (SMOW) resp. from all stages reflect a relatively constant T of dep., which from min. and other data is estimated at 200°C. A $\delta\ ^{18}O$ value of +2‰ (SMOW) is calc. for the ore fluid. The bulk of the sulfide $\delta\ ^{34}S$ values are around +1‰ (CDT), which suggests a magmatic sulfur source. However, an equil. model is presented whereby the sulfur is derived from Precambrian sea-water sulfate and the carbon from limestones. The embryo ore fluid (connate sea water?) probably circulated both through the Echo Bay Group and the intrusives, and underwent chemical changes before moving into dilatant zones of min. dep. (Abbr. from authors' abstract). (Ed. note: See also Shegelski, 1973, this volume.)

RODIONOV, S. M., and SHOPENKO, V. V., 1974, Gas-liquid inclusions in cassiterites of the Prodorozhnyii deposits (Komsomol region): Vestnik Mosk.Univ., Geol., 1974, no. 6, p. 96-100 (in Russian; see Translations).

RODZYANKO, N.G., NETREBA, A.V., RYLOV, V.G., SAVIN, S.V., BOGUSH, A.I., ZHAMGOTSEV, O.S., DZHUMAILO, V.I., POKISHCHUK, N.B., PETROS'YANTS, B.A., SAVCHENKO, N.A., AND SAFAROV, Yu.,A., 1973, On physico-chemical conditions of origin of Cu-sulfide mineralization of N. Causasus: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 108-110 (in Russian; translation through the courtesy of A. Kozlowski). Authors at Rostov Univ., N-Caucasian Geological Office, Polytechnical Institue of Novocherkassk.

Deposits of Urup type occur in Devonian differentiated geosynclinal volcanites of the Peredovoi Chain. The wall-rocks are albitized liparites with tuffaceous material, siliceous schists with hematite, basaltic, andesitic and dacitic tuffs. The main ore mineral is pyrite.

Deposits of Filizchay type occur inside aspidic* slates of Aalenian age and bear chalcopyrite, pyrite and sphalerite ores. Pyrrhotite and pyrite make up 90% of the sulfides in the deposits.

Ore bodies of both types formed during complicated polystage pneumatolytic-hydrothermal processes in the temperature range 450-40°C. (Authors' abstract) (Metamorphic; sericite, hydromica, coaly matter, detrital mins., low porosity)

Parameters	Urup type	Filizchay type
Metallogenetic epoch	Variscan	Kimmeridgian
Type	Sedimentary-Hydroth.	Hydrotherm.-metasom.
Main ore minerals	Pyrite, chalcopyrite sphalerite, bornite	Pyrrhotite, pyrite chalcopyr., sphalerite
Other ore minerals	Hematite, "sitapartite" (bixbyite, $(Mn,Fe)_2O_3$), gal.	Melnikovite-pyrite, galenite
Vein minerals	Quartz, sericite, chlorite, calcite	Quartz, siderite, chlorite, calcite, sericite, aragonite
Depth of formation (m)	500-1000	2000-2500
Characteristic ore trace elements	Ag,Au,Se,Te,Cd,Tl,In, As	Co,Se,Bi,Sn,Ag,As,Cd,Hg
Elements-indicator	Se, Te	Co,Se
Temperature conditions	1) Pneumatolytic-hydrothermal 430-400°C, pyrite I, chalcopyrite I, sphalerite I. 2) High hydrothermal 400-300°C, quartz I, pyrite II, sphalerite II, chalcopyrite II. 3) Moderate hydroth. 300-175°C, pyrite III, chalcopyrite III, sphalerite III, bornite I, quartz II 4) Low hydrothermal (175) 150-50°C, chalcopyrite IV, pyrite IV, bornite II, quartz III	1) Pneumatolytic-hydroth. 475-400°C, pyrrhotite I, pyrite I. 2) High hydrothermal 380-260°C pyrrhotite II, pyrite II, quartz I, chalcopyrite I 3) Moderate hydrother. 250-140°C, quartz II, chalcopyrite II, sphalerite I, pyrrhotite III, pyrite III, galenite 4) Low hydrothermal 140-40°C, quartz III, pyrite IV, sphalerite II, chalcopyrite III, aragonite
Solution concentration	Concentration decrease from moderate to low one during temperature drop	Low concentration
pH	Alkaline	Alkaline

RODZYANKO, N.G., TRUFANOV, V.N., NETREBA, A.B., SAVIN, S.V., PETROSYANTS, B.A., DZHUMAILO, V.I., ZHAMGOTSEV, O.S., SAFAROV, YU. A., VASILIENKO, V.N., POLISHCHUK, I.B., 1973, Geotemperature conditions of origin of main genetic types of N. Caucasus endogenetic deposits: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 35-36 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Rostov Univ. and North-Caucasian Geological Survey.

For the N. Caucasus metallogeny the endogenetic deposits of W, Mo, Cu, Pb, Zn, Hg ("color" & rare metals) are typical. Their origin takes place in the conditions of rift area activity, in the ranges of stable bodies of the Russian Platform and Arabian Plate. Deposits include skarn, hydrothermal and exhalation-sedimentary types.

The spatial arrangement of deposits depends upon the regional geochemical properties of Caucasian metallogenetic province and the change from the periphery to the central part, from the low-and moderate-temperature deposits of hydrothermal nature to the higher-temperature skarn deposits and other ore-bearing formations (from 40-60 up to 700°C and more).

On the basis over 10,000 thermobarometric analyses of mineral associations, two geobaric areas were ascertained with the suitable values of T&P, bounding the range of origin of the main genetic types of endogenetic deposits of the region. The first one is characterized by temp. 450-500°C and low pressures (300-350 atm and lower), at which the mineral associations of volcanogenic-sedimentary deposits were formed. The second one is connected with a wide range of temperature values (100-120 up to 600-650°C and more) and with higher pressures (up to 1000-1200 atm). The second area bears various hydrothermal deposits, rare metal pegmatites and metasomatites).

The composition and the succession of ore deposit origin depend upon the temperature zonation and the general direction of mineralogenesis processes from the higher energetic levels toward the lower. This tendency is also supported by the regular change of the respective mineral parageneses and geochemical associations of ore elements.

The vertical range of ore mineralization is in inverse proportion with the paleotemperature gradients, which for the Hg and other low-temperature deposits equals about 3-3,5°C/100 m, and for skarn and other high-temperature deposits the gradients reached 10-12°/100 m; these differences explain the various depths of development of productive ore-formation zones; from some km for Hg deposits to 1,5 - 1 km for high-temperature skarns and hydrothermal deposits. (Authors' abstract, shortened by A. K.).

ROEDDER, Edwin, 1974a, Changes in ore fluid with time, from fluid inclusion studies at Creede, Colorado (abst.): Internat. Assoc. on the Genesis of Ore Deposits, Fourth Symposium, Varna, Sept. 1974, Abstracts of Papers: Sofia, IAGOD, p. 273-274 (in English). Author at U.S. Geol. Sur., Reston, Va.

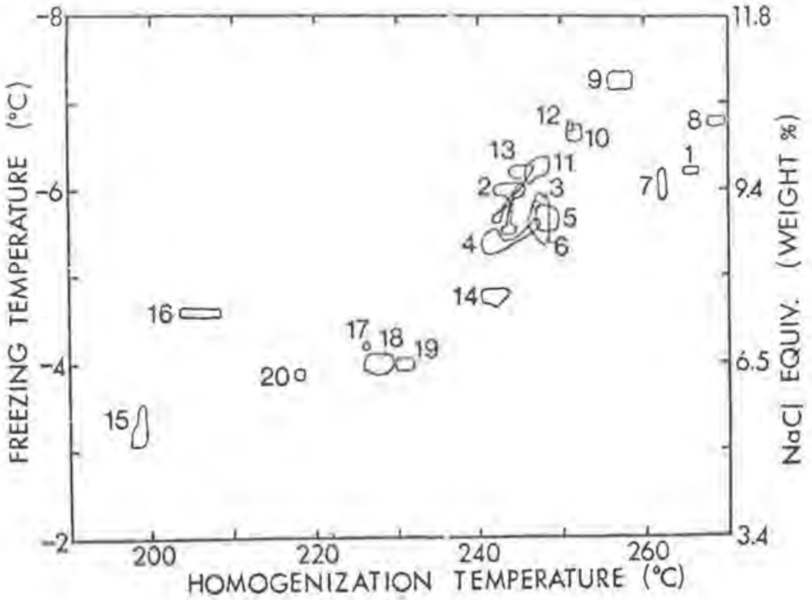
As part of a larger joint investigation of the environment of ore deposition of the epithermal Ag-Pb-Zn-Cu ores in the Creede district, Mineral County, Colorado, detailed studies have been made of the fluid incs. in a 3-cm thick growth band from a large group of zoned subparallel sphalerite crystals. The complex "stratigraphic succession" in this crystal (and other cogenetic crystals from the sampling area) had been previously established by P. M. Bethke and P. B. Barton, Jr., using criteria such as color and its variability, zones of accidental solid inclusions, codeposited minerals, minor element concentrations, and leach zones (i.e., disconformities). The 3-cm band was thus subdivided into 20 "stratigraphic horizons" or zones; all 20 zones together make up only a small part of the total ore depositional history at Creede. As many as 20 presumably representative, P incs. (221 in all) were selected from various parts of each of the 20 zones, in a series of doubly polished plates. The individual incs. varied from about 15 to 450 µm in diameter.

Dets. were made of T_H (essentially equal to crystal growth T in this shallow deposit) and freezing T (T_{Frz}, a function of the salinity of the trapped fluid) for each inc. in each group. These were made essentially as "blind" dets., over a period of months, without the operator knowing how the individual samples fitted together. The results of these dets. proved to be surprisingly consistent, internally. The incs. in each zone form very tight clusters on a diagram of T_H vs T_{Frz} with a total range for all clusters from 198° to 269°C (T_H), and -3.1 to -7.3°C (T_{Frz}; 5.1

to 10.9 wt. % NaCl equiv.). The sequence of groups on the diagram shows that, during the deposition of the 3-cm layer of sphalerite, the salinity and T first increased and then decreased, with several minor reversals. There is almost no overlap of the points from one group with those of adjacent groups in the sequence.

These results prove that: (1) the variations used to establish the sphalerite "stratigraphy" are paralleled by changes in the ore fluids trapped in incs.; (2) if such fine structure is ignored in sampling, serious errors in interpretation of the results can occur; (3) even the more nebulous boundaries are significant (i.e., the ore fluids changed significantly from one zone to the next); (4) P incs. can be recognized adequately in this material; (5) the incs. have not necked down since trapping; (6) the experimental techniques used have excellent precision (but unspecified accuracy); (7) no recognizable difference exists between large and small incs. from the same group; and (8) these incs. obviously did not leak.

It is important to note that much smaller sphalerite crystals in this same mine have probably formed from the same range of fluids, but their size may not permit as detailed stratigraphic assignment of any given inc. Detailed correlation of growth zones from one crystal to another in the same sample, and eventually with other samples and other parts of the mine is essential to understanding many aspects of ore deposition, such as the nature of the hydrologic flow in the system, the establishment of the contemporaneity of deposition of several different minerals, the chemistry of the ore-forming fluid, and, eventually, the cause of the ore deposition. (Author's abstract.)



ROEDDER, Edwin, **1974b**, Silicate liquid immiscibility in lunar and terrestrial magmas (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 6, no. 6, p. 540-541. Author at U.S. Geol. Sur., Reston, Va., 22092

A review of the evidence for immiscibility, particularly in silicate melt incs. (ER)

ROEDDER, Edwin, and WEIBLEN, P.W., 1974a, (Petrology of lunar igneous rocks (abst.)): Geol. Survey Research 1974, U.S. Geol. Surv. Prof. Paper 900, p. 214-215.

Comps. of silicate-melt incs. in ign. textured spinel troctolite 62295 trace the liquid line of descent of the parent melt of this rock. The sample contains the most complete suite of silicate-melt incs. found to date in any lunar ign. rock. Microprobe anal. show that these incs. have silica contents ranging in wt. % from 46.9 to 66.9; atomic Fe/Fe+Mg, from 0.16 to 0.64; and CIPW normative quartz contents from 2 to 39.7. Petrologic mixing calcs. using the comps. of the bulk rock, mins., and melt incs. (after the method of T.L. Wright and P.C. Doherty (1970) suggest that the xliz. sequence was as follows: spinel, olivine, minor titanium-rich phase, plagioclase. The mixing calcs. also permit estimates of the amount of melt of the comp. of any given inc. that can be generated by fractional xliz. of the parent melt. These studies of the xliz. of 62295 suggest that spinel-olivine cumulates could have been formed during differentiation of the plagioclase-rich lunar highlands; thus they are a possible highlands rock type. (Authors' abstract) (Abstracted briefly in Weiblen and Roedder, 1973, Fluid Inclusion Research - Proc. of COFFI, v. 6, 1973, p. 166)

ROEDDER, Edwin, and WEIBLEN, P.W., 1974b, An unusual barred olivine chondrule in spinel troctolite 62295, in Lunar Sci. V, Abstracts of Papers Fifth Lunar Sci. Conf., Houston, TX, v. 2, p. 639-641.

Silicate melt and plagioclase incs., and unusual olivine zoning in this chondrule make its origin enigmatic. (ER) (Also reported briefly in USGS Prof. Paper 900, p. 215 (1974)

ROEDDER, Edwin, and WEIBLEN, P.W., 1974c, Silicate melt inclusions and glasses in lunar soil fragments from the Luna 16 core sample, in Lunar Soil from Sea of Fertility, A.P. Vinogradov, ed.: Moscow, "Nauka" Pub. House, p. 239-249 (in Russian).

A Russian translation of an article (with source unstated) that appeared originally in Earth and Planet. Sci. Letters, v. 13, 1972, pp. 272-285, and was abstracted in Fluid Inclusion Research - Proceedings of COFFI, v. 5, p. 93, 1972. (ER)

ROEGGE, J.S., LOGSDON, M.J., YOUNG, H.S., BARR, H.B., BORCSIK, M., and HOLLAND, H.D., 1974, Halogens in apatites from the Providencia area, Mexico: Econ. Geol., v. 69, p. 229-240.

Chloride almost certainly plays an important role in extracting base metals from granitic magmas. The Cl^- content of apatite may be a better indicator than the Cl^- content of biotite for the Cl^-/OH^- ratio in granitic magmas. These results do not prove that the apatites have maintained their original comp., but they are sufficiently encouraging to warrant further studies of apatite as an indicator of Cl^-/OH^- ratios in granitic magmas. (From the authors' abstract)

ROSE, A.W., 1974, Chloride complexing of copper and silver in the origin of red bed copper sandstone-type uranium and related ore deposits (abst.): Econ. Geol., v. 69, p. 1186. Author at Departmentof Geosciences, The Pennsylvania State University, University Park, Pennsylvania 16802.

A theory of origin of stratiform red bed deposits involving solution in chloride-rich fluids and precipitation upon reduction. (ER)

RUMBLE, Douglas, III, 1974, Use of mineral solid solutions to measure gradients in the chemical potentials of volatile components in regionally metamorphosed rocks (extended abst.): Geol. Soc. Amer. Abstracts with

Programs, v. 6, no. 7, p. 933-935. Author at Geophysical Laboratory, Carnegie Institution of Washington, 2801 Upton St., N.W., Wash.D.C. 20008.

RUTHERFORD, M.J., HESS, P.C., and DANIEL, G.H., 1974, Experimental liquid line of descent and liquid immiscibility for basalt 70017, in Fifth Lunar Sci. Conf. Proc., Geochim. Cosmo. Acta Suppl. 5, v. 1, p. 569-583. Authors at Department of Geological Sciences, Brown University, Providence, Rhode Island 02912.

Liquid immiscibility has been experimentally produced after about 97% fractional crystallization of a high-titanium lunar basalt (70017). The liquid line of descent leading to immiscibility was defined by a series of partial equilibrium and fractional crystallization experiments at a pressure less than 1 atmosphere, and is characterized by enrichment of FeO,K_2O, SiO_2 and MnO and depletion of MgO and TiO_2 in the residual liquids. At the onset of liquid immiscibility, the residual liquid is of ferrobasalt composition and major SiO_2 enrichment was not necessary to attain the two liquid stability field. The compositions of the two liquids are less fractionated than Apollo 11 immiscible liquids and are significantly more aluminous. The experimentally produced immiscible liquids are remarkably similar to those occurring in 70017,127 suggesting that the experimental liquid line of descent has reached a point in the melt evolution path nearly identical to that of the lunar rock. During the late-stage fractional crystallization history, liquids immediately adjacent to crystallizing minerals fractionated along paths deviating from that of the bulk liquid. Therefore, liquids entrapped as fluid inclusions are not always representative of the bulk fluid. Liquid immiscibility was attained in certain locally fractionated regions before the bulk liquids became immiscible. The initial appearance of immiscible liquids in the form of SiO_2-rich spherules is typically in the vicinity of plagioclase-liquid contacts. (Authors' abstract)

RYABCHIKOV, I.D., 1974, Melting relations in silicate systems with water and chlorides (abst.): Internat. Mineral. Assoc. Ninth Gen. Meeting, West Berlin and Regensburg, W. Germany, Collected Abstracts: West Berlin, German Mineralog. Soc., p. 162 (in English). Author at Moscow,USSR.

The data on dissociation of alkali halides in supercritical aqueous solutions and thermodynamic treatment of phase diagram for the system NaCl-H_2O show that both H_2O-rich vapor and NaCl-rich liquids in this system are close to ideal solutions (above $\sim$ 500°C).

The miscibility gap between vapor and chloride-rich liquid at relatively low pressures (below 1.5 kb at the Ts of granite solidus) is substituted at higher P by compositional range where the properties of fluid phase gradually change from those of aqueous vapor to chloride melt with almost constant activities of components. This is corroborated by the experimental data on chloride distribution between water-chloride fluid and granitic melts at 800°C and 2 kb.

Very low solubility of chlorides in acid silicate melts (Kilinc, Burnham, 1972; Ryabchikov, Wall, Burnham, 1974) and rock-forming silicates in aqueous solutions together with the above discussed properties of high T water-chloride mixtures (exsolution at lower P and transitional range at higher P) causes the solidus Ts and solubility of water in silicate melt in the systems rock-forming silicate - chloride - water to be nearly identical with those in boundary system silicate - water up to very high concentrations of chlorides in the bulk composition. This is demonstrated by experimental data on the system granite - chlorides - water (Ryabchikov, Hamilton, 1971). (Author's abstract)

RYABCHIKOV, I.D., DURASOVA, N.A., and BARSUKOV, V.L., 1974, The role of volatiles in the mobilization of tin from granitic magmas (extended abst.), in Metallization associated with acid magmatism, v. 1, p. 287-288, ed. M. Stemprok: Prague, Geological Survey (a volume of papers presented at the MAWAM Symposium, Karlovy Vary, Czechoslovakia, Oct. 1974) (in English). First author at IGEM, Moscow, USSR.

A discussion of experimental data on distribution of Sn between melt and fluid phases, and the effects of F and B. (ER)

RYABCHIKOV, I.D., WALL, V.J., and BURNHAM, C.W., 1974, Equilibria of ore-forming fluids with acid magmatic rocks: Geol. Rudn. Mest., v. 16, no. 3, p. 15-26 (in Russian). First author at Inst. Geol. Ore Deps., Pet., Min. and Geochem. of Acad. Sci. USSR, Moscow.

The partitioning of Cl, Fe, Zn, Na, K and Ca between aq.-Cl solns, acid silicate melts and some mins. of granitoids were studied exper. under P - 2 kbar and T = 600-800°C. During xliz. of acid magma with clark concs. of Cl, Fe and Zn, the metals fall into soln. in amounts suitable for forming of commercial deps. (Authors' abstract, translated by A.K.)

RYE, R.O., 1974, A comparison of sphalerite-galena sulfur isotope temperatures with filling temperatures of fluid inclusions: Econ. Geol., v. 69, p. 26-32. Author at U.S. Geol. Sur., Denver, Colo.

An attempt has been made to evaluate the applicability of the various experimental sphalerite-galena sulfur isotope fractionation curves as a geothermometer for sulfide ore deposits. Sulfur isotope fractionations for 32 coexisting sphalerite-galena pairs from Providencia, Mexico, and from five other ore deposits are plotted against T_H of fluid incs. in sphalerite.

In the temperature range 370° to 200°C, sulfur isotope fractionations plotted according to T_H data are within ±0.3 permil of the experimental curve of Czamanske and Rye (1974). Conversely almost all of the sulfur isotope temperatures based on their curve are within ±40°C of T_H, and the majority are within ±20°C. The sulfur isotope temperatures based on the experimental curve of Kajiwara and Krouse (1971) average about 40°C higher than T_H, and those based on the curve of Grootenboer and Schwarcz (1969) average about 20°C lower.

Replicate analyses of individual sphalerite-galena pairs indicate that under the best circumstances an error of ±20°C is inherent in the use of the sulfur isotope geothermometer.

In the temperature range 200° to 110°C the very large range observed for sulfur isotope fractionations in natural sphalerite-galena pairs suggests that sulfur isotope disequilibrium may occur in low-temperature hydrothermal ore deposits. (Author's abstract)

RYE, R.O., DOE, B.R., and WELLS, J.D., 1974, Stable isotope and lead isotope study of the Cortez, Nevada, gold deposit and surrounding area: Jour. Research U.S. Geol. Survey, v. 2, no. 1, p. 13-23. Authors at U.S. Geol. Survey, Denver, Colo.

Isotope studies of sulfur, carbon, hydrogen, oxygen, and lead were carried out to clarify the age and origin of the Cortez gold deposit and the surrounding mineralized area. The hydrogen isotope data indicate that meteoric water was the dominant component of the ore-forming fluids at Cortez. The hydrogen isotope data on fluid from fluid incs. and clay alteration support geologic evidence for a Tertiary age for the deposit.

The oxidation of the ore probably occurred during the deposition of postore calcite and was caused by waters whose oxygen isotopic composition was distinctly different from that of the ore fluids. The carbon isotope data suggest that the only carbon present in the ore fluids was derived from solution of the host rock. The lead and sulfur data are consistent with a possible sedimentary derivation for the gold in the ore. Lead and sulfur isotope distributions indicate that much of the galena mineralization in the area occurred during the Jurassic. (Authors' abstract)

RYE, R.O., HALL, W.E., and OHMOTO, Hiroshi, 1974, Carbon, hydrogen, oxygen, and sulfur isotope study of the Darwin lead-silver-zinc deposit, Southern California: Econ. Geol., v. 69, p. 468-481. First author at U.S. Geol. Survey, Denver, Colo.

The ores at Darwin occur as massive replacement bodies in silicated limestones of Pennsylvanian and Permian age adjacent to a Jurassic quartz monzonite stock. Three types of ore have a definite spatial relationship to the quartz monzonite: (1) pyrite-sphalerite-galena ores, (2) pyrite-pyrrhotite-magnetite-sphalerite-galena ores, and (3) galena-Ag-Bi-Se ores.

The $\delta^{34}S$ values of all sulfide minerals range from +4.4 to -5.7 permil. The $\delta^{34}S$ values for individual minerals tend to decrease with respect to both space and paragenetic time. The Δ_{sl-gn} values range from 1.5 to 2.5 permil and correspond to a temperature range of 325°±55°C. The sphalerite-galena sulfur isotope temperatures at a given locality are reproducible to ±30°C and are consistent with temperatures determined by other means.

Analyses of water in three samples of fluid incs. in sphalerite indicate that the ore fluids had δD values of -66±4 permil, a total salinity that reached at least 20 percent, and K/Na atomic rations of 0.23±0.03. Isotopic and thermochemical data indicate that the ore fluids had average values of $\delta^{34}S_{\Sigma s}=3$ permil, $\delta^{13}C_{\Sigma c}=-3.5$ permil, $\Sigma S=0.01$ mole/Kg H_2O, $f_{CO_2}=$ 12±8 bars, and $\Sigma C=0.15\pm0.06$ mole/Kg H_2O.

The $\delta^{18}O$ values of postsulfide calcites have a range of 12.8±1.5 permil in the pyrite ores and 17±2 permil in the pyrrhotite ores. Similar values for relict limestone host rock in these areas indicate that oxygen isotopic equilibrium was established between the calcite precipitating fluids and the wall rock. The $\delta^{13}C$ values of the calcites, however, range from -5.8 to -3.6 permil and are considerably more negative than the limestone in the host rock, indicating that carbon isotopic equilibrium was not established between the fluids and the wall rock.

Thermochemical data indicate that the pH of the ore fluids was about 4.8 as they traveled through the quartz monzonite at $T\sim350$°C. When the fluids completely equilibrated with the relict limestone and calc-silicate host rock, the pH increased to 6.7. This increase in pH as the fluids traveled upward and away from the quartz monzonite was responsible for the spatial distrubution of iron sulfide assemblages, for variations in $\delta^{34}S$ values of sulfides, and probably caused precipitation of the ore. (Authors' abstract)

RYE, R.O., and KELLY, W.C., 1974a, (Panasqueira tin-tungsten deposits (abst.)): Geol. Survey Research 1974, U.S. Geol. Sur. Prof. Paper 900, p. 142. (see next item)

RYE, R.O., and KELLY, W.C., 1974b, Stable-isotope systematics of the Panasqueira, Portugal, tin-tungsten deposit (abst.): Econ. Geol., v. 69, p. 1187. First author at U.S. Geol. Survey, Federal Center, Denver, Colorado 80225.

Geologic and geochemical data on Panasqueira are presented in a companion abstract by Kelly. The $\delta^{34}S$ values for main- and late-stage sulfides range from -0.1 to -0.9‰ and -10.1 to -11.3‰, respectively, indicating a deep source for main-stage sulfur but a shallow source for late-stage sulfur. The $\delta^{13}C$ values of main- and late-stage carbonates are from -10.9 to -13.1‰ and -8.4 to -14.2‰ respectively. The calculated $\delta^{13}C\Sigma c$ values for the carbonate fluids are more negative than normally observed for deep-seated carbon and may indicate that a substantial organic component was present in the main- and late-stage fluids. The $\delta^{18}O$ values of main-stage quartz in the horizontal veins range from 11.2 to 16.0‰ and appear to increase systematically away from the cupola. Calculated $\delta^{18}O_{H_2O}$ values of the hydrothermal fluid average about 2.8‰ in the cupola and increase to about 6.8‰ at the edge of the vein system in the surrounding schists. The spatial zonation of the $\delta^{18}O$ values in the hydrothermal fluids probably reflects the oxygen isotope exchange history of the fluids as they traveled from the granitic cupola into the isotopically heavier schists. Judged from $\delta^{18}O$ data on carbonates, the $\delta^{18}O_{H_2O}$ values of the main- and late-stage hydrothermal fluids were very similar. The δD values of inclusion fluids in main- and late-stage minerals range from -45 to -123‰. The δD systematic are unusual but apparently indicate that the hydrothermal fluids were predominantly magmatic during the deposition of some minerals but mixtures of meteoric and magmatic during the deposition of others. (Authors' abstract)

RYE, R.O., and OHMOTO, Hiroshi, 1974, Sulfur and carbon isotopes and ore genesis: a review: Econ Geol., v. 69, p. 826-842. First author at U.S. Geol. Survey, Denver, Colo.

An extensive review of the significance of isotopic data on ore minerals and their inclusions. (ER)

RYE, D.M. and RYE, R.O., 1974, Homestake gold mine, South Dakota: I. Stable isotope studies: Econ. Geol., v. 69, p. 293-317.

A very extensive study of the isotope ratios for sulfur and oxygen in various minerals. Includes short section on inclusions (p. 309-310). Data on the δD of H_2O, $\delta^{13}C$ of CO_2, CO_2/H_2O mole ratios, and CH_4 content in fluid incs. are consistent with a meta. origin for the ore body and are distinctly different from the data obtained on Tertiary ore deps. in the surrounding area. Furthermore, the Tertiary ore bodies in the area do not demonstrate any of the isotope systematics obs. in the Homestake ore body.

The isotopic and geologic data suggest that the gold and other constituents of the ore dep. were indigenous to the Homestake form. and were probably of syngenetic, "exhalative origin." The ore deps. were formed when the syngenetic components were conc. in dilatant zones during meta. (Modified from the authors' abstract.)

RYE, R.O., and SAWKINS, F.J., 1974, Fluid inclusion and stable isotope studies on the Casapalca Ag-Pb-Zn-Cu deposit, Central Andes, Peru: Econ. Geol., v. 69, p. 181-205. First author at U.S. Geol. Sur., Denver, Co.

The extensive Casapalca vein system occurs in Tertiary red beds and volcanic rocks. The deps. contain primarily pyrite, sphalerite, galena, and tetrahedrite, accompanied by quartz and minor calcite gangue. The results of paragenetic studies of the Carlos Francisco section suggest that vein filling can be subdivided into three identifiable stages: (1) the main sulfide stage, characterized by simple sulfide minerals and quartz (>80% of vein filling), (2) a late sulfide-sufosalt stage (∿15% of vein filling), and (3) a postore stage of calcite dep. (<5% of vein filling). T_H studies of fluid incs. in xls. of sphalerite and quartz from both main- and late-stage vug assemblages indicate dep. of main-stage ore T range of ∿370° to ∿320°C and dep. of late-stage assemblages within the range ∿320° to ∿280°C. Less reliable data from fluid incs. in calcite suggest dep. of postore calcites at Ts from <300° to ∿200°C.

A consideration of the P regime during ore dep. based on the inc. data provides somewhat ambiguous results, but it is est. with some confidence that the uppermost levels of the Casapalca vein system lay at depths of ∿1,000 m below the surface at the time of min. Assuming that P fluctuations have not unduly distorted the T_H patterns, a progressive drop in T with time during min. is indicated, and the existence of sharp T gradients within the vein system is precluded.

Studies of the salinity of fluid incs. in quartz and sphalerite indicate that the salt content of the ore sols. ranged erratically from 4 to 40 equi. weight % NaCl during main-stage dep. and from 4 to 12 equiv. weight % NaCl during late-stage dep. All incs. containing high vapor-to-liquid ratios in main-stage quartz and sphalerite are intimately assoc. with high salinity incs., suggesting the sporadic occurrence of high salinity, "boiling" fluids in the vein system.

The δD values from incs. in main- and late-stage sphalerite, tetrahedrite, and quartz range from -48 permil to -60 permil. Beginning with calcite dep., the δD values of the fluids became more negative, reaching a value as low as -151 permil during the dep. of the late calcites. The δD values for present-day surface waters at Casapalca avg. -118 permil.

The $\delta^{18}O$ of the hyd. fluids was det. from anal. of water in fluid incs. and from $\delta^{18}O$ values of quartz and calcite. The $\delta^{18}O$ of most of the hyd. fluids avgd. about 7 permil during ore min., indicating that most of the fluids were derived from a high-T silicate source. This and other factors indicate that the Casapalca vein system is most probably underlain by a felsic intrusive of late Tertiary age. During postore dep., $\delta^{18}O$ of the hyd. fluids reached values lower than -6 permil.

The data on the hyd. carbon, based on analyses of CO_2 in fluid incs. and $\delta^{13}C$ values in the carbonates, indicate that the $\delta^{13}C$ of the hyd. fluids avgd. about -6.0±0.5 permil during main- and late-stage dep. and ranged from -8.6 permil to -2.2 permil during postore calcite dep. Most of the carbon was probably derived from a deep-seated and nonlimestone source, although increasingly greater amounts of limestone carbon were contributed to the hyd. fluids during the later stages of calcite dep.

The $\delta^{34}S$ values of sulfides fall in a very narrow range throughout the paragenesis with the total range for sphalerite -0.4 permil to 2.4 permil. The sulfur isotope data indicate a deep-seated source for the hyd. sulfur with an average $\delta^{34}S$ of about 1.5 permil.

The stable isotope (δD values in particular) and fluid inc. data obtained in this study of the Casapalca dep. are all compatible with a relatively simple model for ore genesis. The data indicate that main-stage ore dep. was affected by hyd. fluids of deep-seated post-magmatic origin and that the incursion of meteoric waters and components derived from upper crustal sources was restricted to postore calcite dep. The data also suggest that some regions of the Andes were at considerable elevation at the time of ore dep. (Authors' abstract)

RYTUBA, J., and DICKSON, F. W., 1974, Reaction of pyrite + pyrrhotite + quartz + gold with NaCl-H_2O solutions, 300-500°C, 500-1500 bars, and genetic implications (abst.): Internat. Assoc. on the Genesis of Ore Deposits, Fourth Symposium, Varna, Sept. 1974, Abstracts of Papers: Sofia, IAGOD, p. 312-313 (in English). Authors at Geol. Dept., Stanford Univ., Stanford, Calif.

The data obtained suggest that gold goes into solution as a Au-bisulfide complex ion, probably $Au(HS)_2^-$. Quantitatively significant gold-chloride complexes do not appear to exist, but the amount of sulfur species in solution is strongly affected by Cl^-, providing an indirect effect on gold solubility by Cl^-.

Possible sources for such fluids, and mechanisms of Au precipitation are discussed. (ER)

RYZHENKO, B.N., 1974, The principal regularities of the thermodynamic process of electrolyte dissociation of inorganic materials and an appraisal of the form of transport of chemical elements in hydrothermal solutions: PhD dissertation abstract ("Avtoreferat"), Vernadski Inst. 51 pp.(In Russian)

An experimental and theoretical study with many figures and tables. (ER)

SABOURAUD-ROSSET, Christiane, 1973, Cl/Br ratios in liquid inclusions in gypsum crystals from various deposits: correlations with cryoscopy and genetic interpretations (abst): Sci. de la Terre, Réunion Annuelle, Paris, 1973, p. 375 (in French; translation courtesy Chris Eastoe). Author at Lab. de Géol, Ecole Normale Sup., 16, rue d'Ulm, Paris 5ème France.

In gypsum Br is present only in fluid incs. Neutron activation anal. permits det. Cl/Br without contamination and with 10% precision. Fifty-eight samples were analy. and mean ratios presented (for ref., Mediterranean water has Cl/Br = 325). The salinities of the incls. were also obtained, by freezing, and the data used to evaluate the geological history of samples from various localities. Four categories of gypsum deps. were found, with Cl/Br ratios as follows:

150-250 - Gypsum of marine or sabkha origin. The waters could have been enriched in bromine by the conc. of brines, or by an abundance of org. matter, or could have been of diff. initial comp. from present seawater. These include deps. from New Caledonia (recent, marine, 157 or 206), Tunisia, Sabkha el Melah (coastal sabkha, 194), Sicily (Miocene, marine, 175) France, Corneilles-en-Parisis (233).

300-350 - Gypsum from salt-marshes. Freezing expers. indicate whether or not there has been leaching. These include French deps. from Aigues-Mortes (unalt., 315) and from Bourg de Batz (leached, 350).

400-700 - Gypsum xlized from mixed continental and marine waters, shown to contain NaCl by cryoscopy, or gypsum leached by meteoric waters, e.g. the Oligocene gypsum of southern France at Mazan (386) and Portel (630).

Over 1000 - Gypsum with a long history of leaching and rexliz., such as the Triassic Alpine gypsum from Bramans (1164). (Author's abstract, considerably shortened; see next item also).

SABOURAUD-ROSSET, Christiane, 1974, Determination by neutron activation of the Cl/Br ratio in fluid inclusions in various gypsums. Correlation with results of microcryoscopy and genetic interpretations: Sedimentology, v. 21, p. 415-431 (in French with English abst). Author at Labo. Geol., Ecole norm. sup., 46 rue d'Ulm, Paris 5e.

In gypsum Br is present only in fluid incs. Neutron activation anal. permits det. Cl/Br without contamination and within 10% accuracy. Fifty-eight samples were analy. The salinities of the incls. were also obtained, by freezing, and the data used to evaluate the geological history of samples from coastal salt **pans** in France (Recent), New Caledonia, Tunisia, Sicily (Upper Miocene), Paris (Eocene and Oligocene). (From the author's abstract, greatly abbreviated)

SAFAROV, Yu.A., BOGOMOLOV, A.Kh. AND FEDCHENKO, P.I., 1973, Thermobarometric investigations of inclusons in quartz of ore-bearing granitoids of Tyrnyauz deposit: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 202-204 (in Russian; translation through the courtesy of A. Kozlowski). Authors at Rostov Univ. and Tyrnyauz Works.

The following occurrences of leucocratic granitoids were studied: Massif "Pauk" ("Spider")-level 2615 m; "Samolyot"("Aeroplane")-level 2615 m; Northern Plot-borehole 800, Gallery No. 18, level 2317 m; El'dzhurtinskiy granite - borehole 600 plus liparites from 3 necks (Northern, Middle and Southern). (The size) and phase composition of inclusions in quartz in leucocratic granites of "Samoloyot" is as follows: 1) gas - liquid 5-25 μm; G:L = 1:4 - 3:2; 2) gaseous and essentially gaseous, 3-10 μm; with equilibriated morphology (prism and rhombohedron); 3) crystalline-fluid, isometric, G up to 30%, L = 10-15%, crystals up to 60%, daughter minerals yellowish and greenish, primary; 4) melt inclusions, square or rectangular, 8-10 μm, 90% of vacuole filled by crystalline aggregate + 10% by gas.

Inclusions in quartz of granitoids of "Pauk" have phase ratios very similar to those from "Samolyot," plus inclusions of the "satellite-type" (S.A. Kursher, V.N. Trufanow, and A.T. Ushak 1965): vacuoles of gas distributed in "oasis" groups (3-5 inclusions) surrounded by minute (1-2 μm) gas inclusions.

Inclusions in quartz from granitoids of Northern Plot are closely similar to above described ones; the number and size of inclusions decrease with increase in depth; in deep levels gaseous incluions are absent.

Phase composition of inclusions in quartz from El'dzhurtinskiy granite is similar to that from leucogranites. In granites of investigated borehole 600 in the interval 957-1476 m one may observe enlargement of dimensions of G-L and essentially gaseous inclusions.

In quartz of liparites from necks melt inclusions (vacuoles filled by fine grained aggregate, glass and gas, 5-15 μm) were found. Gaseous, gaseous-liquid and polyphase inclusions are absent.

T_H of 2 samples of El'dzhurtinskiy granite: 1219/4 from borehole 600, plus 2 samples of leucocratic granites: 54 and 1220/1, level 2615 m, borehole 800, were 510-620°C. (Authors' abstract)

SAINTIVES, Jean-Paul, 1973, Endotaxic rutile needles in pegmatitic quartz of the Labourd massif, (Atlantic Pyrenees): scanning electron microscopy: C. R. Acad. Sci. (Paris), v. 277, ser. D, no. 21, p. 2293-2296 (in French).

Rutile needles (submicrometer thickness) were ident. , cutting across voids in the broken surface of quartz samples (i.e., opened fluid incs.). (ER)

SAKAI, Hitoshi, and MATSUBAYA, Osamu, 1974, Isotopic geochemistry of the thermal waters of Japan and its bearing on the Kuroko ore solutions: Econ. Geol., v. 69, p. 974-991.

Thermal water systems at ocean coasts are mixtures of hydrothermal oceanic and local meteoric waters. They are characterized isotopically by $\delta^{18}O$ and δD values intermediate between oceanic and local meteoric values and chemically by dominance of Na^+, Ca^{2+}, Cl^-, and low concentrations of SO_4^{2-} and Mg^{2+}. The chemical features are due to hydrothermal interaction between sea water and host rocks, involving precipitation of anhydrite. Dissolved sulfates retain, in most cases, the original isotopic values of sea-water sulfates during these reactions.

The ore solutions responsible for Kuroko ore deposits were similar to both coastal thermal waters and to some of the marine connate waters. The ore solutions were nearly neutral Na-Ca-Cl-type brines of low sulfate concentration, but of higher salinity than average sea water. Their $\delta^{18}O$ values were close to zero, but their δD values varies from 0 to -30 per mil, depending on mixing ratios with meteoric water or on the original values of the connate waters. The $\delta^{34}S$ values of dissolved sulfates were close to those of Miocene sea-water sulfates. The sulfate-deficient saline ore solution would have been high in Ba^{2+}. Barite was precipitated from this solution at the top zone of the stratified Kuroko ore deposits, where sulfate ions were replenished from overlying sea water. (From the authors' abstract)

SAMARTSEV, U.T., ZAKHVATKIN, V.A., KAZIMIRSKIY, V.F., MIKHAYLOVA, L.V. and BIRYUKOV, V.F., 1973, On zoning of the Berezovo gold deposit in the Central Ural: Geol. Rudn. Mest., v. 15, no. 1, p. 110-117 (in Russian; abstract courtesy A. Kozlowski). Authors at Tula Section of the Central Sci.-Research, Geol-Prospecting Inst., Tula.

T_D of mins. of four stages of min. are as follows: 330-200° (quartz, ankerite), 180-150° (quartz), 130-90° (quartz), 100-60°C (calcite). Quartz of the first generation from upper levels of the dep. gave T_H 185-250°C, and from lower levels - 280-320°C.

SAMOYLOV, V.S.,1974, Genetic types and facies of carbonatites, in Metasomatism and ore-formation, ed. D.S. Korzhinski: Moscow, "Nauka" Press, p. 196-204 (in Russian; abstract courtesy A. Kozlowski).

On basis of studies of fluid incs., T of origin of minerals of zeolite facies in carbonatites were ranged from 195 to 80°C.

SAMOYLOV, V.S., and RAZVOZZHAYEVA, E.A., 1970, Behavior of rare elements during the process of formation of carbonatities with rare metals mineralization: Geol. Rudn. Mest., 1970, no. 2, p. 38-49 (in Russian; abstract in Econ. Geol., v. 69, p. 720, 1974).

Ts are given for various stages as follows (method unspecified): calcite-carbonatite with hatchettolite (betafite), 480 ± 50°C; dolomite-calcite carbonatite with pyrochlore, 350 ± 50°C; ankerite carbonatites with columbite and RE carbonates, 250 ± 20°C. (ER)

SANG, J.S., HEUER, A.H., and COOPER. A.R., 1974, Diffusion of tritiated water in β-quartz (abst.): Amer. Geophy. Union Trans., EOS, v. 55, no. 4, p. 481. Authors at Dept. of Metallurgy, Case Western Reserve Univ., Cleveland, O. 44106.

SASAKI, Akira, 1974a, Sulfur isotopic evolution in Precambrian sea and strata-bound sulfide deposits (abst.): Internat. Assoc. on the Genesis of Ore Deposits, Fourth Symposium, Varna, Sept. 1974, Abstracts of Papers: Sofia, IAGOD, p. 236 (in English). Author at Geol. Surv. of Japan, Tokyo, Japan.

SASAKI, Akira, **1974b,** Isotopic data of Kuroko deposits: Mining Geol. (Japan) Spec. Issue no. 6, p. 389-397 (in English).
Reviews fluid inc. data from literature. (ER)

SAWKINS, F. J., and RYE, R. O., 1974, Fluid-inclusion and stable isotope studies indicating mixing of magmatic and meteoric waters, Caudalosa silver deposit, Central Andes, Peru (abst.): Internat. Assoc. on the Genesis of Ore Deposits, Fourth Symposium, Varna, Sept. 1974, Abstracts of Papers: Sofia, IAGOD, p. 237-238 (in English). First author at Dept. of Geol. and Geophy., Univ. of Minn., Minneapolis, Minn.

In the Caudalosa area a number of Ag- and base metal-bearing fissure veins occur in upper Tertiary volcanic rocks. These host rocks consist of essentially flat-lying andesite flows, interbedded with tuffs and pyroclastics, and intruded locally by small plugs and stocks of andesite and dacite.

The ore-bearing fissure veins contain base metal sulfides and Ag-bearing sulfosalts in a gangue consisting predominantly of quartz and lesser amounts of pyrite. Small amounts of rhodochrosite, dolomite, calcite, and barite are also present. Paragenetic studies indicate that quartz was deposited throughout most of the vein filling period and that in general sulfides were succeeded by sulfosalts. Locally, however, a distinctive late generation of sphalerite accompanied by lesser amounts of chalcopyrite and galena is present. Barite terminates the paragenetic sequence.

T, salinity and H/D ratio studies were made on fluid incs. in suitable ore and gangue mins. at various stages of the paragenetic sequence. These indicate:

(1) A T range of ore dep. from 325° to 270°C through most of the paragenesis with a decline in T from 250° to 170°C during late-stage sphalerite dep., and finally barite pption. at less than 100°C.

(2) Fluctuation of the salinity of the hyd. fluids between values of 4 to 18 equiv. wt. % NaCl, with the highest salinities associated with dep. of late-stage sphalerite.

(3) Fluctuation of the δD values of the hyd. fluids from values close to local modern meteoric water (av. $\delta D = -120$ SMOW) to values more closely representative of magmatic water ($\delta D = -60$ to -70).

(4) A close relationship between salinity and δD values; low salinity trapped fluids exhibiting more negative δD values and higher salinity fluids exhibiting less negative δD values.

These results indicate a hydrologic regime operated during veinfilling in which water of magmatic origin was mixing sporadically with ambient meteoric ground water. Most stages of sulfide min., however, appear to be closely associated with periods of influx of waters whose δD comp. is indicative of a magmatic origin. (Authors' abstract.)

SCHERP, A., and STRÜBEL, G., 1974, Hydrothermal investigation of the system $BaSO_4$-$SrSO_4$-$NaCl$-H_2O and its bearing on Ba-Sr - mineralizations (abst.): Internat. Assoc. on the Genesis of Ore Deposits, Fourth Symposium, Varna, Sept. 1974, Abstracts of Papers: Sofia, IAGOD, p. 464 (in English). Authors at Geol. Land. von Nordrhein-Westfalen, Krefeld Min.-Pet. Inst. der Justus Liebig-Univ., Giessen.

Experimental results of the solubility behavior of $BaSO_4$ and $SrSO_4$ in water and in aqueous NaCl solutions can explain the Ba and Sr contents of recent and fossil brines found in some West German barite occurrences: (1) Considerable solubility increase of $BaSO_4$ and $SrSO_4$ in the presence of NaCl, and also with increasing P and density; (2) Inverse solubility behavior of $BaSO_4$ and $SrSO_4$ between 20°-350°C and also between 350°-450°C in NaCl-containing solutions; and (3) Retrograde solubility region for $BaSO_4$ in the system $BaSO_4$-NaCl-H_2O between 450°-350°C. (From the authors' abstract.)

SEDLETSKII, V.I., TRUFANOV, V.N., & MAISKII, YU. G., 1973, Mechanism of mobilization and the nature of highly-mineralized brines in halogenide formations: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 42-44 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Rostov University.

Halogenide formations of various regions of the world contain highly concentrated brines (320-500 g of salts/l). In composition, chlorides of Ca, Na, and Mg prevail, plus relatively high concentrations of B, Li, Rb, Sr and other minor elements in amounts that cannot be explained by condensation processes in the primitive brine. A number of components were found which are not characteristic of the parent salt basins, such as I, NH_3, naphtenes and humic acids, combustible gases, and bitumens. Often in salt deposits there occur relatively large voids filled by CO_2, CH_4, N_2 and other gases.

Investigations of the parent fluid inclusions dispersed in saline rocks prove that they have the composition as the above brines, and permits an inference of genetic connections.

To explain the kinetics of solution mobilization and migration in salt formations and for recognition of the scale of these processes, experiments on thermodynamic activation of fluid inclusions were made in halite and sylvite. The inclusions ranged from 1500 to 2500 per mm^3 (1.5-2.0 liter of brine per cubic meter of rock).

Experiments were made as follows: specimens were placed in an autoclave, the working volume of which was filled with thermoresistant silicone oil and runs made at 100, 200 and 300°C. At 100-150°C the coalescence of inclusion vacuoles became the major process, and at 150-200°C the phase relations between gas and solution in inclusions of various primary filling ratios are equalized. At 200-300°C necking of inclusions becomes the dominant process, resulting in divided inclusions of fluid and gas. The next process is their migration, with speeds of 0.1 - 0.3 micrometer/hr, toward higher temperatures and lower pressures.

On the basis of these experimental data, the origin of the highly concentrated brine lenses in salt formations and their specific composition may be explained by the evolution of the fluids migrating in the salt formation and their localization in structurally weakened zones. In this case, the salt formations are the "geological membrane" with a selective permeability for individual chemical compounds, and, on the other hand, they detemine the main form of material transport as discrete microportions of highly-mobile fluid.

Such a mechanism of fluid transport may explain the significant hydrocarbon enrichment of gas accumulations above salt formations, in comparison with those lying below the salts, as a result of influx of certain components from the underlying oil-bearing layers. Also this may explain the accumulations of borates in certain parts of salt domes. (Author's abstract)

SEDOVA, I.S., 1973, Comparison of P-T conditions of formation and origin of some metamorphic formations, determined by the paleothermometric method and the homogenization of gas-liquid inclusions: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 201-202 (in Russian; translation provided through the courtesy of A. Kozlowski). Author at Inst. of Geology and Geochronology of the Precambrian, Acad. Sci. of USSR, Leningrad.

(...) A comparison is made of the thermodynamic data on metamorphism and ultrametamorphism obtained from mineralogical thermobarometry, from mineral parageneses and from inclusions of mineral-forming media as independent methods. The following massifs were investigated: Tsagan-Oluevskiy massif (E Transbaikal'ye), Muzkol'skiy Complex (Central Pamir), Precambrian formations of S.W. Pamir and Precambrian cover of the Aldan Shield.

Tsagan-Oluevskiy massif is the outcrop of pre-Mesozoic foundation with overlying conglomerates of Lower Middle Jurassic age. Rocks of both complexes were simultaneously metamorphosed and the degree of metamorphism increases toward the center of massif from greenschist facies (biotitic subfacies, zone I) to high-temp. amphibolitic facies of the ultrametamorphism (IV). Maximum T_H of G-L inclusions, probably close to the maximum T of metamorphism, increase from zone I (350-400°C) to zone IV (700°C, sometimes reaching 850-900°C in zones of migmatites; P of fluid from 1600 to 2200 atm). Investigation of feldspars for concentrations of Ca, Sr, Ba and Na, supports these results.

Rocks of the Muzkol'skiy Complex (data of M.S. Dyufur) during Alpine epoch were submitted to metamorphism under conditions of greenschist amphibolitic faces of high pressures (kyanite-type metamorphism) with a decrease of pressure in the following stages of metamorphism (transition to andalusite - type). Maximum T_H in quartz, kyanite and garnet increase from 350-400°C to 600-650°C respectively, and in many cases are in agreement with data of mineralogical thermobarometry.

Precambrian formations of SW Pamir were subjected to 4 tectonic-metamorphic cycles (data of workers from Inst. of Geol. and Geochronology of the Precambrian, Acad. Sci. of USSR). Metamorphic conditions changed from granulite facies at high pressure, through high-temp. amphibolitic facies at high pressures, and low-temp. amphibolitic facies at moderate and low pressures. Intervals of maximum T_H in various minerals were 850-750°C to 680-570°C to 550-440°C.

Ultrametamorphogenic granitoids, formed under amphibolitic facies conditions (cover of Aldan Shield, Pamir) are characterized by various groups of inclusions with T_H up to 700°C.

T obtained by the two-feldspar and amphibole-plagioclase thermometers are usually lower. Dimensions and number of inclusions of mineral-forming media in these rocks are smaller in the shallower intrusive granitoids. (Author's abstract, abbreviated by A.K.)

SEKI, Y., 1974, The role of CO_2 in low-grade metamorphism (abst.): Internat. Symp. on Water-Rock Interaction, Czechoslovakia, Sept. 9-17, 1974, Abstracts: Prague, Geological Survey, p. 58 (in English). Author at Dept. of Found. Eng., Saitana Univ., Urawa, Japan.

SELYANGIN O.B., 1973, Temperature conditions of forming of certain types of crystalline inclusions in recent volcanites of Kamchatka: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press,

p. 210 (in Russian; translation provided through the courtesy of A. Kozlowski). Author at Inst. of Volcanology, Far-East Scientific Center, Acad. Sci. of USSR.

Some samples of allivalites and eucrites from the volcanoes Malyi Semyachik and Il'inskiy, as well as gabbro from Malyi Semyachik, were submitted to thermometric analysis. Melt microinclusions are developed in them to various degrees. Anorthite plagioclase (up to No. 95) is especially poor in inclusions; this plagioclase is most idiomorphic and it (is) the main component of the ultrabasic xenoliths. Rarely very fine (0.005 mm) gas-glass inclusions may be found and they usually occur either in the outer parts of crystals or near the intergrowth boundaries, characterizing seemingly the end stage of crystallization. In interstitial xenomorphic olivines and clinopyroxenes incluisions are very common and sometimes they reach dimensions of 2-3 mm. Inclusions are comparatively common and evenly developed in minerals of gabbro. One may distinguish glass-gas and in various degree crystallized microinclusions. T_H runs made in a microstage with Pt heating element, in a neutral atmosphere (argon) for olivines, have an accuracy of ± 10-15°C.

Results obtained are as follows:

Rock	Mineral	T_H, °C
Allivalites ÷ eucrites,		
Malyi Semyachik	Anorthite	1430 - 1340
Do., Il'inskiy	"	1400 - 1390
Do., M.Semyachik	Olivine	1430 - 1380
Do., Il'inskiy	"	1400 - 1270
Do., M.Semyachik	Clinopyroxene	1270 - 1230
Do., Il'inskiy	"	1190 - 1180
Gabbro, M.Semyachik	Bytownite-labradorite	1340 - 1260
" "	Clinopyroxene	1220 - 1170

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

SEYRANYAN, V.B., 1973, Zoning of pyrite deposits in Northern Armenia: Akad. Nauk SSSR Doklady, v. 211, no. 2, p. 420-421 (in Russian; translated in Dokl. Akad Nauk SSSR v. 211, p. 62-63, 1974.)

The decrep. Ts of sulfides from deep parts of the veins ranges from 240° to 280° and much exceeds that of sulfides from upper parts of the same veins (160° to 180°). The colloform and metacolloidal ore of stratiform shoots was evidently deposited at a lower T. (ER)

SHADE, J.W., 1974, Hydrolysis reactions in the SiO_2-excess portion of the system $K_2O-Al_2O_3-SiO_2-H_2O$ in chloride fluids at magmatic conditions: Econ. Geol. v. 69, p. 218-228.

Equilibrium aK^+/aH^+ ratios for three divariant hydrolysis reactions involving muscovite, K-feldspar, and andalusite in the quartz-present region of the system $K_2O-Al_2O_3-SiO_2-H_2O$ were determined in 2 molal KCl-HCl solutions between 400° and 800°C and from one to seven kilobars. The three reactions are:

$$1.5KAlSi_3O_8+K^+ = 0.5KAl_3Si_3O_{10}(OH)_2+3SiO_2+K^+$$
$$KAl_3Si_3O_{10}(OH)_2+H^+ = 1.5Al_2SiO_5+1.5SiO_2+1.5H_2O+K^+$$
$$KAlSi_3O_8+H^+ = 0.5Al_2SiO_5+2.5SiO_2+0.5H_2O+K^+$$

which in closed system can be represented by divariant surfaces in P-T-ΣK/ΣH space. The surfaces meet at the univariant curve represented by:

$2KAl_3Si_3O_{10}(OH)_2+4.5SiO_2+K^+ = 3KAlSi_3O_8+1.5Al_2SiO_5+1.5H_2O+H^+$
Isobaric equilibrium conditions for this reaction at one and two kilobars are: 1 Kb, 625±15°C, log ΣK/ΣH = 0.3 2 Kb, 670±15°C, log ΣK/ΣH = 0.9 Activities of species in solution at experimental P and T were calculated from ΣK/ΣH data, available ionization constant data, and molal volume data. These calculations suggest that hydrothermal fluids rising from depth, if buffered by the above reactions, are initially neutral, but may become about 3 pH units acid at depths equivalent to one kilobar total pressure. These data are consistent with recently published values of lower pressures and temperatures, and also imply a possible error of about five kilocalories in the free energy of formation of andalusite. (Author's abstract)

SHAPOVALOV, V.S. & SHAVKUNOV, B.N., 1973, Temperature conditions of origin of gold mineralizations of Baim ore region in W. Chukotka: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 48-49 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at NE Complex of Scientific-Research Institute of Far-East Scientific Center of Academy of Sciences USSR, Magadan-SWKNII DWNC AN SSSR.

In the Baim ore region some fields of ore mineralization as veins, zones of veinlets, etc. were distinguished. Thermometric analysis of minerals gave results as follows:

Mineral association	Composition of veins	Mineral-thermometer	Temperature °C
Molybdenite -quartz	Quartz, molybdenite, pyrite, chalcopyrite	Quartz	410-230
Chalcopyrite -quartz	Quartz, chalcopyrite, pyrite, molybdenite, magnetite	Quartz	615-320
Tetrahedrite -quartz	Quartz, calcite, dolomite, tetrahedrite, pyrite, chalcopyrite	Quartz	275-150
		Calcite	160-120
		Dolomite	110-95
Galena sphalerite-carbonate-quartz	Quartz, rhodochrosite, calcite, sphalerite galena, pyrite, chalcopyrite, tennantite, bournonite, electrum, silver minerals	Calcite-I	260-210
		Quartz-II	365-170
		Quartz-III	190-120
		Calcite-II	160-145
Hematite -magnetite -quartz	Quartz, hematite, magnetite, pyrite	Quartz	155-120

The temperature inversions testify to a relatively long and pulsating regime of mineral-forming process in the ore-forming ranges. (Authors' abstract)

SHARAKSHINOV, A.O., 1973, Pyroxenes from alkaline rocks of certain massifs of Vitim Upland, in Minerals and parageneses of minerals of rocks: **Leningrad, "Nauka" Publishing** House, p. 31-40 (in Russian).

T_H of incs. in aegirine-augites from ijolite of Mukhal'skiy massif - 800-830°C, and in pyroxenes from urtite of Nizhne-Burul'zaiskiy massif - 680-885°C. (A.K.)

SHARONOV, B.N., KOZLOV, A.N., AND NIKITIN, D.V., 1973, Ascertaining of zoning and stages of formation of rock-crystal deposits by thermometric methods: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 284-285 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Leningrad Geol. Inst., Leningrad.

During thermometric investigations of vein quartz at a deposit in Pripolyarnyi Ural by the decrepitation method, four types of quartz were distinguished, differing by decrepitophonic activity and shape of decrepigraphs, but visually impossible to distinguish.

Type 1: decrepigraphs have 2 distinct peaks at ca. 400 and 600°C.

Type 2: 2 great peaks at 200 and 300°C often united into one very large peak, plus peaks 400 and 600°C, as type 1;

Type 3: 2 moderate peaks at 200 and 300°C; the latter always occurs as a shoulder on a larger peak at 400°C. A peak at 600°C is also present;

Type 4: peaks 400 and 600°C occur, plus peaks of small and moderate intensity and variable T in the interval 80-300°C.

Differences in the decrepitophonic characteristics of vein quartz depends upon the action of various crystal-forming solutions on formed earlier quartz bodies leaving G-L inclusions. (Authors' abstract)

SHARONOV, B.N., LIR, Yu.V., and KOZLOV, A.V., 1973, On question of interpretation of decrepigraphs of vein quartz: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 309-311 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Leningrad Mining Inst., Leningrad.

(...) Based on decrepigraphs, one may ascertain the number of inclusions broken during heating of a sample. Many authors have suggested that inclusions of solutions occurring close to the surface of a grain break immediately after homogenization (...) and T of beginning of mass decrepitation is similar to T_H. These conclusions are not necessarily true. Decrepigraphs of vein quartz have such shapes, that generally accepted objective criteria cannot be used, and cause subjective and erroneous interpretation.

To provide such objective criteria, a large number of measurements of T_H and T_D were made, taking as material various types of vein quartz. Statistical calculations proved correlation between shape, size, filling, composition, T_H and T_D of inclusions.

Studies of inclusions with similar F, composition and T_H gave very wide intervals of T_D. Part of the inclusions broke before homogenization, individual inclusions at T_H, and the greatest part after homogenization, being superheated 200 to 300°C and more. A simple linear relation exists between size and shape and T_D of inclusion: large and irregular inclusions break earlier, sometimes before homogenization. (...) Observations of groups of inclusions with similar size and morphology, but with various T_H (interval of T_H not given, A.K.) prove that inclusions of such a group decrepitate in a narrow T interval 20-40°C, arranged in accordance with depth of occurrence of inclusions in the grain. Relation between T_H and T_D has a composite character and correlates with size and shape of inclusion. (...) Inclusions of submicroscopic dimensions decrepitate uniformly at T higher than 500°C, independent of T of origin.

(...) Quartz bearing healed fractures give decrepigraphs with some peaks; the appearance of the peaks changes with composition and size of inclusions, and the maximum peak is not always connected with T_H of inclusions. (Authors' abstract, abbreviated by A.K.)

SHATAGIN, N.N., 1973, Dependence of decrepitation temperature on size of inclusions, thickness of inclusion wall, and pressure 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. 293-295. (in Russian; translation provided through the courtesy of A. Kozlowski). Author at Moscov University.

The influence of each of the three individual factors in the title ($dT = T_D - T_H$) has been investigated by various authors. The value dT decreases with larger inclusion size and increases with wall thickness. These two opposing factors are independent of each other; their similar influence was shown by a mathematical expression. The author also wanted to include in the equation the pressure occurring at the time of quartz crystallization as a significant variable.

The results of measurements of the above parameters on 100 individual gaseous-liquid inclusions in synthetic quartz grown in the P interval 170-1800 atm, obtained by B.A. Dorogovin, were used in the calculations.

Regression equations were studied using computer BESM-4. The equation:

$$dT = 68.4 + 0.018P - 10.97\ln L + 10.89\ln r \pm 13.6;$$

was accepted as the best, where $dP = T_D - T_H$; P - pressure of quartz synthesis, atm; L - length of inclusion; r - distance of inclusion from the nearest side of grain. The last two values are in somewhat unusual units: values read from micrometer screw of the MIN-8 microscope (made in USSR); these units are more convenient to use for minute inclusions than mm.

Using this equation curves were made showing the significance of each of the factors.

Conclusions

1. The value dT is proportional to P: a 100 atm increase of P causes an increase of dT of $\sim 2°C$.

2. The relationship between dT and r has a more complex logarithmic form; the relationship between dT with L is simple and with r is inverse. (Author's abstract)

SHATSKIY, V.S., 1974, Teralite crystallization conditions from Goryachegorskiy massif (Kuznetskiy Alatau), in Mineralogy of endogenetic deposits, Yu. A. Dolgov and V. S. Sobolev, eds.: Novosibirsk, Acad. Sci. USSR, Sib. Branch, Inst. Geol. and Geophys., p. 91-95 (in Russian; abstract courtesy A. Kozlowski).

Melt inclusions, containing gas + glass + crystals, were found in plagioclase, pyroxene and nepheline. T_H in plagioclase 1240 to 1260°C, in pyroxene 1140 to 1170°C, in nepheline 1040 to 1100°C.

SHCHERBA, G.N., KUDRYASHOV, A.V., LAUMULIN, T.M., MASGUTOV, R.A., and SENCHILO, N.P., 1974, Ore content in the intrusion-overintrusion zone of the two types of rare-metal-bearing Kazakhstan granites (extended abst.), in Metallization associated with acid magmatism, v. 1, p. 113-118, ed. M. Stemprok: Prague, Geological Survey (a volume of papers presented at the MAWAM Symposium, Karlovy Vary, Czechoslovakia, Oct. 1974) (in English).

The composition of the solutions extracted from the GL incs. in minerals indicates the following to be characteristic of the lower molybdenum lode zone: higher solution alkalinity, higher K, Ca, Na, Cl, HCO_3^- contents, lower F and SO_4 contents, higher T and P values. (From p. 115 of the authors' abstract.)

SHCHERBA, G.N., SALIN, B.A., GUBAYDULIN, F.G., SENCHILO, N.P., MUKHLA, K.A., and KORMUSHIN, V.A., 1974, Forming of scheelite-bearing stock Boguty (S. Kazakhstan): Geol. Rudn. Mest., v. 16, no. 6, p. 3-17 (in Russian; abstract courtesy A. Kozlowski). Authors at Inst. of Geol. Sciences of Acad. Sci. of Kazakhstan, Alma-Ata.

The dep. is greisen-type, consisting also of veins and veinlets, and formed under conds. as shown in table, derived from fluid incs ; pH of inc. sols. ranges from 7.31 to 7.62.

(continued below)

Generation	Ore minerals	Wt. % of total solids in sol. in L phase								vol.% of G phase			T_H, °C	P, bar
		Na	K	Ca	Mg	HCO_3	Cl	SO_4	F	CO_2	H_2S	others		
Metamorphic quartz	pyrite	16	6	4	1	35	25	6	5	61	13	26		
Feldspar - quartz	scheelite	6	24	2	1	29	22	3	12					
Quartz	scheelite, molybdenite	15	7	7	2	29	22	13	6	69	16	13	330-120	588
Muscovite-quartz and muscovite	scheelite, wolframite, pyrite. molybdenite, bismuthite	13	6	6	2	33	20	17	2	40	17	42	330-160	682
		12	7	25	0.6	31	20	2	2					
Quartz-sulfide	pyrite, sphalerite, galena, chalcopyrite	12	2	6	1	33	34	0.6	11	36	11	53	330-130	
Calcite and zeolite													110-60	

Table 4 of original

(same sequence as above)

SHCHERBA, G.N., SENCHILO, N.P., & KORMUSHIN, V.A., 1974, Main physico-chemical factors of vertical zoning of rare metal ore mineralization: Internat. Assoc. on the Genesis of Ore Deposits, Fourth Symposium, Varna, Sept., 1974, Abstracts of Papers: Sofia, IAGOD, p. 58-59 (in Russian; translation courtesy A. Kozlowski). Authors at K.I. Satpaev Inst. of Geol. Sci. of Acad. Sci. of Kazakh SSR, Alma-Ata.

(...) Ore-forming sols. are nearly neutral, but in lower Mo-rich zone they are rather acid and in upper W-rich zone they become alkaline under action of carbonates. In lower Mo-rich part of vein pH of solutions equals about 7; in upper part of the same vein, bearing mainly wolframite, pH equals 5,(sic) when the vein is all in alumosilicate rocks (e.g., Karaoba dep.) Incs. in lower part of vein are richer in Cl & HCO_3 and poorer in F & SO_4 than upper part; the lower part bears also larger amounts of K, Ca and Na. T of sols. decreased from 410 to 180°. (Authors' abstract, shortened by A.K.)

SHCHIRITSA, A.S., 1974, Quartz from veins of Donbass and features of its genesis, in Typomorphism of Ukrainian Quartz, edited by Ye. K. Lazarenko, Acad. Sci. Ukr. SSR: Kiev, Naukova Dumka Pub. House, p. 70-74 (in Russian; translation courtesy A. Kozlowski). Author at Experimental Enterprise of Inst. of Geochemistry and Physics of Minerals of Acad. Sci. Ukr. SSR, Kiev.

In milky and transparent quartz from veins of Nagol'nyi region three groups of incs. were found: (1) S, with liquid CO_2, $T_H = 300$-350°C, P = 600-700 atm, conc. of homog. parent sols. 4% NaCl; (2) S, with liquid CO_2, $T_H = 150$-180°C, P = 700-580 atm, parent sols. heterogenous; (3) P and early S, 0-5% liquid CO_2, $T_H = 130$-270°C, conc. of homogenous parent sols. 8%. Early sols. bear high conc. K, lower Na, and are Cl-SO_4 type with lesser HCO_3; later conc. of K decreases and Ca increases. Cl is the main anion; others are distinctly subordinate (A.K.).

SHEGELSKI, R.J., 1973, Geology and mineralogy of the Terra silver mine, Camsell River, Northwest Territories: MS. thesis, Univ. Toronto, Canada.

Fluid incs. of the gangue assoc. with the nickel diarsenide period of min. indicate the presence of a hyd. fluid with salinities between 30 and 35 equiv. wt. % NaCl and P-corrected T_H of 180° to 370°C. (From the author's abstract; see also Robinson and Badham, 1974, this volume).

SHEPPARD, S.M.F., and TAYLOR, H.P., Jr., 1974, Hydrogen and oxygen isotope evidence for the origins of water in the Boulder batholith and the Butte ore deposits, Montana: Econ. Geol. v. 69, p. 926-946.

Meteoric water-rock interaction was a widespread phenomenon during cooling and late-stage crystallization of the Boulder batholith but only locally occurred on a large scale.

At Butte, the isotopic data for hydrous alteration minerals (biotite, sericite, pyrophyllite, clays) and the calculated $\delta^{18}O$ water values at the selected temperatures are:

Stage	δD Mineral	$\delta^{18}O$ Mineral	$\delta^{18}O$ Water	T°C
Pre-Main Stage	−160 to −170	+3 to + 5	+ 6 to +9	600
Main Stage. Central	−115 to −180	−9 to +12	−12 to +8	300
Intermediate	−130 to −155	−4 to + 7	− 7 to +4	300
Peripheral	−130 to −145	−2 to + 4	− 5 to +1	300

The large variations in $\delta^{18}O$ water for the Main Stage mineralization indicate that fluids of radically different isotopic composition were present at different times and/or places during the evolution of the alteration assemblages; this is probably a result of variable degrees of interaction between the wall rocks and the hydrothermal fluids or to mixing of meteoric waters with different histories. (From the authors' abstract)

SHIKAZONO, Naotatsu, 1974a, Physico-chemical properties of ore-forming solution responsible for the formation of Toyoha Pb-Zn deposits, Hokkaido, Japan: Geochem. Jour., v. 8, p. 37-46. Author at Geol. Inst. Univ. Tokyo, Hongo, Tokyo 113. (In English)

Physico-chem. props. of ore-forming sol. responsible for the form. of Toyoha Pb-Zn vein type deps., Japan are est. on the basis of the min. assemb. and fluid incls. The conc. of total dissolved sulfur is est. in a range from 10^{-2} to 10^{-3} mol/ℓ which is consistent with that of hot springs accompanying sulfide dep. The probable ranges of the other variables such as pH, NaCl and base metal contents of ore-form. sol. are also calc. These est. values are compared with those of hot springs, Broadland geothermal area, New Zealand, now depositing sulfide mins. It is concluded that both hyd. sols. are very similar with respect to physico-chem. props. and both are characterized by (1) total dissolved sulfur in excess over base metals, (2) neutral to slightly alkaline pH, and (3) low NaCl content. These characteristic features are very different from those of Salton Sea geothermal brine which is now depositing sulfide minerals with total dissolved sulfur insufficient for base metals, slightly acid to neutral, and has high NaCl content. (Author's abstract)

SHIKAZONO, Naotatsu, 1974b, Physico-chemical environment and mechanism of volcanic hydrothermal ore deposition in Japan, with special reference to oxygen fugacity: Jour. Fac. Sci., Univ. Tokyo, Sec. II, v. 19, no. 1, p. 27-56. Author at Geol. Inst., Univ. Tokyo, Hongo, Dkyo 113, Japan. (In English)

Theoretically, the composition of a given hydrothermal mineral and the compositional relation in coexisting minerals in hydrothermal ore-forming system are able to be described in terms of many physico-chemical variables. The possible ranges of these variables in the ore-forming system for volcanic hydrothermal ore deposition in Japan are estimated. It is concluded that the variables except oxygen fugacity are relatively constant in comparison with oxygen fugacity. Assuming that the terms expressed as a function of these variables are held constant among different ore-forming processes, the dependence of composition and compositional relation of minerals on oxygen fugacity are theoretically derived.

Based on the theoretical consideration and the chemical analysis of the hydrothermal minerals commonly observed, the difference in oxygen fugacity for the various hydrothermal ore depositions is obtained. The oxygen fugacity at the time of formation of Cu-Pb-Zn vein type deposits is deduced to be changed considerably and to be relatively low in general. On the contrary, oxygen fugacity range at the time of formation of epithermal Au-Ag vein type deposits and of Kuroko deposits is deduced to be narrow and to be higher than those for Cu-Pb-Zn vein type deposits.

Solubility dependence of monosulfide on oxygen fugacity is derived. The solubility is high and changes with change of oxygen fugacity under the oxidized sulfur species predominant region. However, under the reduced sulfur species predominant region, it is low and does not depend on oxygen fugacity. Mechanism of monosulfide precipitation in volcanic hydrothermal ore formation is then discussed.

Origin of ore-forming components is discussed mainly on the basis of the chemical composition of ore-forming solution estimated from the thermochemical studies.

It is concluded that the est. of chem. environments for volcanic hyd. ore deps., theoretical study on the soly. of ore mins., and the consideration on origin of ore-forming components, suggest the importance of the reduction of circulating waters (surface water, connate water, or sea water) for most hyd. ore dep. (From author's abstract)

SHILIN, A.I., NENASHEV, N.I., and ZAYTSEV, A.I., 1973, Temperature conditions of forming of Ilintas ore junction (E. Yakutia): Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 328-329 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Inst. of Geol. of Yakutian Division of Siberian Branch of Acad. Sci. of USSR.

The Ilintas ore junction occurs in the SW part of the granitoid Bezymyannyi massif, as a zone of the Ilintasskoe ore field, with a complex of ore bodies and dikes of acid and neutral composition.

By mineralogical-genetic classification Ilintas belongs to the tourmaline type of cassiterite-sulfide formation and is characterized by a non-continuous process of ore formation including three stages of origin: cassiterite-tourmaline, cassiterite-arsenopyrite-quartz and sulfide-carbonate.

T of formation of the granitoids was evaluated by use of the petrochemical geothermometer of B.P. Kudinov (1971) and Sc geothermometer of Oftedal (1943). Temperature of formation of the ore bodies was evaluated on basis of T_H and T_D of gas-liquid inclusions in quartz.

1. T of magma which gave the granitoid bodies (from granodiorites to fine-grained granites) as indicated by the petrochemical geothermometer, ranged from 800 to 650°C.

2. T of crystallization of these granitoids was in the interval 600-510°C (Sc geothermometer).

3. On the basis of homogenization of G-L inclusions in quartz of hydrothermal formations of Ilintas, four T intervals were found: 150-200, 240-300, 320-370 and 400-490°C.

4. In the same quartz, on basis of beginning and end of mass decrepitation of G-L inclusions, four T intervals were also distinguished: 120-180, 220-280, 320-440 and 500-580°C.

Composite and broad decrepigraphs and histograms of T_H of G-L inclusions in quartz depend on polystage processes of ore-formation at Ilintas, as indicated by geological and microscopic studies. (Authors' abstract)

SHMAKIN, B.I., MAKAGON, V.M., KONEV, A.A., and IVANOV, A.N., 1973, Amazonite pegmatites of Pryol'khon'e region (western Baikalia): Zap. Vses. Mineral. Ob-va., v. 102, no. 5, p. 591 (in Russian; abstract courtesy T.M. Sushchevskaya).

As part of a min. and geochem. study of amazonite pegs., numerous G/L incs. of flattened morphology were found in amazonite and microcline, from zones characterized by intensive amazonitization and connected processes. The incs. are situated along cleavage planes. The gas phase is

~30 vol. %, and liquid CO_2 and solid phases are often observed. T_H is 150-220°, but the solid phases didn't disappear. The authors believe that the data indicate a low T for amazonitization, confirming the previous data of Feldman, et al., 1967, and Bazarov, et al., 1972.

SHMULOVICH, K.I., 1973: Diagram of mineral equilibria in system CaO-MgO-SiO_2-CO_2 and certain applications for problems of contact metamorphism, in Contrib. to Physico-Chem. Petrology, V.A. Zharikov, et al., eds: Moscow, "Nauka" Pub. House, v. 3, pp. 19-35 (in Russian; abstract courtesy A. Kozlowski).

Exper. P_{CO_2}- T diagrams of min. equil. of 3- and 4-component systems were made and analysis of boundaries of stability of characteristic mins. was performed. If taken into account non-ideal features of system CO_2-H_2O, T of equil. of reaction of decarbonatization decreases at T<600°C and increases at T>600°C; the interval of T change is larger than 100°C, proving possibility of forming of contact meta. rocks at T lower than those obtained during studies of carbonate system (Authors' abstract).

SHNAIDER, M.S. AND SHNAIDER, A.A., 1973, Temperature conditions of mineral formation of some tin deposits of N Sikhote - Alin': Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 75 (in Russian; translation through the courtesy of A. Kozlowski). Authors at Far-East Inst. of Mineral Raw Materials -DVIMS.

Decrepitation phenomena of the main minerals of the Mopau and Pionerskoe Sn deposits, such as quartz, cassiterite, chalcopyrite, arsenopyrite, and pyrrhotite, were investigated. As the conventional temperature of mineral origin, the temp. of beginning of its mass decrepitation ("T") was accepted. Such parameters as decrepitation intensity (amount of impluses per 1 g of sample; "N") and loss of weight on decrepitation ("PV") were also noted.

In ores of the Mopau deposit the periodicity and the sequence of mineral origin are expressed by the course of decrepitation: from the early to late generations the temp. of beginning of mass decrepitation decreases.

In the same way the reverse polyascendent vertical zonality of the Mopau deposit was reexamined and supported. (...). The most distant associations from the "core" region have higher "T" than the closer ones.

In ores of the Pionerskoe deposit the decrease of "T" follows from the low to the upper horizons. There the simple polyascendent vertical zonality occurs: the earliest mineral associations were ascertained in the deep horizons, and the late associations were formed at the distant zones. (Authors' abstract)

SHUGUROVA, N.A., SHOKHONOVA, L.A., BERZINA, A.P., PROSKURYAKOV, A.A., AND SOTNIKOV, V.I., 1973, Evolution of gas composition of mineral-forming solutions at some copper-molybdenum deposits: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 161-162 (in Russian; translation through the courtesy of A. Kozlowski). Authors at Inst. of Geology and Geochemistry, Siberian Branch of Acad. Sci., USSR, Novosibirsk.

Role of gaseous component in mineral-forming solutions during formation of copper-molybdenum deposits was significant, especially during formation of explosive breccias and early alteration of wall-rocks (where inclusions of gaseous and essentially gaseous nature were always ascertained). In later minerals during temperature drop the role of gas phase decreases.

As indicated by data from individual inclusions in quartz and in apatite, the evolution of gases from early to late mineral stages was as follows: in the early stages, including explosive breccias, zones of dispersed K-feldspathization of ore-bearing porphyritic bodies and early silicification, high-temp. gases prevailed strongly, with significant amounts of halogens (presence of NaCl and KCl in inclusions and increased content of Cl in apatite). During temperature decline (below 500-450°C) the role of S, CO_2 and noble gases increases. After precipitaion of sulfides, in the solutions, the role of S decreases and CO_2 becomes one of the main components. Especially in quartz of quartz-alunite veinlets from high levels of Kal'makyrskoe deposit, inclusions (gas-liquid) with crystals of molybdenum (misprint for molybdenite? A.K.), T_H was found to be 340-370°C, and no high temp. gases were found. When such sulfide ore was absent, the amount of sulfur increased sharply. At a similar depth, in quartz-sericite veinlets in inclusions with T_H 360-380°C, the gas phase consists mainly of H_2O vapor. During boiling (ca 400°C), the gas component of the remaining solution is enriched in N_2 and noble gases. Oxygen was not found in any analyzed inclusion. (Authors' abstract)

SIGURDSON, D.R., 1974, Fluid inclusion thermometry and paragenesis at the Silver Dyke mine, Mineral County, Nevada (abst.): Geol. Soc. Amer. Abstracts with Programs, v. 6, p. 252-253. Author at Dep. of Chem., Cal. State College, Dominguez Hills, CA 90747.

The Silver Dyke scheelite dep. in the Excelsior Range of Mineral County, Nevada occurs along an extensive and highly silicified fault which cuts Mesozoic and Tertiary volcanic rocks.

T_H of P. fluid incs. in both quartz and scheelite were grouped around 290°C. Corrections for 0-25% salinity and 400±100 bars give T_F 313±19°C for scheelite and quartz. Small amounts of pyrite, chalcopyrite and tellurides were formed later, presumably at lower Ts. (From the author's abstract)

SIMMONS, Gene, and RICHTER, Dorothy, 1974, Microscopic tubes in igneous rocks (abst.): Geol Soc. Amer. Abstracts with Programs, v. 6, no. 7, p. 957. Authors at Department of Earth and Planetary Sciences, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139.

Microscopic tubes, which are quite distinct from fluid inclusions and microcracks, have been observed in several igneous rocks and may be quite common. They have either circular or elliptical cross sections and lengths of ten to hundreds of microns. Tubes have thus far been recognized in quartz, feldspar, pyroxene and olivine in granite, gabbro, diabase, anorthosite and several lunar basalts. They can be divided into the following types: a) hollow, b) partially- and c) completely-filled with a solid phase. The tubes can be further divided into crystallographically- and randomly-oriented types. They usually occur as sets of two to several tubes in the same crystal; they have not been observed continuing from one crystal to another. A few sets of tubes are spatially continuous with planes of inclusions which are in turn symmetrically related to fresh-appearing material which we interpret as the site of a healed crack. The origin of microscopic tubes is not completely understood but we suggest that they may be the result of (1) solution by late magmatic fluids, (2) etching of dislocations by ground water, and (3) healing of flat cracks.

SIVORONOV, A.A., AND ROSIKHINA, A.I., 1973, Thermometry of inclusions in garnet from various metamorphic facies: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 240-242 (in Russian; translation through the courtesy of A. Kozlowski). Authors at L'vov Univ.

1. (...) The following rocks were investigated: Berdichov "granites" - biotite-garnet blastites, formed under conditions of granulitic facies (Ukrainian Shield), garnet - pyroxene metasomatites and ferriferous quartzites of amphibolitic facies from Olenegorskoe Fe-ore deposit (Kola Peninsula) and garnet-cummingtonite schists of epidote-amphibolite facies (Krivorozhskiy synclinorium).

2. (...)

3. (...) T_H of inclusions in biotite-garnet blastites of granulitic facies = 850°C, homogenization of L and G phases in gas and dissolution of solid phase only beings at this temp. (sic.). Olenegrosk metasomatites of amphibolite facies are characterized by T_H 550-625°C. Garnet from epidote-amphibolite facies formed at minimal T = 420°C. (...).

4. Investigation of primary and psuedo-secondary inclusons in garnet from rocks of various metamorphic facies revealed significant differences in character and mode of distribution of inclusions in the minerals. Especially interesting are inclusions in garnet of the granulite facies, conditionally classified as essentially gaseous (Ermakov's classification). Amount of the gas varies over a wide range, and the inclusions bear numerous crystalline phases and some liquid phase. Inclusions have irregular, elongated walls, often with strange shape; their dimensions are about hundredths of millimeter. They usually have a linear arrangement, parallel to zones of crystal growth.

Inclusions in garnet of the amphibolite facies (Olenegorsk) have the shape of negative crystals of the host-mineral, their dimensions are very small (thousandths of a mm), are gaseous-liquid, and homogenize in the gas phase.

Garnet of epidote-amphibolite facies bears numerous, syngenetic G-L inclusions of tubular shape, arranged in chains according to growth zones.

5. (...) Formation of Berdichov "granites" has begun under action of a gas-like medium bearing relatively high concentrations of salts. Solid phases in the inclusions have crystallized from a highly concentrated gas phase, although not necessarily from the volume now present in the inclusion.

Metamorphic alteration of rocks of amphibolite and epidote-amphibolite facies took place under action of gas-aqueous medium over a relatively wide T interval, from 650 to 400°C. (Authors' abstract, with abbreviations by A.K.)

SKINNER, B.J., 1974, Review of Fluid Inclusion Research - Proc. of COFFI, v. 3, 1970: Econ. Geol., v. 69, p. 423.

SKIPPEN, G.B., 1974, Thermodynamics of experimental sub-solidus silicate systems including mixed volatiles (abst.): Internat. Mineral. Assoc. Ninth Gen. Meeting, West Berlin and Regensburg, W. Germany, Collected Abstracts: West Berlin, German Mineralog. Soc., p. 159 (in English).

A review of data for $CaO-MgO-SiO_2-CO_2-H_2O$, to calculate a model for siliceous carbonate rocks. The model expresses the stability field of common mineral assemblages as functions of temperature, total pressure, fluid composition, and carbonate phase composition. (From the author's abstract)

SLIVKO, M.M., 1973, Comparative physico-chemical characteristics of solutions of inclusions in tourmalines of micaceous and rare-metal pegmatites: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov, Univ. Press, pp. 183-185 (in Russian; translation provided through the courtesy of A. Kozlowski). Author at L'vov Univ.

Peculiarities of mineral and element composition of micaceous and rare-metal pegmatites are determined by the character of the metasomatic stage of their formation; this information can be obtained by investigation of inclusions in tourmaline - the important typomorphic mineral of pegmatites. The author has studied solution in inclusions in tourmalines of pegmatites from Ukraine, Middle Ural, Kola Peninsula, Mama River pegmatitic province, Zabaikal'ye, E. Sayans, etc.

1. Tourmalinizing solutions in micaceous pegmatites (schorl-muscovite type of Fersman) were saturated by CO_2 (strong dominance of CO_2 over halogens). Inclusions in tourmalines of rare-metal pegmatites (sodium-lithium type of Fersman), in addition to CO_2, bear significant amounts of halogens (F+ and Cl). Na is the main cation in the inclusions. Attention is paid to the role of alkali-halide type compounds in transport of some rare metals.

2. The pH of the solutions in individual inclusions and of water leachates from tourmalines of micaceous pegmatites (pH of the leachates up to 8.3; of inclusions - 7.3 - 7.5) are higher than of the rare-metal pegmatites (up to 6.5 and 6.6 - 7.2 respectively). These data are similar to results of measurements of pH of solutions during hydrothermal synthesis of tourmalines (Smith 1948; Frondel, Collet 1957, Voskresenskaya 1968).

3. The tourmalinization process in pegmatites of both types was caused essentially by hydrothermal solutions (evidenced by homogenization type of inclusions). Ontogenically documented primary inclusions, independent of phase composition at room temp. (L_{H_2} + G, L_{H_2O} + G+S; $L_{H_2}O + L_{CO_2}$; $L_{H_2} + L_{CO_2}$ + G, etc.) homogenize in the liquid phase, although exceptions were noted.

4. Maximum T_H of inclusions in investigated pegmatites ranges in the interval 50-70°C. Tourmaline-formation in micaceous pegmatites is characterized by higher and more constant temps.; primary inclusions in tourmalines of Na-Li pegmatites homogenize at wide range of temp., depending on the place of the tourmaline crystals in postmagmatic process of formation of the pegmatitic body.

5. Metasomatic mineral formation in micaceous pegmatites took place under higher and stable P (up to 1000-1500 atm.), than in rare-metal ones. As indicated by fluid inclusions in tourmalines, the difference is as large as 1000 atm. Inclusions bearing CO_2 (liquid) commonly occurring in tourmalines from micaceous pegmatites of Archaic and Proterozoic age (e.g., Ukrainian Shield; Mama River Region), testify to high pressures of formation of these pegmatites.

6. In conclusions, problems of extrapolation of phase and chemical composition of inclusion solutions (pH, Eh, concentration, type of compounds) to primary mineral-forming solutions of postmagmatic stage of pegmatite formation, were discussed. (Author's abstract, abbreviated by A. Kozlowski).

SLIVKO, M.M., **1974a**, A comparison of physical-chemical characteristics of solutions from inclusions in tourmalines from mica and rare mineral pegmatites: L'vov. Mineral. Sbornik, v. 28, no. 1, p. 40-46 (in Russian with English abstract). Author at L'vov. Univ.

A comparative study was made of sols. from incs. in tourmalines from mica and rare min. peg. based on T_H, T_{Frz}, and anal. of water extracts of incs. The comparison shows some similar features and some differences in the comp. and state of the tourmaline-forming sols. In mica pegmatites these sols. formed at higher T and P. In the rare min.peg. sols. an important role is played by halides. The leading cation in both cases is sodium. (Author's abstract, modified by ER)

SLIVKO, M.M., **1974b**, Obituary: L'vov. Mineral. Sborn., v. 28, no. 3, p. 81-84 (in Russian).

This obituary of M.M. Slivko gives a bibliography of his works (75 to 1973), many of which deal with fluid incs. in tourmaline. (ER)

ŠMEJKAL, Václav, 1974, Sulfur, carbon and oxygen isotopes and the sulfate salinity during the deposition of the Cypris formation (Miocene of the Cheb and Sokolov basins in west Bohemia) (abst.): Internat. Symp. on Water-Rock Interaction, Czechoslovakia, Sept. 9-17, 1974, Abstracts: Prague, Geological Survey, p. 12 (in English). Author at Ûstřední ústav geologický, Prague, Czechoslovakia.

SMERTENKO, V.M., and KHAKIMOV, A.Kh, 1973, Zoning of crystals of quartz from "cavity-crystallizer" chamber pegmatites: Life of the Earth, Sbornik Museum Earth Sciences, Moscow Gos. Univ., v. 9, p. 115-122 (in Russian).

A review of published literature. (ER)

SMIRNOV, V.I., 1973, Problems of geology of ore deposits at the International Geological Congress in Canada: Geol. Rudn. Mest., v. 15, no. 1, p. 3-15 (in Russian).

The paper bears note on the COFFI symposium, p. 7. (A.K.)

SMITH, F.W., 1974, Yttrium content of fluorite as a guide to vein intersections in partially developed fluorspar ore bodies: A.I.M.E. Trans., v. 255, p. 95-96. Author at Dept. Geol. Sci., Univ. of Durham, Science Labs., Durham, England. TN 73L203.

The relative conc. of yttrium in fluorite is a good indicator, in the North Pennines, of the direction of flow of min. fluids. In all of the ore bodies so far studied in detail in this region, the conc. of yttrium increases markedly in the direction of vein intersections that are believed to have acted as feeder zones to the remainder of the bodies. (From the author's text)

SMITH, F.W., and HIRST, D.M., 1974, Analysis of trace elements and fluid inclusions in fluorite from the Ardennes massif: Annales de la Soc. Geol. de Belgique, v. 97, p. 281-285. Authors at Department of Geological Sciences, University of Durham, Durham, England.

Fluid inc. and trace element data for fluorite from the Ardennes confirm that the min. is from deps. of Mississippi Valley type. Na/K ratios are, however, unusually low, with high K conc. in the inc. brines. Comparisons are made with other min. areas, particularly Derbyshire, England. (Authors' abstract)

SMITH, F.W. and PHILLIPS, R., 1974, Temperature gradients and ore deposition in the North Pennine orefield (abst.): Internat. Mineral. Assoc. Ninth Gen. Meeting, West Berlin and Regensburg, W. Germany, Collected Abstracts: West Berlin, German Mineralog. Soc., p. 34 (in English). Authors at Durham, U.K.

Measurements on fluid incs. in fluorite have been used to establish transverse, longitudinal and vertical temperature gradients in the PbS - ZnS - CaF_2 - $BaSO_4$ - bearing veins of these Hercynian age deposits. Vertical gradients varying from 0.1°C/m at 500 m depth to 0.5°C/m near surface are found, with T_F ranging from 195 to 130°C. The significance of these results in understanding the mode of formation of the ores is discussed. (Authors' abstract).

SNOW, D.B., 1974, The identification of second phases within bubbles in annealed doped tungsten wire: Metal. Trans., v. 5, p. 2375-2381.

Elemental potassium (K) was detected within bubbles formed in annealed, commercially doped W wire by transmission electron microscopy and selected area diffraction. The bubbles in specimens which had been annealed in hydrogen contained liquid K, solid K, and small quantities of KH. Only solid K was observed within bubbles when specimens were annealed in $<10^{-5}$ mm Hg vacuum. The K solidified epitaxially on the W bubble surface and had virtually the same lattice orientation. The KH usually displayed a specific orientation relationship with the solid K and the W. (Author's abstract)

SOBOLEV, N.V., 1974, Syngenetic crystalline inclusions in natural diamonds (abst.): Internat. Mineral. Assoc. Ninth Gen. Meeting, West Berlin and Regensburg, W. Germany, Collected Abstracts: West Berlin, German Mineralog. Soc., p. 109 (in English). Author at Novosibirsk,USSR.

Electron microprobe studies show that diamonds from Yakutia and elsewhere contain incs. of olivine, chromite, garnet, clinopyroxene, enstatite and rutile, some of which have grown simultaneously with diamond. The study of incs. justifies that diamonds crystallized within the upper mantle, between 150 and 200 km, in equilibrium with included minerals and an igneous melt. (From the author's abstract)

SOKOLOV, S.V., 1973, Minerals and inclusions of mineral-forming solutions as indicators of conditions of origin of carbonatites: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 220-221 (in Russian; translation through the courtesy of A. Kozlowski). Author at All-Union Inst. of Raw Materials, Moscow.

Carbonatites and synchronous calcite-bearing silicate rocks, plus apatite-magnetite and other metasomatites were formed during a polystage carbonatite process. For deep carbonatite complexes of Aldan, E Sayan and Kola Peninsula one may ascertain the general direction of alteration of one type of rocks by the others.

(...) The carbonatite process develops in a wide T interval during T decrease. Determination of T (see Table) was made by use of some geothermometers (...).

For individual stages of formation of rocks of ultrabasic-alkaline and carbonatite massifs, the following T intervals (°C) were found: Magmatic stage -ultrabasites 1450-1100; -alkaline rocks of ijolite series plus associated silicate metasomites 1160-675; -nepheline syenites 750-620.
Postmagmatic stage
-carbonatites plus syncarbonatite metasomatites:
I stage - 630 to 520-500 III " - 400 to 300
II " - 520 - 500 to 400 IV " - 300 to 190;

	T_H 1/	T_D 2/	Exsolution structures	Arnold's method	Perchuk's geothermometers	Fields of mineral stability
			Pre-carbonatite formations			
	880-1160				675	
			Carbonatite formations			
Stages I	495-560	360-415	700		540-630	520-500
II	355-440	300-330	400			520/500/-390
III	290-365	260-275		300-375	350-400	420-300
IV	190-230	210-225			300	320/300/-200
			Post-carbonatite formations			
	155-195	205				250-200

Note: 1/ T_H of primary inclusions; influence of P and concentration of solutions omitted;

2/ T_D accepted as T of beginning of mass decrepitation.

- post carbonatitic carbonate-silicate rocks 195-80.

The carbonatite-forming process develops under action of high-temp. liquid-like solutions with regularly changing density and pH, in accordance with T drop. At early stages the density was relatively low (small F values for primary G-L inclusions). T decrease was accompanied by transformation of supercritical fluids into the usual hydrothermal fluids. Increasing density was accompanied by increase of acidity (Author's abstract, abbreviated by A.K.)

SOKOLOV, S.V., 1974, On the mode of forming of carbonatites, in Metasomatism and ore-formation, ed. D.S. Korzhinskii: Moscow, "Nauka" Press, p. 190-196 (in Russian; abstract courtesy A. Kozlowski).

On the basis of thermoluminescense of carbonates and T_H and T_D studies of fluid incs. in calcite and apatite from Sette-Daban Province (Yakutia) and Kovdorskiy Massif (Kola Peninsula), the following stages of process of carbonatite forming were ascertained: I - 630-520°C; II - 520-400°C; III - 400-300°C; IV - 300-200°C and final stage of forming of carbonate-silicate rocks down to T = 80°C.

SOKOLOV, S.V., + EPSHTEYN, Ye.M., 1974, Thermometric study of metasomatic carbonatite: Akad. Nauk SSSR, Doklady, v. 210, no. 1, p. 191-194 (in Russian; trans. in Doklady Acad. Sci. USSR, v. 210, (1974), p. 174-177; abst. in Internat. Geol. Rev., v. 15, no. 8, p. 979). Authors at All-Union Research Inst. of Min. Products, Moscow.

Carbonatization 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 T phases, the facies of which are reliably identified by several independent methods in the Sette-Daban and East Sayan massifs. T_H of incs. in mins., the biotite-pyroxene, amphibole-pyroxene, and pyrrhotite-pyrite geothermometers, mass decrep., T of breakdown of solid sols., and exper. data on stability of mins. indicate the following T limits of the facies, °C: 625/630-515/520; 515/520-400; 400-303/300; 300-200/190. (Authors' abstract)

SOMMER, M.A., and SMITH, R.L., 1974, Analyses of silicate melt inclusions from silicic lavas (abst.): Geol Soc. Amer. Abstracts with Programs, v. 6, no. 7, p. 960-961. First author at Department of Geological Sciences, Brown University, Providence, Rhode Island 02912.

Silicate melt inclusions in quartz phenocrysts from silicic lavas of the Jemez Mountains, New Mexico were analyzed. The chemical analyses included electron microprobe and mass spectrometric determinations. Physical analyses included microscope heating and crushing stage determinations. Bulk chemical differences were observed between inclusions, the greatest chemical differences occuring between those inclusions with the greatest textural inhomogeneity. Inclusion textural variations observed included: devitrification, zoning, evidence of quenching, grain growth, and resorption of the host phenocryst. Devitrified inclusions had wide chemical variations and some inclusions had pronounced compositional zoning. The zoned inclusions had a rim enriched in potassium and silica and a core enriched in sodium and very high in volatiles. Compositional bulk reconstruction of the zoned or modified inclusions was unsatisfactory suggesting that only clear glassy inclusions could be analyzed with analytical certainty. Glassy inclusions are rhyolitic in bulk composition but have variations in total volatiles based on microprobe difference techniques. Total volatiles ranged from 1 to 6 weight percent based on microprobe and mass spectrometric determinations. Clear glassy inclusions had volatile compositions typically H_2O = 85%, CO = 5%, with minor amounts of chlorine, methane, hydrogen, and various hydrocarbons. Inclusions with large bubbles were occasionally observed to contain high pressure gas suggesting volatile boiling during eruption and solidification. (Authors' abstract).

SOROKIN, V.I. and BEZMEN, N.I., 1973: Sulfides of Zn-Fe-S system in equilibrium with solutions of chlorides at 600°C and 1000 kg/cm^2, in Contrib. to Physico-Chem. Petrology, V.A. Zharikov, et al., eds.: Moscow, "Nauka" Pub. House, v. 3, pp. 36-42 (in Russian; abstract courtesy A. Kozlowski).

Reactions were made in 1 M sol. of NH_4Cl and 2M sol. of NaCl, over 12-930 hours, in argon in open ampules, followed by water quench. Reaction products were invest. by mineragraphic, X-ray powder patterns and electron microprobe methods. Solids present: sphalerite, hexagonal pyrrhotite, pyrite and magnetite. Sphalerite in equil. with pyrrhotite and pyrite bears 18 ± 1.5 mol. % FeS and pyrrhotite has comp. 46.22 ± 0.15 atom. % Fe, agreeing with previous studies. For distribution of Fe between sphalerite and pyrrhotite the existence of various curves for NH_4Cl and NaCl sols. was det. Time for equil. in NH_4Cl sols.- 350-400 hours, in NaCl sols. - 150-500 hours. Concs. in sols. in equil. with solid phases in g/ℓ: NH_4Cl sols: Zn 6.36, Fe 7.54, S ≤ 19.5; sols. of NaCl: Zn 4.06, Fe 8.7, S 16.9. (Authors' abstract, shortened by A.K.)

SOROKIN, V.I. and CHICHAGOV, A.V., 1974, Sulfides of system: Zn-Fe-S in equilibrium with aqueous solution NH_4Cl at 400°C and 1000 kg/cm^2: in Contrib. to Physico-Chem. Petrology, V.A. Zharikov, et al., eds.: Moscow, "Nauka" Pub. House, v. 4, pp. 176-185 (in Russian).

SOTNIKOV, V.I., and BERZINA, A.P., 1974, Physico-chemical aspects of metasomatism during subvolcanic ore formation, in Mineralogy of endogenetic deposits, Yu. A. Dolgov and V. S. Sobolev, eds.: Novosibirsk, Acad. Sci. USSR, Sib. Branch, Inst. Geol. and Geophys., p. 3-12 (in Russian; abstract courtesy A. Kozlowski).

On the basis of fluid inclusion data one may ascertain the following main scheme of evolution of mineral-forming solutions: early stage - separation of gases from shallow magmas, gas-like very mobile solutions of low salt concentration, T, 700 to 900°C, P, $\leq$ 2000 atm; processes of metasomatic origin of K-feldspar and albite. The solutions are mainly chloride, possibly transport and disseminate ore elements, and form element aureoles. Together with gas-like solutions, liquid ones do exist (at 600°C and probably higher). In early metasomatites of the Sorskoe deposit the amount of atmospheric argon is as high as 60% of all Ar trapped in the fluid inclusions. Alkaline chloride solutions often boil at 400 to 500°C, forming water-salt melts very active during metasomatic processes. The phase inversion phenomenon forms a suitable condition for the precipitation of ore minerals, as well as for silicification and sericitization. In the peripheral parts of the deposits the main role the condensates of gas emanations are displayed. The anion composition of the solutions is the important factor determining the type of metasomatic alteration: albitization of K-feldspar can be caused by Na-Cl and Na-F solutions but probably not by Na-CO_3^{2-} (experimental data). In fluid inclusion solutions significant amounts of ore elements were ascertained, e.g., in early K-feldspathized rocks of Sorskoe Deposit, 25.5 ppm of Mo were determined by the water leachate method (amount vs the rock weight).

SOTNIKOV, V.I., BERZINA, A.P., NIKITINA, E.I., SKURIDIN, V.A., and PROSKURYAKOV, A.A., 1974, Relationship between copper-molybdenum mineralization and subvolcanic granitoids (extended abst.), <u>in</u> Metallization associated with acid magmatism, v. 1, p. 123-126, ed. M. Stemprok: Prague, Geological Survey (a volume of papers presented at the MAWAM Symposium, Karlovy Vary, Czechoslovakia, Oct. 1974) (in English). Authors at Inst. Geol. and Geophy., Novosibirsk, USSR.

The (unnamed) deposits show predominantly high-T (480-520°), essentially gaseous incs. with high HCl contents and CO_2 in the late magmatic porphyries (e.g., apatite). With decreasing T_H the gas phase has more N_2 + inert gases.

Hydrothermal-metasomatic minerogenesis occurred over a wide range of T, from 600-800°C in the initial period (K-feldspathization, albitization, early silicification) to 250-450°C during the ore formation stage (and also sericitization, silicification, argillization) and lower in the closing period. P changed from 2,000 to 100-80 atm. Solutions were predominantly Na-Cl type. Two groups of deposits are distinguished: one with low salt concentrations and rare multiphase incs, the other with aqueous salt melts. Total salinity and T decrease towards the marginal parts of deposits. The latter deposits show evolution from gaseous, dilute high-T fluids (as a result of magma degasification) to aqueous salt liquids formed as a result of repeated boiling of solutions. The high salt concentration is also connected with extraction of chlorine from the enclosing rock. (ER)

SOTNIKOV, V.I., BERZINA, A.P. AND PROSKURYAKOV, A.A., 1973, Physicochemical conditions of endogenous processes during subvolcanic oreformation: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 81-83 (in Russian; translation through the courtesy of A. Kozlowski). Authors at Inst. of Geology and Geophysics, Siberian Branch of Academy of Sciences USSR, Novosibirsk IGiG SO AN SSSR.

Fluid inclusions in quartz and apatite revealed the physico-chemical properties of the formation process of polystage Cu-Mo deposits in E. Transbaikalia, Kuznetskiy Alatau, and Middle Asia, connected with the origin of subvolcanic porphyritic complexes.

During early stage - the stage of intensive separation of gases from shallow magmas - solutions were mainly gasesous, bearing low concentrations of salts. The separation of high-temp. gas-like solutions (up to 700-800°C, under pressure $\sim$ 1000 atm) was accompanied with formation of explosive breccias and significant dissemination of ore elements. Together with gas-like solutions, high-temp. liquid solutions (up to 600°C and higher) with high salt concentrations, were found.

At 700-100°C and 2000-1200 atm extensive alteration of wall rocks (feldspathization, albitization, early silicification) took place under action of gas-like solutions passing with temp. drop into liquid ones. Essential formation of ores and accompanying process of sericitization, argillitization and silicification developed at lower temp. (250-450°C) and pressures (1000-200 atm) from liquid solutions. At temp. $\sim$ 400°C boiling phenomenon often occurred.

At deposits of Middle Asia high concentrations of solutions (up to 60% of NaCl plus KCl)-practically aqueous salt melts--originated in the process of multiple boiling, with significant decrease of concentration and temp. toward the periphery of the deposit. At deposits of E. Transbaikalia solutions with less chloride and increasing partitioning of CO_2 were found. Deposits from Kuznetskiy Alatau are characterized by low concentrations (rare polyphase inclusions) with significant amounts of F^-. Various chemical composition of fluids resulted in different wall-rock alterations (E. Transbaikalia - mainly argillitization; Kuznetskiy Alatau - albitization).

The above peculiarities were stated also in porphyry copper deposits (Roedder 1971). (Authors' abstract)

STALDER, H.A., and WAGNER, A., 1974, Scapolite, a fissure mineral from Camperio: Mineralienfreund, v. 4, p. 41-56 (in German). First author at Naturhist. Museum, Bernastr. 15, 3000 Bern, Switzerland.

A detailed study of the occurrences, paragenesis, and fluid incs. in this Alpine fissure assemblage. The incs. in assoc. quartz from various stages in the paragenesis homog. at 350°C (early) to 150°C (late). T_{Frz} (-5 to -20°C), CO_2-hydrate melting Ts (0 to +10°C), and T_H of CO_2 G-L (20 to 31°C) also vary with stage. For further details, see extended abstract of Wagner, et al., 1972, in Translations, this volume. (ER)

STEPANOV, G.N. AND KURYAKOVA, O.P., 1973, Geochemical peculiarities of ore-forming solutions of tungsten deposits from Primor'ye: Abstracts of papers form the Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp 140-141 (in Russian, translation through the courtesy of A. Kozlowski). Authors at Far-East Geological Institue, Far-East Scientific Center-DVGI DVNC, Vladivostok.

Tungsten deposits of Primor'ye consist of following types: skarn-sulfide-scheelite, quartz-wolframite and quartz-scheelite.

In water leachates of minerals of skarn-sulfide-scheelite deposits of hypabyssal facies, connected with small intrusions, Ca exceeds Na, and there are small amounts of K and Mg, and among anions, HCO_3^- and S exceed halogens. In the deeper deposits of that facies the amount of alkalies as well as of chloride increases, and amount of S decreases.

During quartz-wolframite formation from solutions of rare-metal-wolframite deposits connected with final fine-grained granites the main elements are Na, K (Na/K = 10.5) and Cl, and bicarbonate ion occurs in small amount. In paragenses with topaz or fluorite significant amounts of fluorine were determined in leachates.

Quartz-wolframite deposits connected with batholith-like intrusives of acid granitoids were formed from alkaline-bicarbonate solutions, Na/K = 1.6 to 2.0, with a small amount of chlorine.

Hydrothermal solutions for the Au-wolframite deposits are characterized by mainly Na-Cl solutions (Na/K = 4.9 - 5.1).

Hydrothermal solutions for the quartz-scheelite deposits (quartz veins in large granodiortie massives) are of Mg - K - S - Cl = HCO_3^- composition. (Authors' abstract)

STĘPISIEWICZ, Marek, 1974, Physico-chemical conditions of origin of postmagmatic minerals in Strzelin granites: MS thesis, Warsaw Univ., 32 pp. (in Polish). Author at Fac. of Geol., Inst. of Geochem., Min. and Pet., Warszawa 02-089m al. Żwirki i Wigury 93. Abstract courtesy A. Kozlowski.

The late Variscan Strezelin-Žulova massif intrudes meta. rocks and bears pegs. consisting of several generations of quartz and feldspars, and of biotite, muscovite, garnet, tourmaline, topaz, beryl, apatite, sphene, strzegomite (strigovite), epidote, stilbite, kaolinite, psilomelane, prehnite, laumontite (the first discovery described in a recent paper) calcite, chlorite, sericite, pyrrhotite, chalcopyrite, pyrite, molybdenite, sphalerite, native bismuth and galena. Incs. in quartz were ident. by presence of 3450cm^{-1} band of molecular water in IR spectra. Fluid incs. (mainly in quartz) are two-phase (various ratios of liquid H_2O and vapor) and three-phase ($L_{H_2O} + L_{CO_2} + G$). In some quartz and in calcite mainly one-phase liquid aqueous incs. were found. proving xliz. from cold sols. at ∿40-50°C. T_H and T_D are as follows:

Locality	Mineral	T_H, °C	T_D, °C	Number of samples
Strzelin	Quartz	400-100	390-270	4
	Garnet	-	455-430	1
	Tourmaline	-	500-420	1
	Molybdenite	-	305-235	1
	Chalcopyrite	-	305-270	1
	Sphalerite	-	295-230	1
	Pyrrhotite	-	240-155	1
Gębczyce	Quartz	390-180	320-130	5
Gęsiniec	Quartz	340-125	400-240	3
	Pyrite	-	340-325	1
Górka	Quartz	330-110	380-290	5
Maciejowice	Quartz	360-90	not decrep.	2
Nadziejów	Quartz	315-100	305-120	2

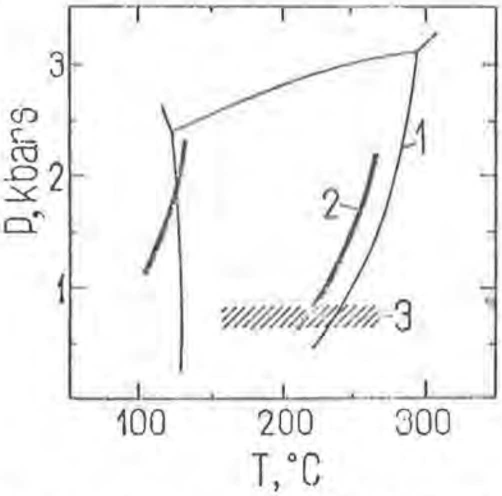
Three water leachates from quartz show the following comp., in weight % of inc. filling.

Three water leachates from quartz show the following comp., in weight % of inc. filling.

Locality	Li	Na	K	Mg	Ca	Sr	Ba	Al	Mn	Fe	F	Cl
Strzelin	0.035	0.39	0.33	0.007	0.43	0.023	0.003	0.39	0.022	0.09	0.21	2.2
Maciejowice	0.048	1.0	1.0	0.044	0.33	0.030	0.007	1.16	0.022	0.16	0.58	6.3
Nadziejów	0.145	1.7	1.9	0.033	0.40	0.015	0.008	1.75	0.033	0.23	0.47	6.8

Note: Trace amounts of B and Cu were found; the missing anions are probably bicarbonate and sulfide. Ps (method of Naumov and Malinin) range from 650 to 800 atm at 250-300°C. Special attention was paid to the conditions of origin of laumontite. T and P were det. by use of incs. in assoc. quartz. As these incs. contained liquid CO_2, the diagram of laumontite stability in the presence of CO_2 (Senderov, 1973, Geokhimia no. 2) was used.

Fig. Area of stability of laumontite in systems $CaAl_2Si_2O_8 - SiO_2 - H_2O$ (1), $CaAl_2Si_2O_8 - SiO_2 - H_2O - CO_2$ (2) with the area assigned for laumontite formation from Strzelin (3).



STOIBER, R.E., and ROSE, W.I., Jr., 1974, Fumarole incrustations at active Central American volcanoes: Geoch. et Cosmo. Acta, v. 38, p. 495 to 516. First author at Dept. Earth Sci., Dartmouth College, Hanover, N.H. 03755.

Most incrustation mins. are sulfates. The most abundant and frequently found mins. are: sulfur, hematite, halite, sylvite, gypsum, ralstonite, anhydrite, thenardite and langbeinite. Incrustation suites dep. around fumaroles to produce a zonal pattern which is a response to the rapidly changing T and PO_2 at the mouth of the vent. The observed zoning pattern can be explained by the reaction of a volcanic gas composed of H_2O, SO_2, CO_2, HCl and HF, along with trace amounts of volatile cations, which interacts with the atmosphere and the fumarole wallrock. (Authors' abstract, abbreviated)

SUSHCHEVSKAYA, T.M., 1974, Concentration of rare and ore elements in hydrothermal solutions (from data of analysis of inclusions in minerals): in Hydrothermal mineral-forming solutions of the areas of active volcanism, Publ. house "Nauka", Siberian Branch, editor S. I. Naboko, p. 126-133 (in Russian; abstract courtesy A. Kozlowski). Author at Inst. of Geochem. and Anal. Chem. of Acad. Sci. USSR.

Following values of conc. were found in incs. in quartz: Li: 0.72-1.25 mg/kg of sample, Rb: 0.33-0.68 mg/kg, Cs: 0.05-3.20 mg/kg, NH_4^+ in quartz, fluorite and cassiterite: 0.10-3.60g/l of sol. in incs. (24 dets.), B in quartz, cassiterite and fluorite: 0.01-0.44 g/l (18 dets.), Cu in incs. in quartz: 0.005-0.176 g/l (5 dets.), Pb in incs. in quartz: 0.003-0.041 g/l (5 dets.), Ag in incs. in quartz: 0.00005-0.188 g/l (4 dets.).

SUTULOV, Alexander, 1974, Copper porphyries, Univ. of Utah Printing Services, 200 pp.

A review of the porphyry copper deps. of the world, their genesis, distribution, production, and metallurgy. (ER)

TAKENOUCHI, Sukune, and IMAI, H., 1974, Fluid inclusion study at the Fujugatani and Kiwada area of southwestern Japan (abst.): Internat. Assoc. on the Genesis of Ore Deposits, Fourth Symposium, Varna, Sept. 1974, Abstracts of Papers: Sofia, IAGOD, p. 278-279 (in English). Authors at Dept. of Min. Dev. Eng., Univ. of Tokyo, Tokyo, Japan.

The Fujigatani and Kiwada tungsten mines are in scheelite-bearing skarns and quartz veins genetically related with a shallow late Cretaceous granitic intrusion (300 m below surface).

Fluid incs. in quartz from veins and granite are all L + G. Most in the veins are P negative crystals, but those in the granite are irregular and considered S. T_H for the veins and granite ranges from 200°C to 260°C. Salinity ranges from 1 to 7 wt. % NaCl equiv. in both. There is no recognizable slope to a plot of T_H vs T_{Frz}.

It is concluded that the temperature and salinity of the fluid which formed the veins and those which permeated through the granite were almost the same, and that the temperature stayed uniform during the formation of ore deposits throughout the area, as might be expected from the nearby granitic intrusive. It is supposed that the ore-forming fluid was probably released at deeper places rather than the upper parts of the granitic body. These incs. are remarkably different from highly saline incs. often found in porphyry near some base metal ore deposits. (Modified by ER from the authors' abstract.)

TAKENOUCHI, Sukune, and KATSURA, Tadahiko, 1972, Volcanic glass inclusions in rhyolite and tuff from the Chitose mine, Hokkaido: Mining Geol. (Japan), v. 22, no. 5, p. 383-391 (in Japanese with English abstract.)

Volcanic glass incs. in the quartz phenocrysts of rhyolite and in the quartz grains of rhyolitic tuff from the Chitose gold-silver mine, Hokkaido, were studied by means of the microscopic observation, heating exper., electron-probe microanalysis and laser-probe microanalysis. The glass incs. in the rhyolite generally consist of transparent glass and a bubble, and some of them contain dendritic xls. The glass incs. in the tuff, however, contain reddish brown hexagonal tabular xls., short prismatic xls., and long prismatic or acicular xls. The heating exper. revealed that T_H of the glass incs. in rhyolite was 1,000°C - 1,200°C, while that of tuff was in the range 870°∿1,000°C.

The major comps. of glass incs. in rhyolite and tuff were det. by the electron-probe microanalysis as follows: SiO_2:70∿76 wt.%, Al_2O_3: ±12 wt.%, Na_2O:2∿5 wt. %, K_2O:2∿4 wt. %, CaO:±1 wt. %, MgO:<0.2 wt. %, FeO (total): ±0.8 wt. %. No distinct difference was recognized between the glass inc. of rhyolite and that of tuff. The laser-probe microanalysis showed the presence of Cu, Ag, Ti and Zn in the glass incs.

Though the present data are not enough to draw any general conclusions on the form. of glass incs. in volcanic rocks, it is presumed that glass incs. provide the approximate thermal history. This presumed history, however, gives merely a general trend, because phase changes such as melting, nucleation and growth of xls. in glass incs. occur metastably in various degrees. The devitrification of glass incs. does not necessarily require slow cooling, because the hyd. action would also cause devitrification. Larger incs. are more frequently devitrified than smaller incs. (Authors' abstract)

TASHKER, E.M., 1974, Influence of composition of impurities in quartz crystals on features of quartz glass (exemplified by quartz from Ukraine and Ural), in Typomorphism of Ukrainian Quartz, edited by Ye. K. Lazarenko, Acad. Sci. Ukr. SSR: Kiev, Naukova Dumka Pub. House, p. 117-118 (in Russian; translation courtesy A. Kozlowski). Author at All-Union Scientific-Research Inst. of Synthesis of Mineral Raw Materials,Alexandrov.

Role of G/L incs. in quartz raw materials is evaluated, especially in form. of dispersed minute bubbles in silica glass, that decrease the transparency of glass, especially in UV (A.K.).

TAYLOR, H.P., Jr., **1974a**, The application of oxygen and hydrogen isotope studies to problems of hydrothermal alteration and ore deposition: Econ. Geol., v. 69, p. 843-883.

$^{18}O/^{16}O$ and D/H anals. of hyd. mins. and fluid incs. can provide data on Ts and attainment of equil., but they are principally useful as isotopic tracers in det. the origin of the H_2O involved in ore dep. This results from the fact that diff. sources of H_2O in the earth's crust, namely primary magmatic, meta., oceanic, connate, and meteoric, all exhibit char. δD and/or $\delta^{18}O$ values. Recent studies have provided quan. data emphasizing the importance of meteoric H_2O in many hyd. 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 hyd. convection systems that persist throughout the xliz. 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 deps. and their assoc. propylitic alt. zones in volcanic terranes (western Cascades, Tonopah, Comstock, Goldfield, the San Juans) were formed by such low-^{18}O meteoric fluids; the very high water/rock ratios imply that such ore-bearing fluids are relatively dilute water. If the country rocks are less permeable, as in many porphyry copper environments, less outside water is available and dominantly magmatic-hyd. fluids are isotopically identified as the source of the biotite-K feldspar alt. in the core zones of the porphyry stocks. A less pronounced meteoric-hyd. circulation, perhaps involving Na-Ca-Cl brines in the country rocks, is set up outside the stock. Such sols. are responsible for the pyrite-sericite and hypogene clay alt. zones in the outer portions of the stock. These zones tend to collapse and encroach 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 form. may occur and this can also be distinguished from the hypogene clay alt. by means of $\delta^{18}O$ and δD anals. (Author's abstract)

TAYLOR, H.P., Jr., **1974b**, A low-^{18}O, late Precambrian granite batholith in the Seychelles Islands, Indian Ocean: Evidence for formation of ^{18}O-depleted magmas and interaction with ancient meteoric ground waters: Geol. Soc. Amer. Abstracts with Programs, v. 6, no. 7, p. 981-982. Author at Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, California 91109.

TEWHEY, J.D., and HESS, P.C., 1974, Two-phase region of SrO - CaO - SiO_2 melts (abst.): Amer. Geophy. Union Trans., EOS, v. 55, no. 4, p. 483. Authors at Dept. of Geol. Sci., Brown Univ., Providence, R.I. 02912.

TIMOFEEV, A.V., SHTEINSHNEIDER, T.L., and KHOTEEV, A.D., 1973. The conditions of quartz-carbonate vein formation at a rare-metal deposit by data on fluid inclusions: 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. 61-62 (In Russian; translation provided by Dr. E.I. Dolomanova of I.G.E.M., Moscow). Authors at IGEM, USSR Academy of Sciences, Moscow.

The deposit is controlled by major faults: the Main Fault bounds its footwall and the Carbonate Fault, the hanging wall. The deposit has been formed through four stages: pyritic, ore mineralization, ankeritic and quartz-carbonate. The quartz-carbonate stage is confined to the above-mentioned faults and more seldom to minor breaks in between.

Minerals were formed under falling solution temperatures (the drop was abrupt between stages and gradual within stages).

The following temperature intervals are recognized: the pyritic stage, 230-210°; ore mineralisation stage, 220-170°; ankeritic stage, 190-160°; and quartz-carbonate stage, 160-100°. The inclusions in quartz from the veins of the last stage are 0.005 - 0.05 mm in size. Few of them are three-phase (gas + liquid + solid and gas + liquid + liquid CO_2), but most of them are gaseous-liquid (the gaseous phase content is 10 to 45 percent by volume).

For the quartz specimens taken from the zones of the Main and Carbonate faults, the temperature of inclusions homogenization varies in the range of 80° to 440° with two maxima: well-defined between 100° and 200° and vague between 260° and 300°.

For the quartz from the veins occuring far from these faults, a clear-cut maximum of 100° to 220° in inclusion homogenization temperature is observed. Away from the faults this maximum tends to shift toward the lower temperatures. (Authors' abstract).

TIMOFEEVSKII, D.A. AND ADRIANOVA, S.I., 1973, Comparative characteristics of formation temperature of gold deposits of various ore formations: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov University Press, p. 54 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Central Scientific-Research Geological-Prospecting Institute of Geology Ministry USSR, Moscow.

Gold deposits in USSR are divided into 7 ore formations, depending on dominant classes or large groups of minerals. For deposits of the Au-silicate-sulfide formation, higher temps. of origin are characteristic (750-550°C), related with pre-ore skarn stage.

The highest values of formation temp. were ascertained for deposits of gold-albite-quartz (480-340°C), gold-sulfide-quartz (460-340°C, homogenization data, or 550-400°C, decrepitation data) and gold-sulfide (480-340°C) formations, and the lowest ones - for gold-carbonate-sulfide (410-320°C), gold-barite-sulfide (370-320°C) and gold-adularia-chalcedony-quartz (420-210°C) for the beginning of the ore stage are characteristic only for some deposits of NE USSR, but are not characteristic for the majority of other deposits of gold-chalcedony-adularia-quartz formation.

Generalized temp. intervals of formation of mineral associations with early gold range from 410 to 210°C, and with late gold - 320-100°C. The main part of the productive gold mineralization precipitated in the range 250-150°C, and the remaining part at temp. not exceeding 300°C. (Authors' abstract)

TIMOFEEVSKIY, D.A. and ANDRYANOVA, S.I., 1974, On physico-chemical conditions of forming of gold deposits of various ore formations in USSR (abst.): Internat. Assoc. on the Genesis of Ore Deposits, Fourth Symposium, Varna, Sept., 1974, Abstracts of Papers: Sofia, IAGOD, p. 265-266 (in Russian; translation courtesy A. Kozlowski). Authors at Central Scientific-Research Geol.-Prospecting Inst. - CNIGRI, Moscow, USSR.

(...) Deps. of Au-silicate-sulfide form. have high values of upper ranges of T of min.-form. (750-550°C) - skarn stage, sols. are of Cl-alkaline earth type with HCO_3^-, Na:K ratio = 1:1 to 3:1, pH from alkaline to weakly acid.

Upper T range for Au-albite-quartz form. - 480-340°C, Au-sulfide-quartz - T_H 460-340°C and T_D 550-440°C, Au-sulfide-480-340°C; lower T range is taken by Au-carbonate-sulfide form. - 410-320°C, Au-barite-sulfide - 370-320°C, Au-chalcedony-adularia-quartz - 420-210°C. Relatively low T (245-210°C) of beginning of ore stage are known only for several deps.

T of origin of min. assocs. with early gold - 430-180°C, with the late - 320-100. Main mass of gold precips. at 250-150°C, and the remaining part - at T $\geq$300°C.

Au-sulfide, Au-quartz and Au-sulfide-quartz forms. formed at pneumatolytic-hydorthermal stage, often from conc. sols. of Cl-K-Na + CO_2 type, and at hydrothermal stage - from sols. conc. at initial stage and becoming more and more diluted at later stages, with composition of HCO_3-$HSiO_3$-F-Cl-alkaline earths + subordinate alkalies + some SO_4. Initial sols. were weakly acid and the late sols. - neutral to weakly alkaline. During precip. of gold the amount of alkalies increases with Na>K and of alkaline earths - decreases, often with Mg>Ca. Also role of halogens and HCO_3 increases as sols. become rather alkaline.

Gold-adularia-chalcedony-quartz deps. formed from carbonate weakly acid to alkaline sols. of HCO_3-$HSiO_3$-Cl-F-Ca-alkalies type (+ Mg and SO_4). Individual changes of comp. were noted at various deps. (Authors' abstract shortened by A.K.)

TKACHENKO, V.P., 1973, Typomorphic peculiariaties of microinclusions (in minerals) of granitoids from central part of N. Caucasus in connection with their tungsten-bearing nature: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 205-206 (in Russian; translation through the courtesy of A. Kozlowski). Author at Rostov University.

Inclusions were investigated in quartz from Upper Paleozoic granitoids (two-mica granites, granite-porphyries), pegmatoid bodies, and hydrothermal veins of tungsten-bearing ore district Kurgashin-Chat.

In the granitoids two types of quartz were found. The first type is practically free of inclusions, and the second one bears large numbers of small G-L inclusions with increasing dimensions as follows: two-mica granites (1-8μm) - granite porphyries (5-20 μm), accompanied by increasing role of gas component from 10-20% to 20-50% respectively.

For two-mica granites investigated in a 1.5 km section an increase of gas phase was found in the apical part of the intrusive.

In granite porphyries, together with G-L inclusions, crystal-fluid, crystallized, and melt inclusions occur in minor amounts.

Pegmatoids are connected with the apical parts of the two-mica-granite massif and mainly with dikes of granite porphyries. Inclusions are G-L, crystallized, (with or without gas phase), crystal-fluid, essentially gaseous, and essentially CO_2. Essentially gaseous and G-L inclusions with dimensions 10-25 μm prevail.

In ore-bearing quartz veins the most common inclusions are G-L and L-G (5-15 μm), and lesser numbers of crystal-fluid and "dry" gas types were found.

The similarity of the features of inclusions in the quartz of granite porphyries, pegmatoids, and tungsten-bearing veins can be used as an additional criterion of their genetic connection. (Author's abstract)

TOKHTUEV, G.V., 1974, Prospecting of ferrugious quartzites and rich Precambrian iron ores on the basis of genetic criteria (abst.): Internat. Assoc. on the Genesis of Ore Deposits, Fourth Symposium, Varna, Sept., 1974, Abstracts of Papers: Sofia, IAGOD, p. 434-435 (in Russian; translation courtesy A. Kozlowski). Author at Inst. of Geochem. and Physics of Minerals of Acad. Sci. of Ukrainian SSR, Kiev.

Iron ores were meta. by heated vadose waters at 80-140°C (T_D of quartz). (A.K.)

TOKUNAGA, Masayuki, and HONMA, Hisahide, 1974, Fluid inclusions in the minerals from some Kuroko deposits, in Geology of Kuroko Deposits, S. Ishihara, ed.: Mining Geol. (Japan) Spec. Issue no. 6, p. 385-388 (in English).

T_H of quartz from siliceous, black, and yellow ores range from about 120°-195° (Furutobe mine); 200°-268° (Ainai mine); 210°-260° (Kosaka mine); and 197-293° (Shakanai mine). Most in the siliceous ores are in the range 200-260°. Incs. in barite vary from 90 - 245°C. Few data on incs. in the yellow and black ores range 140-170°C. T_{Frz} of incs. in barite from siliceous and black ores showed 3-6 wt. % NaCl equiv. (ER)

TOLSTIKHIN, I. N., MAMYRIN, B.A., KHABARIN, L.B., and ERLIKH, E.N., 1974, Isotope composition of helium in ultrabasic xenoliths from volcanic rocks of Kamchatka: Earth Plan. Sci. Letters, v. 22, p. 75-84. First author at Inst. of Precambrian Geol. and Geochron., USSR Acad. Sci., Leningrad, USSR.

The purpose of this work is to refine our knowledge about the nature of helium with a high abundance of the rare isotope ^3He($^3He/^4He = 10^{-5}$) discovered in terrestrial volcanic gases in 1968.

We discuss here the results of isotope anal. of helium released by step-wise heating of ultrabasic xenoliths and some volcanic rocks. On the basis of these results, possible sources of ^3He in the earth due to fission and nuclear reactions are considered critically. The most probable source of the high abundance of ^3He is shown to be due to the capture and trapping of primordial He by the earth during its formation (primordial helium $^3He/^4He = 3 \times 10^{-4}$), a small but significant fraction of which has been retained to the present time. (Authors' abstract)

TOMILENKO, A.A., 1973, Conditions of regional metamorphism of the

Verkhnealdanskiy complex Iyengrskaya series from the Aldan Shield: Abstract of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 232-233 (in Russian; translation provided through the courtesy of A. Kozlowski). Author at Inst. of Geol. and Geophysics, Siberian Branch, Acad. Sci. of USSR, Novosibirsk.

Crystallized inclusions were investigated in quartz from the lencocratic part of migmatites and liquid inclusions in quartz, sillimanite and garnet from quartzites and gneisses of the Verkhnealdanskiy complex, Iyengraskaya series from the Aldan Shield. Crystallized inclusions (up to 0.009 mm long) consist of solid crystals plus a gas bubble up to 0.0008 mm in diameter. Among liquid inclusions, one-phase CO_2 liquid were proved by cryometry (triple point - 56.6°C.)

T_H of crystallized inclusions (minimal T of migmatite crystallization) = 820-900°C, P calculated from density of CO_2 at these temp. was in the range 6.0-6.5 kbar.

By ultramicrochemical analysis of crystallized inclusions in migmatites (in addition to), the following gas groups were found (in vol. %) group 1, CO_2 - 58.5 to 69.5; group 2, (H_2S-HCL-SO_2-NH_3-HF) - 15.3 to 24.0; group 3, N_2 plus rare gases - 8.0 to 20.7. In sillimanite (liquid inclusions; same group designations): First area, 1, 100%; second area, 1, 65.5 to 83.2; 2, 6.8 to 7.8; 3, 8.1 to 18.9; third area, 1, 15.3 to 17.9; 3, 82.1 to 84.7. In garnet and in quartz, 100% group 1. (Author's abstract)

TOURAY, Jean-Claude and BARLIER, Jacques, 1974, Liquid and gaseous hydrocarbon inclusions in quartz monocrystals from "Terres noires" and "Flysch a helminthoides" (French Alps): A mineralogical investigation (abst.): Internat. Mineral. Assoc. Ninth Gen. Meeting, West Berlin and Regensburg, W. Germany, Collected Abstracts: West Berlin, German Mineralog. Soc., p. 26 (in English). Authors at Orleans, France.

An optical study of ∿ 1000 gaseous and liquid hydrocarbon incs. in quartz from septaria (Terres noires) or fissure veins (flysch a helminthoides) on heating and freezing stages. The following were determined in the range -150°C to +200°C: melting temperatures of paraffins, partial T_H, φ total T_H. When possible in those water-poor samples, thermometric and cryoscopic investigations have been made.

The collected quartz crystals fall in two classes, based on a microreflectometric study of the disseminated organic material in the rocks. The contact between the two classes lies ∿ NW-SE, near Barles. On the basis of temperature reflectance curves, this contact corresponds to the 180°C - 200°C paleoisotherm; temperatures are lower to the west (155°C to 175°C) and higher to the east (210 to 230°C). Among the differences between organic incs. in quartz from the two areas one may notice:

-An eastward decrease of T_H of the one phase gaseous incs.* (sic.) probably explained by an increase of their density and perhaps by an increase in the amount of CH_4, compared with other light alkanes.

-An eastward decrease of T_H of the "petroleum" bearing incs. possibly depending on a pressure increase.

Such oppositions, and also data from aqueous incs. may be explained by diagenetic vs. anchimetamorphic growth of the host quartz. (Modified by ER from authors' abstract). (* May refer to T_H at <ambient T) (See also paper by Barlier et al., 1974, this volume).

TOURAY, Jean-Claude, and TONA, Frédéric, 1974, Geodynamic interpretation of a fluid inclusion study; first example in the Sierra de Lujar (Granada, Spain): Revue de Géog. Physique et de Géol. Dynam. , Ser. 2, v. 16, pt. 1, p. 71-74 (in French).

Thermo-optical study of fluid incs. in fluorite samples from "Sierra de Lujar" indicates a minimum burial of 2 km. Combined with geol. data (F. Tona, 1973), this fact implies the existence of nappes now eroded. (Authors' abstract)

TOURET, Jacques, **1974a**, The origin and significance of CO_2 of the granulite facies: Réunion annuelle des Sciences de la Terre, 2ème, Pont-à-Mousson, April 1974, p. 372 (in French).

See next abstract.

TOURET, J., **1974b**, Granulite facies and CO_2 fluids: Centenaire de la Soc. Géol. de Belgique, Géol. des Domaines Cristallins, Liège, 1974, p. 267-287 (in French with English abstract). Author at Univ. de Nancy I, C.O. 140, 54037 Nancy Cedex.

Granulite facies rocks contain water-deficient assembs. which occur in high grade meta. rocks (catazone) if $P_{H_2O} < P_{total}$. A specific type of incs. containing high d. CO_2-rich fluids is abundant in most samples from all over the world and interpreted as an evidence of a water-free and carbonic (mainly CO_2, but possibly hydrocarbons)-rich fluid phase during granulite facies meta. The source of CO_2 is essentially juvenile (upper mantle). From the location and features of granulite facies rocks, a model of the dist. of fluids within the continental crust is proposed, CO_2 being conc. in the lower part of the crust between Conrad and Mohorovicic discontinuities. (Author's abstract)

TROFIMOV, V.S., 1974, Amber: Moscow, Publ. House "Nedra", 183 pp., (in Russian; abstract courtesy A. Kozlowski).

Varieties of amber bear gas incs. as follows (diam. of inc., µm; number of incs. per 1 mm^2 of section; and ratio of general surface of incs./surface of section): "cloudy" variety (20; 600; 0.10), "Bastard" (2.5-12; 2,500; 0.25), "ivory-like" (0.8-4; 900,000; 0.42-0.52). "Ivory-like" amber bears incs. filled by "metamorphosed air" consisting of N_2, CO_2, O_2, H_2, CH_4 + (traces) Ar, Kr, Xe, Ne, He. Blue colour of amber is caused by sufficiently small incs. (from pp. 31 and 33). See also: Nesmelova Z.N. and Khabakov A.V., 1967: Gaseous incs. in Peribaltic amber, Materialy VSEGEI, new series, v. 110, p. 225-230.

TROSHIN, Yu. P., BOIKO, S. M., GREBENSHCHIKOVA, V. I., PETROV, L. L., and NOVIKOV, V. M., 1974, The calculation of volatiles, ore and trace elements lost into host rocks at the formation of the Khapcheranginsky and Sherlovogorsky tin-bearing intrusions: Yearbook, 1973, Inst. of Geochemistry, "Nauka" Pub. House, Novosibirsk, p. 71-74 (in Russian with English abstract).

By geophysical methods there have been est. intrusion forms and mass. The quan. of volatiles, ore and trace elements lost into host rocks has been det. The quan. of lost water is from 10% to 60% of the intrusion mass. The quan. of F, Cl and ore components lost is large. Their source could not have been the intrusion. A great part of the elements has been supplied from deep sources. (Authors' abstract.)

TROSHIN, Yu. P., BOIKO, S. M., and NOVIKOV, V. M., 1974, The sequence and conditions of forming of postmagmatic mineralization in the Kukulbeisky and Khapcheranginsky-Lubavinsky ore regions of Transbaikalia: Yearbook, 1973, Inst. of Geochemistry, "Nauka" Pub. House, Novosibirsk, p. 198-202 (in Russian with English abstract).

Geochemical obs. upon the zonal distrib. of volatiles within the intrusions state a sequence of volatile separation at degassing: CO_2-HCl-H_2O-HF. The chemical comp. of gas-liquid incs. in mins. shows an analogical comp. change of hyd. sols. In the region there are distinguished three stages of ore genesis: HCO_3-Cl, H_2O-F and F, forming respectively Au-Mo, W and Sn min. This agrees with the transfer of Au and Mo into a HCO_3-Cl medium, W as H_2WO_4, $HW_6O_{21}^{-5}$, WO_4^{-2} and Sn as $Sn(OH,F)_6^{-2}$. (Authors' abstract)

TRUESDELL, A.H., **1974a,** Oxygen isotope activities and concentrations in aqueous salt solutions at elevated temperatures: Consequences for isotope geochemistry: Earth Plan. Sci. Letters, v. 23, p. 387-396. Author at U.S. Geol. Sur., Menlo Park, Calif. (USA).

Studies of the effect of dissolved salts on the oxygen isotope activity ratio of water have been extended to 275°C. Dehydrated salts were added to water of known isotope comp. and the sols. were equil. with CO_2 which was sampled for anal. For comparison similar studies were made using pure water. Results on water nearly coincide with earlier cals. Salt effects diminish with increasing T only for sols. of $MgCl_2$ and LiCl. Other salt sols. show complex behavior due to the T-dependent form. of ion pairs of changing character. Equil. fractionations ($10^3 \ln \alpha$) between 1 molal sols. and pure water at 25, 100, and 275°C are: NaCl 0.0, -1.5, +1.0; KCl 0.0, -1.0, +2.0; LiCl -1.0, -0.6, -0.5; $CaCl_2$ -0.4, -1.8, +0.8; $MgCl_2$ -1.1, -0.7, -0.3; $MgSO_4$ -1.1, +0.1, -; NaF (0.8 m) 0.0, -1.5, -0.3; and NH_4Cl (0.55 m) 0.0, -1.2, -1.3. These effects are significant in the isotope study of hot saline fluids responsible for ore dep. and of fluids found in certain geothermal systems. Minor modification of published isotope geothermometers may be required. (Author's abstract)

TRUESDELL, A.H., **1974b,** Chemical evidence of subsurface structure and fluid flow in a geothermal system (abst.): Internat. Symp. on Water-Rock Interaction, Czechoslovakia, Sept. 9-17, 1974, Abstracts: Prague, Geological Survey, p. 59-60 (in English). Author at U.S. Geol. Surv., Menlo Park, Cal. 94025, USA.

TRUESDELL, A.H., and O'NEIL, J.R., 1974, (Chemical and isotopic studies of hot-spring waters and gases from Shoshone Geyser Basin, Yellowstone National Park (abst.)): Geol. Survey Research 1974, U.S. Geol. Sur. Prof. Paper 900, p. 147.

Hot-spring character and chem. change systematically from east to west across Shoshone Geyser Basin, Yellowstone National Park, Wyo. These trends are oblique to four N. 50°E. lineaments, along which occur almost all of the hot springs, fumaroles, and sublacustrine gas vents. Chem. changes from east to west include decreasing $H_2S:CO_2$, (H_2O+CO_2): total gas, and total gas:water. Furthermore, the neutral and alkaline springs show decreasing chlorine content and $Cl:HCO_3$ from east to west. The SiO_2 contents and Na:K:Ca relationships indicate subsurface reservoir Ts from 203°C in the east to 160°C in the west. Although salinity of waters varies widely, Cl:B is ±20% in all samples.

These chem. patterns indicated to Truesdell (1974) that as the thermal water flows obliquely upward from east to west, it undergoes steam separation, reacts with rocks, and is diluted with low-chloride ground water.

Carbon-isotope anal. range in δC^{13} of CO_2 from -10.3 to -3.8, with the lighter values related to the higher T waters on the east. A narrow range of -4.4 to -3.0 is found for the δC^{13} of HCO_3^{-1}. The CO_2 carbon is too low in δC^{13} to have originated from thermal decomp. of limestone, but is compatible with a volcanic source with a possible organic component. Carbon-isotope Ts calc. from CO_2-HCO_3^{-1} pairs correlate well with the chemical geothermometers. (Authors' abstract)

TRUFANOV, V.N., 1973, Thermodynamic (stages) in the formation of deep mineral-forming fluids: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 8-9 (in Russian; translation provided through the courtesy of A. Kozlowski). Author at Rostov University.

Probably during the zonal melting of the Earth's crust and the mantle there exist two essential modes of origin of mineral-forming fluids: 1) regional thermodynamic and spatial activation of fluids from porous, intergranular, cryptocrystalline, clathrate, crystallization, and dispersed in the rocks (aqueous) to form the "transmagmatic" or "intratelluric" fluids whose volume, composition and energetic potential are controlled not only by the crustal, but also by local features in the mantle, superficial and cosmic reserves; 2) exsolution, crystallization and emanation (three stages of differentiation) of shallow magmatic chambers, whose existence depends on structural and energetically anomalous zones in crust and mantle.

Experiments on fluid phase mobilization from granites, basalts, gneisses, and other rocks under conditions of sharp lowering of temp. and pressure and results of numerous measurements of temperature, pressure and chemical parameters of inclusions in minerals prove that generation of hypogene fluids in case (1) takes place under stable P-T values corresponding to the conditions of water solution transformation into supercritical state or phase inversion of low-high quartz. In case (2) the origin of hypogene fluids is the result of degradation of magmatic melts on one of the possible ways: 1) melt - melt and gas - gas and product of condensation, 2) melt - melt and hydrothermal brine - hydrothermal solution, 3) melt - melt and hydrothermal brine and gas - hydrothermal solution.

Both modes of origin of hypogene solutions are connected. The forming of solid phases in the processes of origin of pegmatites, skarns, greisens and hydrothermal mineral assemblages, and other ore-forming processes, is controlled by the following physico-chemical phenomena: metastable states and relaxation effect, structural disorder of solutions, exsolution and immiscibility of the superdense fluids, and heterogenisation with boiling. Statistical analysis of results of fluid inclusion investigation of many Russian deposits shows the following stages of thermodynamic nature during endogenetic ore formation (T in °C/P in atm.): 1) 750-800/5000-6000; 2) 550-600/2500-3000; 3) 375-425/1000-1200; 4) 260-325/500-600; 5) 180-220/300-350; 6) 100-120/100-150. (Author's abstract).

TRUFANOV, V.N., KURSHEV, S.A., MAISKY, U.G., and USHAK, A.T., 1973, Experimental investigation of thermal metamorphism 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 (in Russian; translation provided through the courtesy of N.P. Ermakov). Authors at Rostov State University, Rostov, USSR.

Experimental investigations of thermal activization of the liquid-rich and gas-rich inclusions were realized by the method of overheating at temperatures ranging from 200 to 400°C over their homogenization. These researches were carried out for the study of the interaction mechanism of fluids with minerals under regional and contact metamorphic conditions.

Two possible types of thermal metamorphism of the fluid inclusions were modeled: rapid transitory overheating and relatively slow thermal influence.

The first experimental series were conducted by immersion of samples with fluid inclusions in molten steel for 3-5 seconds; the latter - by heating of preparations in a thermochamber or autoclave at a rate of 2-3°C a minute, to temperatures of 800-1000°C. Natural specimens of quartz, fluorite, calcite, topaz and other minerals were used as objects for investigation.

In the first case (rapid overheating) intensive decrepitation of the main fluid inclusions is observed. It is accompanied by the effects of swelling and formation of "satellite" inclusions. A partial resorption of inclusion walls takes place and their dimensions increase to double, while the vacuole shapes become rounded or ellipsoidal.

In the second case (slow heating) the resorption of walls predominates, with development of skeletal etch figures and recrystallization of mineral substance in the fine-grained aggregate.

Melting rims appear on vacuoles and their contents become heterogeneous when temperature increases. The resorption process ceases when a fluid phase dissolves in the melt completely.

These effects are found most clearly in fluorite and topaz where they take place at temperatures of 550-600°C above the homogenization point. Obtaining analogous results in quartz required temperatures not less than 350-400°C. Liquation (i.e. immiscibility; Ed.) effects, with formation of the incrustate rims and synthesis of new daugter-minerals, were found on cooling of the thermal metamorphism inclusions.

The results of the investigations show that solvent ability of the fluid-inclusion solutions increases strongly on their overheating above the temperature of homogenization and depends on the duration of thermal activization. These fluids are the active factors of autometasomatic and anatexis processes at metamorphic conditions.

Observations of resorption effects may be used for determination of absolute mineral-forming temperatures. If the homogenization temperature is a minimum possible point of mineral formation the temperature of intensive resorption of the inclusion walls is obviously the upper range of crystal growth. (Authors' abstract). Note - Although this is not in the printed abstract volume, it was presented orally.

TURINGE, A.P., 1973, Temperature conditions and stages of crystallization of amethyst: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 331 (in Russian; translation provided through the courtesy of A. Kozlowski). Author at Sixth All-Union Productive Trust, Ministry of Geology of USSR, Moscow.

In crystals of amethyst from S. Yakutia four zones were distinguished with various T_H of G-L inclusions: 1) root zone, colorless, sometimes with pale lilac color, turbid due to numerous G-L inclusions with T_H 300-350°C; 2) central zone, smoky with a number of parallel smoky-brownish zones of growth (200-250°C); upper amethyst zone, relatively uniformly colored, violet-lilac color, (150-180°C); 4) external thin rim zone, colorless rock crystal, rarely with fine zones of smoky color. In all zones two-phase G-L inclusions occur, with dimensions 0.02-0.2 mm, filled by 65-93 vol. % liquid. Pseudosecondary inclusions bearing 60 - 100% of (liquid - A.K.) CO_2 were found.

A polystage course of formation of amethyst was revealed depending on changes of composition and decrease of T of mineral-forming solutions: 1) weakly alkaline stage of crystallization of rock crystal at T higher than 300°C; 2) alkaline stage of crystallization of rock crystal and smoky quartz with aluminium-alkaline color centers (200-250°C); 3) weakly acid stage of crystallization of amethyst with iron-alkaline color centers at T lower than 180°C, passing into weakly alkaline. (Author's abstract)

TVALCHRELIDZE, A.G., 1973, On the relation between regional metamorphism and copper-pyrrhotite ore mineralization in Lower Jurassic shales in Upper Abkhaziya: Geol. Rudn. Mest., v. 15, no. 5, p. 79-87 (in Russian; abstract courtesy A. Kozlowski). Author at Moscow State Univ.

T_H of incs. in ore quartz are 280-300 and 155-200°C: the first T_S are connected with origin of ores (p. 83-84).

TWISS, R.J., 1974, Structure and significance of planar deformation features in synthetic quartz: Geology, v. 2, no. 7, p. 329-332. Author at Dept. of Geology, University of California, Davis, Davis, California 95616.

Creep tests were performed on three polished cylinders of synthetic quartz stressed normal to $(10\bar{1}1)$. Observations of slip bands in reflected light, orientations of planar deformation features on a universal stage, and dislocation structures of these features on a transmission electron microscope are used to deduce slip mechanisms and deformation structures.

Experimental conditions of temperature, pressure, and stress were 600° and 800°C, 3 kb, and between 1.3 and 7 kb .

Slip band data imply the operation of the following slip systems $(10\bar{1}0)[c]$, $(01\bar{1}1)[a_1]$, $(01\bar{1}2)[a_1]$, $(1\bar{1}01)[a_3]$, $(1\bar{1}02)[a_3]$, and possibly $(1\bar{2}12)$.

Two sets of planar deformation features are developed, which are termed laminas and lamellas. Laminas are dense tangles of dislocations subparallel to (0001), probably caused by interference between minor slip on (0001) and slip on $(1\bar{1}01)$ and $(1\bar{2}12)$. Lamellas form subparallel to the major slip planes. Those near $(10\bar{1}0)$ comprise dense associations of dislocations generally parallel to $[a_1]$. They are probably edge dislocations and are of undetermined sign. The observations support the model of Christie and others (1964) that explains the optical properties of such features. (Author's abstract).

UNNI, C.K., and SCHILLING, J-G., 1974, Chlorine in basalts from the Iceland-Reykjanes ridge system (abst.): Amer. Geophy. Union Trans., EOS, v. 55, no. 4, p. 454. Authors at Grad. School of Oceanography, Univ. of Rhode Island, Kingston, R.I. 02881.

URUSOVA, M.A., 1974, Phase equilibria and thermodynamic characteristics of solutions in the systems $NaCl-H_2O$ and $NaOH-H_2O$ at 350 - 550°C: Geokhimiya, 1974, no. 9, p. 1360-1366 (in Russian; translated in Geochem. Internat., v. 11, no. 5, 1974, p. 944-950.) Author at Inst. of

Gen. and Inorg. Chem., Acad. Sci. USSR, Moscow.

Vapor Ps of sols. in the systems NaCl-H_2O and NaOH-H_2O have been det. from 350-550°C in a broad range of concs.: from a few wt.% to saturation in the system NaCl-H_2O and to ∿50 wt.% in the system NaOH-H_2O. Densities of sols. have been measured from 350-450°C in the conc. interval from 10 to 40-50 wt.% and Ps from the P of saturated vapor to 230 kg/cm^2 at 350°C and to 600 kg/cm^2 at 400 and 450°C. Partial molal volumes of NaCl sols. and activity coefficients of water in NaCl and NaOH sols. have been calc. The dependence of the calc. values on T and conc. and the causes of the diffs. in vapor P. and activity coef. of water in the systems NaCl-H_2O and NaOH-H_2O have been analyzed. (Author's abstract)

VAKHRUSHEV, V.A., 1969, Petrographic evidence of liquation of magmatic melts into silicate and the sulfide components: Geol. Rud. Mest., v. 11, no. 1, p. 15-26 (in Russian; abstract in Econ. Geol., v. 69, 1974, p. 565; translated in Intern. Geol. Rev., v. 13, no. 4, 1971,p453-462).

The sulfides present in syenite, gabbro, and recent lavas are all strikingly similar in their morphological features, internal texture, and comp. All are as droplets containing pyrrhotite, chalcopyrite, and pentlandite, plus accessory but presumably later pyrite. The occurrence of sulfide droplets in igneous rocks indicates that under favorable conditions there is a possibility of liquation of considerable amounts of iron, copper, and nickel sulfides, and sulfides of other metals in intrusions which are derivatives of basic magma. (Abbreviated from Econ. Geol.)

VAKHRUSHEV, V.A., and PROKOPTSEV, N.G., 1969, Primary magmatic sulfides in basalts of the oceanic crust and in inclusions of ultrabasic rocks: Geol. Rudn. Mest., v. 11, no. 6, p. 14-26 (in Russian; abstract in Econ. Geol., v. 69, 1974, p. 580).

Basalts from the floor of the Indian and Pacific oceans, and recent flows from Hawaii and Tahiti, and ultrabasic nodules show (interstitial?) primary liquid magmatic CuFeNi sulfides. Andesite and basalt from Kamchatka and the Kurile Islands show globules of similar sulfide as incs. in phenocrysts of silicates, indicating earlier immiscibility. (Adapted from Econ. Geol.)

VALYASHKO, V.M., 1974, High-temperature equilibria with the participation of fluid phase and peculiarities of the formation of highly mineralized solutions (abst.): Internat. Symp. on Water-Rock Interaction, Czechoslovakia, Sept. 9-17, 1974, Abstracts: Prague, Geological Survey, p. 31 (in English). Author at Institut obshchei i neorganicheskoi chimii, AN SSSR, Moskva, USSR.

VALYASHKO, L.M., LAPSHIN, V.A. AND NAZYMOVA, G.N., 1973, Temperature conditions of quartz vein formation in gold deposits from N Caucasus: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 51-52 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors at Moscow Univ.

Gold deposits of the N, Caucasus belong to one genetic type of low sulfide Au-quartz formation, connected with intrusives of an Upper Ordovician gabbro-diorite-granodiorite complex (Koptev-Dvornikov and others, 1968). Investigation of gas - liquid inclusions in milky quartz of ore bodies of those deposits gave results as follows:

Deposit	Inclusion character			T_H°C	T°C^x	Decrepitation temp.	
	Type	Size in mm	% of gas phase			Beginning	Maximum
Bestyube	gas-liquid 2phase	less than 0.003	5 - 20	200-140	230-190	280-300	280-460 I composed (sic)
Stepnyak	-"-	up to 0.005	10 -30	210-180	245-220	280-300	280-460 (I)
Dzhelambet	g-1, 2 phase & 3phase with liquid CO_2	up to 0.01	2o - 4o	28o-24o	320-285	28o-3oo	28o-46o (I) 48o-58o (II)
Ak - tsu	g-1, 2phase	up to o.o15	2o - 4o	28o-24o	32o-285	28o-3oo	28o-46o (I) 48o-58o (II)

NOTE: T°C^x - conventional temp. of mineral formation, calculated according to corrections for lithostatic pressure on basis of homogenization remperature. (Authors' abstract)

VASIL'YEV, V.I., OBOLENSKIY, A.A., and BORISENKO, A.S., 1973, Temperature of formation of mercury deposits: Akad. Nauk SSSR, Doklady, v. 209, no. 2, p. 451-454 (in Russian; trans. in Doklady Acad. Sci. USSR, Earth Sci. Sect., v. 209, p. 103-106, 1974; abst. in Internat. Geol. Rev., v. 15, no. 5, p. 619, 1973). Authors at Inst. of Geol. and Geophy., Sib. Div., USSR Acad. Sci., Novosibirsk.

T_H studies on cinnabar and gangue mins. (quartz, ankerite, calcite, barite, etc.) from nine mercury provinces, USSR in Altai-Sayan, Siberia, Yakutia, and Chukotka show that every one of the deps. formed at <250°C. The bulk of cinnabar comes down at 150-170°C, rarely at 180°C. The T control, principal factor in dep. of the ore from conc. sols., is moderated by other variables, however, very much like soly. of mercury sulfides under exper. conds. The fact that Hg is generally high in natural min. sols. is indicated by the devel. of massive metacolloidal ores, metasomatic dep. of the bulk of the cinnabar, high salinity of the sols. (in the incs), and other evidence. (Authors' abstract)

VENKATESH, C.G., RICE, S.A., and NARTEN, A.H., 1974, Amorphous solid water: an x-ray diffraction study: Science, v. 186, p. 927-928.

VERTUSHKOV, G.N., and SOKOLOV, Yu.A., 1972, Determination of the composition of mineral-forming solutions according to gas-liquid inclusions in quartz: Tr. Sverdl. Gorn. Inst., v. 86, p. 113-116 (in Russian).

Similar to material covered in Vertushkov and Sokolov, 1973, in Fluid Inclusion Research - Proc. of COFFI, v. 6, p. 162-163, 1973.(ER)

VETSHTEIN, V.E., and PINNEKER, E.V., 1974, Deuterium and O^{18} contents indicating the origin and sources of the carbon-dioxide thermal waters of the Karlovy Vary and in cold carbon-dioxide waters of the Františkovy Lázně spa (abst.): Internat. Symp. on Water-Rock Interaction, Czechoslovakia, Sept. 9-17, 1974, Abstracts: Prague, Geological Survey, p. 15 (in English). First author at Institut fizicheskoi khimii im. L.V. Pisarzhevskogo, AN USSR, Kiev, USSR.

VIDALE, R.J., 1974, Compositions of chloride pore solutions in the two-mica "schist," muscovite-phlogopite-albite-sanadine-quartz (abst.): Amer. Geophy. Union Trans., EOS, v. 55, no. 4, p. 450. Author at CNC-11, M/S 514, Los Alamos Sci. Labs., Los Alamos, N.M. 87545

VISHNEVSKY, A.S., and POVARENNYKH, A.S., 1974, On composition of inclusions in synthetic diamond crystals: Dopovidi. Akad. Nauk UKR. RSR. Ser. B:-Geol., Geofiz., Khim., Biol., 1974, no. 1, p. 3-7 (in Ukrainian with English abstract).

VLASOVA, N., and VALYASHKO, M.G., 1974, Alteration of brines of oceanic origin by calcium carbonate (on the problem of the origin of dolomites in Ca-Cl brines) (abst.): Internat. Symp. on Water-Rock Interaction, Czechoslovakia, Sept. 9-17, 1974, Abstracts: Prague, Geological Survey, p. 28-29 (in English). Authors at Moskovskii Gosudarstvennyi Universitet, kaf. geokhimii, Moskva, USSR.

VOLAROVICH, G.P., ANDRUSENKO, N.I. and SHCHEPOT'EV, Yu.M., 1974, Conditions of formation of near surface gold and mercury ores at Kamchataka (abst.): Internat. Assoc. on the Genesis of Ore Deposits, Fourth Symposium, Varna, Sept. 1974, Abstracts of Papers: Sofia, IAGOD, p. 423-424 (in Russian; translation courtesy A. Kozlowski). First author at Central Scientific-Research Geological-Prospecting Inst., Moscow, USSR.

Studies of fluid incs. in Au-Ag and Hg deps., previously det. as epithermal, showed they formed in a wide T range = 500 to 50°C, and the ores pptd. at T = 400-110°C. Early gold-bearing assoc. formed at 410-290°C, main commercial ores (with tellurides and sulfides) - 300-140°C. Hg ores at gold or strictly Hg deps. xlized. at 260-110°C. Parent sols. were of SO_4-Cl-HCO_3-Ca-K-Na type. P. varied from 420 to 70 atm with drops down to 1 atm. Commercial stage is characterized by increase of conc. of CO_2 and/or K, often accompanied by boiling of sols. Phase inversions probably cause the most intensive ore mins. (Authors' abstract, shortened by A.K.)

VOROV'YEV, A.A. and SAL'NIKOV, V.N., 1974, Observations of electrical phenomena in minerals and rocks during physico-chemical processes in them (abst.): Internat. Assoc. on the Genesis of Ore Deposits, Fourth Symposium, Varna, Sept., 1974, Abstracts of Papers: Sofia, IAGOD, p. 248-249 (in Russian; translation courtesy A. Kozlowski). Authors at Tomsk Polytechnical Inst., USSR.

Decrep. is accompanied by electromagnetic radiation emitted by mins. Decrep. of quartz & fluorite is accompanied by change of linear dependence of electroconductivity, change of vacuum in the system, acoustic and light phenomena as well as by electromagnetic radiation in wide range of wavelength. Intensity of radiation depends on P. in incls., among other factors. Wavelength of emitted radiation 9.5 - 2000 m. (Authors' abstract, shortened by A.K.) (See also Korobeynikov, Sal'nikov & Bespal'ko, 1973, in Fluid Inclusion Research - Proc. of COFFI, 1973, v. 6, p. 83.)

VOZNYAK, D.K., 1971, [Primary inclusions in topaz] See Translations.

VOZNYAK, D.K., and KALYUZHNYI, V.A., 1974, Decrepitated inclusions and their significance for reconstruction of P-T conditions of mineral formation (illustrated by quartz from pegmatites of Volhyn), <u>in</u> Typomorphism of Ukrainian Quartz, edited by Ye. K. Lazarenko, Acad. Sci. Ukr. SSR: Kiev, Naukova Dumka Pub. House, p. 18-24 (in Russian; see Translation section).

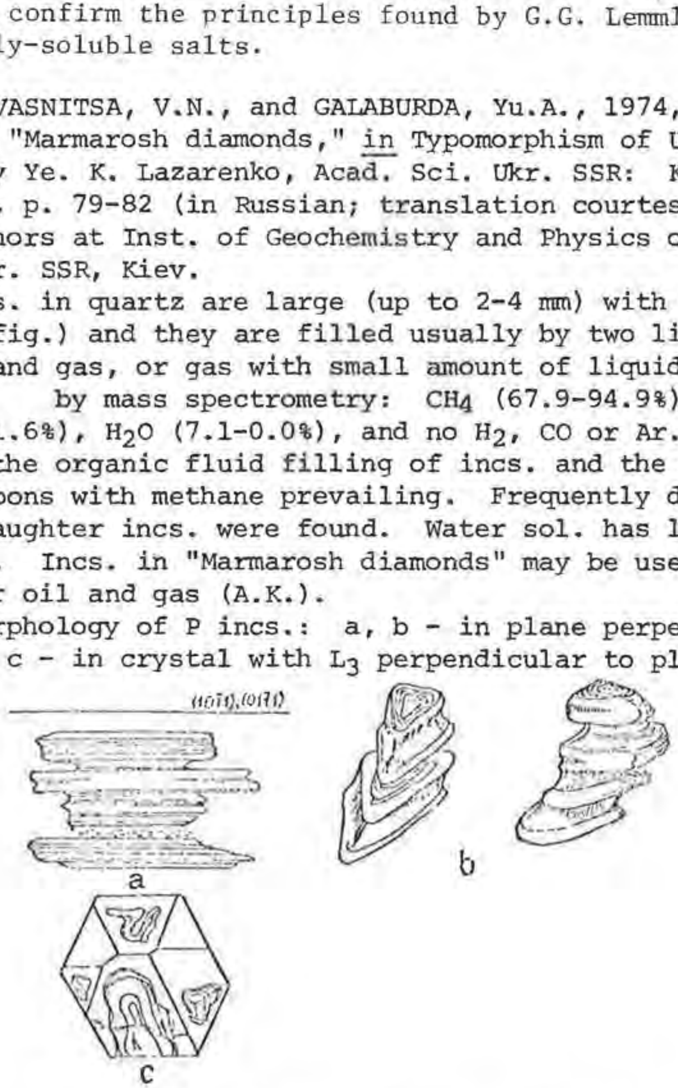
VOZNYAK, D.K., and KALYUZHNYI, Vl.A., 1974, Change of shape of inclusions in minerals of variable composition and its effect on the composition of parent solution isolated in vacuoles: Akad. Nauk SSSR Doklady, v. 212, no. 5, p. 1192-1195 (in Russian; trans. in Doklady Acad. Sci. USSR v. 212, 1974, p. 140-143; abst. in Internat. Geol. Rev., v. 16, no. 1, 1974, p. 117). First author at Inst. Geol. Sci., Ukr. Acad. Sci., Kiev, (abstract courtesy T.M. Sushchevskaya).

Detailed microscopic study of P and S incs. in topaz xls. show evidence of a complex. process of rehealing of fractures in mins. and tranformation of the incs. formed. Xliz. of low-index topaz from the surrounding liquid incs. took place in isolated vacuoles as a result of redeposition of material dissolving mainly from plane (001) to dendritic parts b(010), M(110), and l(120). Conc. of topaz was not high because of moderate values P and T. The degree of transformation of incs. formed at diff. times depends on the continuation of the process. The results obtained confirm the principles found by G.G. Lemmlein in his exper. with easily-soluble salts.

VOZNYAK, D.K., KVASNITSA, V.N., and GALABURDA, Yu.A., 1974, Typomorphic peculiarities of "Marmarosh diamonds," <u>in</u> Typomorphism of Ukrainian Quartz, edited by Ye. K. Lazarenko, Acad. Sci. Ukr. SSR: Kiev, Naukova Dumka Pub. House, p. 79-82 (in Russian; translation courtesy A. Kozlowski). Authors at Inst. of Geochemistry and Physics of Minerals of Acad. Sci. Ukr. SSR, Kiev.

Primary incs. in quartz are large (up to 2-4 mm) with various morphology (see fig.) and they are filled usually by two liquids and gas, one liquid and gas, or gas with small amount of liquid. Individual comp. of incs. by mass spectrometry: CH_4 (67.9-94.9%), N_2 (23.0-3.5%), CO_2 (2.0-1.6%), H_2O (7.1-0.0%), and no H_2, CO or Ar. Luminescent analysis proves the organic fluid filling of incs. and the occurrence of various hydrocarbons with methane prevailing. Frequently decrep. incs. with haloes of daughter incs. were found. Water sol. has low conc. (T_F - -0.1 to -0.2°C). Incs. in "Marmarosh diamonds" may be used as prospecting criterion for oil and gas (A.K.).

Figure. Morphology of P incs.: a, b - in plane perpendicular to face of rhombohedron; c - in crystal with L_3 perpendicular to plane of drawing.



VYNAR, O.N., 1974, Typomorphic features of quartz from postmagmatic rocks of Volhyn, in Typomorphism of Ukrainian Quartz, edited by Ye. K. Lazarenko, Acad. Sci. Ukr. SSR: Kiev, Naukova Dumka Pub. House, p. 54-58 (in Russian; translation courtesy A. Kozlowski). Author at Inst. of Geol. and Geochemistry of Fuels of Acad. Sci. Ukr. SSR, L'vov.

Primary incs. in regeneration quartz in "Zanorysh" (cavity-bearing pegs. - ed.) in Osnitsa granite have T_H = 450°C; G/L incs. in schlieren-like peg. from Korestenskiy pluton - T_H = 250-350°C; in quartz in granites T_H of G/L incs. = 250-370°C; in quartz veins in granites - 200-300°C. In granites incs. with liquid CO_2 are rare, but they frequently bear some dms., including halite. In metasomatic quarts of Sushchano-Perzhanskaya zone incs., often with liquid CO_2 and some dms, have T_H = 200-350°C. Then T_H decreases from granites to pegs. and veins; most of incs. (exluding those indicated) are S incs. Na/K ratio in incs. ranges from 0.8-2.0 in granites to 12.6-19.2 in pegs. and quartz veins. Li content increases from graphic zone (0.2%) to zanorysh (1.6%). In leachates from vein quartz Li was not found. Main anions are Cl^- and HCO_3^-. Gases (200.0-70.6 ml per kg in morion from zanorysh, 47-0 ml per kg in veins) consist of CO_2, H_2, CH_4 and N_2 (A.K.).

WAGNER, A., FREY, M., QUADRIO, F., SCHWARTZKOPFF, J., and STALDER, H.A., 1972, The mineral occurrences of Camperio and Campo Blenio, Canton Tessin: Jb. Naturhist. Museum Bern, 1969-1971, p. 277-360, plus 22 figures and 7 plates (in German) (See Translations).

WALENCZAK, Z., 1974, Invest. of degree of meta. of coal substances in sed. rocks, in Geochemical investigations of bitumens, Results of LXIX Scientific Session of Geological Institute, ed. Wydawnictwa Geologiczne: Warszaw, p. 49-51, (in Polish). Author at Warsaw Univ., Inst. of Geochem., Min. and Pet., 02-089 Warszawa, al. Zwirki i Wigury 93, Poland. Abstract courtesy A. Kozlowski.

The author tried to invest. the partial homog. of bitumen-bearing incs. in authigenic mins. using observation of the fluorescence of organic cpds. Decrep. was also invest. Samples from borehole Zarnowiec IG 1 proved that the paleotemperature of katagenetic transformations (~150°C) was significantly higher that the T measured at the bottom of borehole.

WALEŃCZAK, Z. and WIEWIÓRA, A., 1974, Relationship between the unit cell volume and the lithium and aluminium contents in some Sudetian quartz: Bull. Acad. Polon. Sci., Sér. Sci. Terre, v. 22, no. 1, p. 19-25 (in English; abstract courtesy A. Kozlowski). First author at Inst. Geochem., Min. i Pet., Wydzial Geologii, Warszawa 02-089, al. Zwirki i Wigury 93, Poland.

Correlations of the individual unit cell parameters with T and/or structural Al content that have been proposed by various authors are not verified. Det. T_H of incs. in quartz are as follows: peg., Szklarska Poręba 440°C; drusy, Czarne 170°C; peg., Strzegom 400-180°C; rock crystal, Staniszów 150°C; vein milky, Kudowa 180°C.

WAMPLER, J.M., and YANASE, Yotaro, 1974, Argon adsorption and trapping by cold trap ice (abst.): Amer. Geophy. Union Trans., EOS, v. 55, no. 4, p. 472. Authors at School of Geophys. Sci., Ga. Inst. of Technology, Atlanta, Ga. 30332.

Of pertinence to vacuum extraction studies of incs. (ER)

WEISBROD, Alain, and POTY, Bernard, 1974, Equilibrium between fluids and minerals in the pegmatite of Mayres (Ardèche, France): Réunion Annuelle des Sciences de la Terre, 2ème, Pont-à-Mousson, April 1974, p. 390 (in French; translation courtesy Chris Eastoe). Authors at Centre de Recherches Pét. et Géochim., C.O. n° 1 - 54500 - Vandoeuvre-les-Nancy.

The peg. of Mayres exhibits primary (quartz-orthoclase-albite-cordierite) and "intermediate" (quartz-orthoclase-andalusite-tourmaline) structures upon which a secondary hyd. evolution has superimposed five subsequent parageneses. The primary assocs. correspond to T ∿ 650-700°C and P ∿ 2.5-3.5 kbar. The hyd. evolution seems to have started at lower Ps (∿ 1 kbar) and at 500-600°C, implying an adiabatic decompression. The evolution is marked by fluid unmixing and a lowering of T. K/Na values do not agree with published values for fluids in equil. with feldspars. This may be due to the different behaviors of KCl and NaCl at low P, or to the presence of elements such as P and B in sol.

WESTRICH, H.R., 1974, The solubility of molybdenite in pH buffered KCl-HCl fluids (abst.): Amer. Geoph. Union Trans., EOS, v. 56, no. 12, p. 1200. Author at Dept. of Geol., Arizona State Univ., Tempe, Arizona 85281.

The soly. of molybdenite added to a natural granodiorite assem. has been det. in aq. KCl-HCl sols. Exper. conds. were 400°-650°C, 0.5 to 1.0 Kb fluid P and 1.0 and 2.0 molar KCl sols., with pH, PO$_2$, and PS$_2$ controlled. The soly. of molybdenite was found to be dependent on T and fluid P with a maximum of 3200 ppm at 500°C and 1.0 Kb, and a minimum of 660 ppm at 600°C and 0.5 Kb. An increase in the chloride molarity from 1.0 to 2.0 resulted in an increase of eight percent in molybdenite soly. within the P-T range of the exper. These data suggest possible complexing of molybdenum with chloride at high Ts and Ps. In addition to these data, the results of two exper. one with high initial acidity (HCl sol.) and one with high initial alkalinity (KCl sol.) indicate that soly. is indirectly proportional to the pH of sols. The pronounced variation of the soly. of molybdenite with fluid P, chloride molality and pH, as measured in these expers., could provide a model for the transport and dep. of molybendite in porphyry copper type deps. (Abbreviated, from author's abstract)

WHITE, D.E., **1974a**, (Ore fluids of diverse origins (abst.)): Geol. Survey Research 1974, U.S. Geol. Sur. Prof. Paper 900, p. 143 (See next item).

WHITE, D.E., 1974b, Diverse origins of hydrothermal ore fluids: Econ. Geol., v. 69, p. 954-973. Author at U.S. Geol. Survey, Menlo Park, Calif.

Chem. isotopic, and physical data from fluid incs. ore and gangue mins, and active geothermal systems indicate the general characteristics and probable origins of the dominant ore-transporting waters of many systems. Evaluation of such data from a wide variety of mining districts and hot-spring systems indicate that five classes of waters, here called meteoric, ocean, "evolved connate," meta., and magmatic, account in varying proportions for hyd. fluids.

More than 40 localities are reviewed in this study, including: (1) 6 Hg systems involving meta. or "evolved-connate" waters; (2) 15 epithermal Au-Ag districts and 2 probably similar active hyd. systems involving meteoric water and perhaps as much as 5 or 10 percent of magmatic water; (3) 10 ore districts and 2 active systems with abundant base metals ±Ag, involving waters of diverse origins, including ocean, "evolved-connate," meteoric, and magmatic, usually with salinities above 4 percent; and (4) 5 copper-molybdenum deposits, generally involving early dominance by magmatic water but with increasing proportions of meteoric water during sulfide and postsulfide stages.

Individual constituents, including the metals, Cl, S, and CO_2, may come from the same or different sources than the dominant water. Ign. intrusions frequently provide the energy and perhaps the S and C of the ore deposits, but a magmatic origin of the metals H_2O, and other constituents is commonly assumed uncritically.

Ore dep. may require favorable combinations of circumstances that differ from place to place, but with some combinations being especially favorable. No simple model of origin is likely to explain all or even most metalliferous ore deps. (Author's abstract)

WHITE, D. E., 1974c, Hydrothermal ore fluids of various origins (abst.): Internat. Assoc. on the Genesis of Ore Deposits, Fourth Symposium, Varna, Sept. 1974, Abstracts of Papers: Sofia, IAGOD, p. 280 (in English). Author at U. S. Geol. Surv., Menlo Park, Calif.

Essentially identical to preceding abstract (ER)

WHITE, D. E., 1974d Thermal and mineral waters of different origins (abst.): Internat. Symp. on Water-Rock Interaction, Czechoslovakia, Sept. 9-17, 1974, Abstracts: Prague, Geological Survey, p. 4-5 (in English). Author at U.S. Geological Survey, Menlo Park, California 94025, USA.(See White, 1974b)

WHITE, D.E., 1973, 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, Istituo Internazionale per le Ricerche Geotermiche, Pisa, Italy, v. 1, p. 58-80. Author at U.S. Geol. Survey, Menlo Park, Calif.

An extensive discussion, in particular of thermal, chem., and isotopic data on geothermal systems. (ER)

WILCOX, W.R., 1974, The relation between classical nucleation theory and the solubility of small particles: Jour. of Crystal Growth, v. 26, p. 153-154. Author at Materials Sci. and Chem. Eng. Dept., Univ. of So. Cal., Los Angeles, CA 90007.

For a constrained system, the equation relating xl size to the props. of the fluid at equil. has two sols. The sol. yielding the smallest xl size is for an unstable equil., corresponding to the barrier for nucleation. The sol. yielding the largest xl size is for the stable equil. corresponding to the soly. or equil. T cond. (Author's abstract)

WILLIAMS, Neil, and RYE, D.M., 1974, Alternative interpretation of sulphur isotope ratios in the McArthur lead-zinc-silver deposit: Nature, v. 247, no. 5442, p. 535-537.

The S isotopic ratios are better explained by a single-S source, two-stage min. model than by any of the previously suggested dual-S, syn-sed. models. (ER)

WRIGHT, T.L., 1974, Presentation and interpretation of chemical data for igneous rocks: Contrib. Mineral. Petrol., v. 48, p. 233-248. Author at U.S. Geol. Survey, Reston, VA 22092.

Of value in presentation of silicate melt inc. compositions. (ER)

YAKOVLEV, Ya.V., and LEBEDEV, P.P., 1974, Formation temperature of tin ore deposits from Yano-Borulakhskoe Mezhdurech'ye region, in Mineralogy of endogenous deposits of Yakutia, B.L. Flerov, ed.: Novosibirsk, Siberian Branch of "Nauka" Pub. House, p. 147-156 (in Russian; abstract courtesy A. Kozlowski).

The invest. deps. occur in NE Yakutia, in a folded Upper Triassic sandstone-slate series intruded by polyphase granitoid Upper Cretaceous intrusions and rare Paleogene dikes of diabasic porphyrites. The tin ore bodies are connected with these granitoids. T conds. of ore orgin are as follows (number of measurements in parentheses):

T_H of G/L inclusions (both P and S)

Deposit	Mineral	T_H, °C
Kirgilakhskoe	Quartz	390-290 (30)
Kesterskoe	Quartz from quartz-feldspathic form.	360-150 (20)
	Quartz from quartz-amblygonite aggregates	360-170 (25)
	Amblygonite	330-310 (20)
	Apatite	200-130 (10)
Ege-Khayskoe	Quartz from pre-ore quartz vein	360-300 (10)
	Quartz from cassiterite-silicate-quartz ore	440-250 (40)
	Fluorite, do.	350-240 (30)
	Quartz from sulfide ore	370-280 (5)
	Fluorite from sulfide-carbonate ore	320-200 (15)
	Calcite from late pyrite-calcite veins	150-130 (6)

Temp. of min. form. det. by various methods

Deposit	Mineral assoc.	Minerals	Method	T,°C
Kesterskoe	Quartz-feldspathic peg.	Plagioclase-K-feldspar	Feldspar thermometer	450
	Cassiterite-mica-quartz	Cassiterite	Decrep.	400-430
Ulakhan-Egelyakhskoe	Cassiterite-quartz with arsenopyrite & pyrite	Arsenopyrite-pyrite	Upper range of coexistence	491
Ege-Khayskoe	Sulfide (sphalerite-pyrrhotite)	Cpy-sph.	Exsolution of solid solution	350-400
		Sph-cpy.		350-400
		Cpy-cpyrrhotite		255-450
		Cpy-pyr.		255
		Cpy-cubanite		235
		Cpy-valerite		225

	Sulfide-carbonate	Marc-pyrite	Transformation	400
		Sphalerite	Sphal. thermom.	610-660
		Bismuth	Melting	271
		Hex. pyrrhotite	Transformation	138

YAKOVLEV, Ya. V., LEBEDEV, P.P., AND STEPANOV, Ye. R., 1973, Formation temperature of the Kere-Yuryakhskoe Sn-W deposit: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 71-72 (in Russian; translation through the courtesy of A. Kozlowski) Authors at Inst. of Geology, Yakutian Branch of Siberian Division of Acad. of Sciences USSR-YaF SOAN SSR.

1. The Kere-Yuryakhskoe Sn-W deposit consists of veinlet and vein zones in the internal and external parts of the apical contact zone of a granitic massif. The massif bears porphyritic fine- and medium-grained two-mica granites, and their greisenized varieties: tourmaline-muscovite and muscovite granites.(....)

2. In tourmaline-muscovite and muscovite granites, little quartz-feldspar, quartz-tourmaline-feldspar and feldspar pegmatoid forms, with rare cross cutting veinlets of molybdenite were found. Quartz is the latest mineral bearing major amount of inclusions with T_h = 380-270°C and 230-155°C.

3. In near-vein tourmaline-muscovite-quartz and muscovite-quartz greisens with rare precipitation of ore minerals, inclusions in quartz, cassiterite, muscovite and tourmaline homogenize at 440-280 and 230-285°C.

4. In cassiterite-wolframite-arsenopyrite-quartz veins with rare tourmaline at lateral zones, occurring in the internal zone of the contact, inclusions in milky quartz, semitransparent, and partly recrystallized vein quartz, homogenize in a wide range of temp. 400-110°C, with two maxima at 330-310°C and 220-200°C; in cassiterite T_h = 380-310°C and rarely at 275°C, in wolframite - 325-310°C, in muscovite 360-290°C, in tourmaline 365-340°C.

5. In cassiterite-arsenopyrite-quartz veinlets with overlapping sulfide and carbonate associations, developed on the external side of contact, inclusions in semitransparent quartz homogenize at 385-320°C, 240-225°C and at 155-120°C. Temp. of sulfide paragenesis formation (as indicated by exsolution sphalerite+chalcopyrite, valleriite plus chalcopyrite in sphalerite and native bismuth) was higher than 225°C. Calcite veinlets formed at 200-120°C.

6. All investigated inclusions (over 500) are two-phase, and usually homogenize in the liquid phase. Only some high-temp. inclusions (400-340°C) in vein quartz homogenized in the gas phase. (Authors' abstract, shortened by A.K.)

YARDLEY, B.W.D., 1974, Porphyroblasts and crystallization force': Discussion of some theoretical considerations: Geol. Soc. Amer., Bull., v. 85, p. 61-62. Author at Dep. Geol., Univ. of Bristol BS8 1TR, England.

In view of the apparent ambiguity of textural evidence, some theoretical aspects of the possibility that growing porphyroblasts deform their matrix are considered. It can be shown by a simple model that a growing grain need not work against the load P to displace its matrix. It is suggested that, in meta. rocks, all grains are in contact with a random pore phase analogous to a fluid. When a porphyroblast grows at a boundary with a min., not all of whose molecules will be incorporated in the porphyroblast, then surplus molecules of that min. will be removed in the fluid. If the matrix min. is rather insol., and other more sol. matrix mins. are present nearby, then the growing porphyroblast may push the insol. min. ahead of it into space created by the sol. of soluble ones. In this way, it is possible that displacement of matrix fabrics may occur and produce textures similar to some of those described by Misch (1971). (Author's abstract). (Of pertinence to the trapping of fluid incs. in porphyroblasts)

YUDALEVICH, Z.A. and SANDOMIRSKIY, G.G., 1973, Pregranitoid quartz veins in the North Nurata Range and the southern Bukantau, Western Uzbekistan: Akad. Nauk SSSR, Doklady, v. 210, no. 1, p. 176-179 (in Russian; translated in Doklady Akad. Nauk SSSR, v. 210, p. 50-52, 1974). Authors at Zarafshan Geol. and Geophy. Prospecting Exped., Samarkandgeologiya Trust.

Includes some T_D data (380-170°C). (ER)

YUN, Suckew, 1973, Geothermometrical studies of fluorite deposits with special reference to the studies of fluorites from the Wolaksan area and Cheonil Mine, Chungcheongbuk-Do: Korean Institute of Mining Geology, Jour., v. 6, p. 195-200 (in Korean with English abstract).

T. environments of the form. of fluorite deps. in the Wolaksan area and the Cheonil mine, Chungcheongbuk-Do, are presented and interpreted. These deps. occur as a number of hyd. veins or replacement deps. near the contact zone between Paleozoic limestones and Cretaceous biotite granites. T_H fluorite crystals from Wolaksan area fall in the narrow range 149-167°C, of which lower limit is quite high, while those of the Cheonil Mine show a wide range of 126-177°C, indicating a much lower mean T_F. If the possible correction for P, which may not exceed +30°C, as the depth of the deps. was 1.5km, were applied, the possible highest value of the true T_F of fluorites in both areas might reach ~200°C, indicating these deps. were formed as a series of early products of the epithermal stage of hyd. processes. (Author's abstract)

ZAKHARCHENKO, A.I., 1972a, Chamber pegmatites and their thermodynamic and chemical conditions of formation, in Pegmatites (mineralogy, genesis and commercial evaluation) - Materials of Meeting, Leningrad, 1972, eds. P.M. Tatarinov and S.A. Rudenko, p. 159-169 and 3 plates (p. 8-11 in Illustration section): Leningrad, Ministry of Special Education of RSFSR (in Russian).

On the basis of P incs., zones of aplite and graphic peg. have xlized. from low-melting, volatile-rich melts and rexlized at 800-650°C under >lithostatic P. Internal zones of peg. have xlized. primarily by segregation and rexliz. under action of very active gaseous sols. at 700-500°C. Internal vugs formed from hyd. sols. with extensive metasomatism. (Author's abstract, translated by A.K.).

ZAKHARCHENKO, A.I., 1972b, Phase state and the composition of the sequentially evolved magmatic fluids related to granites and their role in mineral and ore-formation (on the basis of studies of solidified and gas-liquid inclusions), in the Ore-Forming Environment as Determined from Inclusions in Minerals, V.I. Smirnov, ed.: Moscow, "Nauka" Press, p.45 66 (in Russian, translation courtesy Ashoke Lahiry).

This paper was abstracted briefly in COFFI, v. 5. It includes over 50 illustrations and 5 tables of chem. data, and is a wide-ranging review of the author's own data, and data from the literature, on a variety of granitic plutons and their late stage processes. Although a holographic translation of the entire article by Dr. Lahiry has become available, it is not presented here because its content is largely superceded by seven other papers by the same author in 1973 and 1974, abstracted in this and the previous volume of COFFI. (See also related papers by Z. in earlier volumes of COFFI; ER.)

ZAKHARCHENKO, A.I., 1973, Granite- and pegmatite-forming melts and related ore-forming fluid solutions (according to inclusions in minerals): Vopr. Magmat., Metamorf. Orudeneniya Dal'nego Vostoka, dal'nevost. Petrogr. Reg. Soveshch., [Mater.], 2nd, 1972, (Pub. 1973), p. 295-296, ed. S.S. Zimin: Akad Nauk SSSR, Dal'nevost. Nauch. Tsentr.: Vladivostok, USSR., (in Russian), C.A., v. 82, no. 3, 1975, 33448y. Author at Vses. Nauchno-Issled. Geol. Inst., Leningrad, USSR.

Incs. enriched in volatiles, occur in quartz grains of alaskitic granites and aplites; in pegs., the incs. occur in topaz and beryl. T_H of the incs. in quartz (750-900°) and those in topaz (700-800°) were detd. T_H of gas-liq. incs. is accompanied by the loss of volatile components. The granite- and peg.-forming melts crystd. with the development of Sn, Mo, and W ore mineralizations.

ZAKHARCHENKO, A.I., **1974a**, Following alteration of character and composition of inclusions of magmatogenic fluids - information on deep source of halogenic deposits on the Earth (abst.): Internat. Assoc. on the Genesis of Ore Deposits, Fourth Symposium, Varna, Sept., 1974, Abstracts of Papers: Sofia, IAGOD, p. 252-253 (in Russian; translation courtesy A. Kozlowski). Author at All-Union Scientific-Research Geological Institute -VSEGEI-, Leningrad, USSR.

In comp. of postmagmatic fluids the amount of slightly soluble compounds regularly decreases and conc. of salts increases strongly during T drop, yielding the halogen deps. on the Earth's surface.

1. In granites gas-solidified incs. of melts consist of 85-95% mins. and 5-15% of gases + sometimes a few xls. of halite and sylvite (1-3 vol. % of solids). During heating these salts dissolve in the gases and later, at 700-800°C, the melting of min. aggregates begins.

2. In pegs. conc. of slightly soluble mins. decreases from 80 to 20 vol. % (melt aggregates), and fluids and crystals formed from fluids occupy from 0-20 to 60-70 vol. %; the latter crystals consists of 95-60 vol. % of slightly soluble mins. (quartz, feldspars, micas, ore minerals) + 3-5 to 20-30 vol. % of easily soluble salts (protolithionite, cryolite, halite, sylvite). The salts dissolve at 200-300°C, other DMs. xlized from fluids at 450-550°C and at 550-600°C solid aggregates begin to melt.

3. In early postmagmatic veins incs. bear up to 40% salts homogenizing at 500-550°C to form strongly conc. brines.

4. In moderate-and low-T. veins the main dissolved components are easily soluble salts.

At elevated T. the halogens, Na, K, and rare alkalies are the best fluxes for rocks and most active mobilizing media of ore elements, and at the end of min.-forming processes form easily soluable salts. Calcs. prove that endogene processes are the main source of salts in seas and evaporites. (Author's abstract, modified by A.K.).

ZAKHARCHENKO, A.I., **1974b**, Genesis of rare-metal deposits in the formation of parent granites and post-magmatic bodies (from the data of inclusions of melts and fluids in minerals) (extended abst.), in Metallization associated with acid magmatism, v. 1, p. 289-293, ed. M. Stemprok: Prague, Geological Survey (a volume of papers presented at the MAWAM Symposium, Karlovy Vary, Czechoslovakia, Oct. 1974) (in English). Author at VSEGEI, Leningrad, USSR.

(1) Granites of all intrusive phases, up to the latest aplites, contain P gaseous-solidified incs. with 95-80% mineral aggregates. Gas phase ranges from 5-10% in earlier granites to 15-20% in later aplites. Hydrogen and hydrides (sic) are abundant. Fusion starts at 700° and T_H is at 900-1000°C. The abundance of very active hydrides at high T prevents mobilization of rare metals. (2) Within the pegmatites P incs. have transitional character. "Melting aggregate" (i.e., finely crystalline silicate melt phases) decreases to 40-20% and DMs increase to 40-70%. Most DMs dissolve by 550°C and T_H occurs at 600-750° depending on location in the peg. (3) Pre-ore feldspar and quartz-feldspar veins and low-ore albites have no melting aggregate, and $\leq$ 80% DMs. Most DMs dissolve by 550°C. (4) Ore-rich greisen, greisen-quartz and early quartz veins have multiphase P incs. with up to 70 vol. % DMs (10-20 minerals); T_H = 250-520°C. Many of the DMs contain K, Li, and F. (5) Late and post-ore veins still have multiphase P inc., but with decreasing % DMs; T_H is 300 to <100°C. (6) P incs. in rare-metal minerals (wolframites and others) were done by infra-red microscopic methods (Levitskii). In wolframites from ore-bearing veins P incs. are multiphase gaseous -liquid with $\leq$ 60% DMs, down to 30% in later generations; T_H = 500 to 350-300°C. They are mostly HCO_3-Cl-Na sols., with K, Li, and F during the transportation of rare metals. (Modified by ER from the author's abstract.)

ZAKHARCHENKO, A.I., **1974c**, The real nature and character of pegmatite-forming melts - fluids revealed by their inclusions in minerals (abst.): Internat. Mineral. Assoc. Ninth Gen. Meeting, West Berlin and Regensburg, W. Germany, Collected Abstracts: West Berlin, German Mineralog. Soc., p. 36 (in English). Author at Leningrad, USSR.

Difficult features of nature and character of pegmatite-forming melts-solutions and of pegmatite genesis are understood to an extent by studies of original incs. of these melts-solutions relicts in peg. minerals, especially in the fully-differentiated-chamber (pegmatites), partially in quartz, and more often in topaz, beryl, etc.

1) In the wall-rock parent granites the incs. are gaseous-solidified, 90-95% crystallized aggregates of minerals, and 5-10% gases. Aqueous liquid is lacking, but many hydrides (sic.) are present. On heating they fuse in the range 800-1000°C.

2) In the marginal zones of pegmatites the original incs. are also gaseous-solidified, but with higher volatile content (and) up to 20-35% alkali, and free-growing DMs appear. On heating fusion takes place in the range of 650-850°C with complete solution of volatiles.

3) In the inner zones (blocky, monomineralic) the mineral aggregates decrease to 40-20%, and L-G phases with more freegrowing DMs are observed. On heating (450-530°C) at first the DMs dissolve, and then fusion occurs above 530°C.

4) In the incs of the cavity-chamber minerals we observe a complete disappearance of crystallized aggregates of minerals and transition into very concentrated fluids, with $\leq$ 70 % DMs.

Thus, the pegmatite-forming agents consist of easily fusible melts with accumulations of fluxing fluids and their gradual transition into highly concentrated fluids. (Modified by ER from author's abstract).

ZAKHARCHENKO, A.I., 1974d, On the genesis and peculiarities of formation of quartz from various zones of pegmatites, in Typomorphism of Ukrainian Quartz, edited by Ye.K. Lazarenko, Acad. Sci. Ukr. SSR: Kiev, Naukova Dumka Pub. House, p. 24-26 (in Russian; translation courtesy A. Kozlowski). Author at All-Union Scientific-Research Geol. Inst. Leningrad, USSR.

Paper bears results of extensive studies of typomorphic features of quartz with special attention paid to peculiarities of origin including fluid inclusion data, but essentially repeats and reinterprets data from previous papers on parent media for the form. of pegs. (A.K.).

ZAKHARCHENKO, A.I., LEVITSKIY Yu. V. and MOSKALYUK A.A., 1973, Place and conditions of formation of rare-metal deposits as indicated by inclusions of solutions in wolframites and accompanying minerals: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 59-61 (in Russian; translation provided through the courtesy of A. Kozlowski). Authors' at VSEGEI, Leningrad.

1. Rare-metal deposits (W, Sn, Mo, etc.) usually are strictly connected with late-orogenic, often leucocratic and alaskitic granites. In investigated deposits of Kazakhstan there occur the following late- and postmagmatic formations, bearing industrial rare metal deposits which occupy the defined position. After the granite phase and following enrichment in alkalies, volaties, etc., pegmatites formed as pre-ore schlieren, feldspar, and quartz-feldspar veins where rare metal minerals occur only as the latest (phases). Later strictly industrial rare-metal, feldspar-quartz, greisen, greisen-quartz and quartz (with sulfide) veins crystallized. In the end the veins of crest and hornfels quartz without ores, often bearing fluorite, carbonates etc., formed.

2. In intervals during the above sequence of rocks and veins on a background of frequent fracturing, the following change of primary inclusions was found; among them inclusions in wolframite and cassiterite, and accompanying minerals have specific character and occupy specific positions.

Thus in granites and essential zones of pegmatites, melt inclusions bearing "dry" gas (5-15% in granites and 25-40% and more in pegmatites) are the primary ones. Their melting temps range from 850-800°C down to 700° in late granites and to 650-600°C in pegmatites. The lack of liquid phases of aqueous solutions is characteristic (signs occur in pegmatites). In internal zones of pegmatites (feldspathic and quartz-feldspathic), not bearing ores, a change occurs (from) the remnant, easily melting (560-540°C) phase to unusually concentrated, gaseous fluids with the appearance and increase of role of the liquid phase of aqueous solutions. With an increase of these very solutions the rare metal mineralization appears.

3. In industrial rare metal quartz-feldspar greisen, and greisen-quartz veins, in a number of minerals (in wolframite, using IR microscopy) among prevailing secondary inclusions, there were found the primary inclusions filled with very concentrated, essentially liquid solutions, (up to 40-50 % by vol.), with lower concentrations in later, rare metal-sulfide-quartz veins. Rare metal industrial ore formation occurred essentially from 450 to 300°C from very concentrated hydrotherms, as seen from inclusion homogenization. On the basis of composition of solid phases in inclu-

sions and aqueous leachates, essentially rare-metal-forming solutions were those rich in alkalies (Na with increased K, as well as Li and Rb), halogens (Cl with increased F), silica and bicarbonates, and in the late stage - in sulfates. Main rare metal mobilization took place under action of acid solutions and stopped when solutions became neutral and alkaline.

4. Post-ore veins, as proven by the occurrence of liquid primary inclusions with smaller or no solid phases and homogenization below 250-200°C, formed from Na-Ca-Mg chloride-sulfate-bicarbonate solutions with d decreasing concentration.

Thus, rare metals were not distilled from crystallizing melts with early essentially gaseous emanations, but they were mobilized from the solidified rocks, transported and formed deposits under action of early postmagmatic, very concentrated hydrotherms of suitable composition. (Authors' abstract)

ZAKRZHEVSKAYA, N.G., 1973, Inclusions of mineral-forming medium in minerals of foyaites from Khibiny massif, in Minerals and parageneses of minerals of rocks: Leningrad "Nauka" Publishing House, p. 40-52. (In Russian; translated by A.K..)

In nepheline from foyaite from Khibiny four types of incs. were found: solidified, gaseous, liquid and combined. Solidified and combined incs. prevail, liquid ones are rarer and gaseous ones are quite rare. Among liquid incs. hydrocarbon-bearing ones were found. Most incs. are primary. Occurrence of glass incs. proves a magmatic origin for the nepheline. Some hydrocarbon-filled incs. contain an anisotropic L phase, probably petroleum, and probably of inorganic origin. (Author's abstract)

ZALUTSKII, V.V., 1974, Primary liquid inclusions and evolution of feldspars in magmatic granites (abst.): Internat. Mineral. Assoc. Ninth Gen. Meeting, West Berlin and Regensburg, W. Germany, Collected Abstracts: West Berlin, German Mineralog. Soc., p. 38 (in English). Author at Irkutsk, USSR.

In 1940 D.S. Korzhinskii pointed out that feldspars contain abundant tiny incs. usually taken for pellites (sic.). This false pellitization has infrequently been mentioned in literature up to now. The author investigated plagioclase, potassium-sodium feldspar and anorthoclase containing abundant pellite-like incs. from the Middle Paleozic volcano-plutonic series of the western Transbaikal area. G-L incs. can be detected at 500-800 x. They are stable up to 900°C and therefore are regarded as P incs. (sic). The analysis of the location of the incs. and the nature of twinning and exsolution of feldspar enables us to trace their evolution. During twinning and exsolution into phases incs. open and move out. In the process of the microclinization of the orthoclase the P incs. disappear partially or completely. (Author's abstract)

ZANKER, Adam, 1974, Nomograph for calculating the purity of hydrocarbons from freezing points: Erdöl and Kohle, v. 27, no. 1, p. 26-28 (in English with German abstract).

The nomograph refers to the ASTM-Method D-1016-55 (reapproved 1968) and enables a quick calculation of purity of hydrocarbons from freezing points. (Author's abstract). (Pertinent to many calibrations of T_{Frz}.)

ZARAYSKIY, G.P., ZHARIKOV, V.A. and STOYANOVSKA, F.M., 1974, Experimental studies of bimetasomatic skarn formation. Part I. Interaction of oxides and carbonates of Ca and Mg with quartz: in Contrib. to Physico-Chem. Petrology, V.A. Zharikov, et al., eds.: Moscow, "Nauka" Pub. House, v. 4, pp. 29-71 (in Russian; abstract courtesy A. Kozlowski).

Experiments on interaction between silicate and carbonate rocks under hydrothermal conditions were performed at T = 600°C and fluid P-1000 kg/cm^2, sols. of NaCl, $CaCl_2$, $MgCl_2$ and $FeCl_2$. Zones of reaction have sharp contacts and intermediate comp. Asymmetric reaction zones, as well as influence of comp. of sol., ratios of zones, and thdy. parameters of components were investigated. (Authors' abstract shortened by A.K.).

ZARAYSKIY, G.P. and ZYRYANOV, G.P., 1973, Experimental studies of alkaline metasomatism of granites: in Contrib. to Physico-Chem. Petrology, V.A. Zharikov, et al., eds.: Moscow, "Nauka" Pub. House, v. 3, pp. 119-156 (in Russian; abstract courtesy of A. Kozlowski).

Under conditions of open systems with completely mobile components, interaction of sols. of fluorides, chlorides, carbonates and hydroxides of Na and K on biotite and riebeckite granites, was studied at T = 500-600°C and P = 1000 kg/cm^2, for 96 hours. Resulting metasomatic zonal sections were explained from point of view of Korzhinski's diffusion metasomatic zoning theory. The sequence of mobility of rock forming components was stated. In ranges of exper. the most inert are Al, and Fe, the most mobile - H_2O, F(Cl, CO_2), O_2. The intermediate components are: Si, Ca, Na and K. Petrological significance of results is discussed, possibility of forming of riebeckite granites by metasomatism during alkaline alter. of biotite granites is suggested. Fields of devel. of riebeckite granites may be accepted as external zones of metasomatic sections with max. thickness. Internal, most altered zones may be the feldspathic, aegirine-feldspathic or riebeckite-feldspathic metasomatites, locally developed inside granitic massifs. (Authors' abstract).

ZARITSKY, P.V. and ORLOV, O.M., 1973, Mineral formation in karst cavities of the Donets basin: L'vov. Univ. Mineral. Sborn., v. 27, no. 3, p. 258-262 (in Russian with English abstract).

Thermal waters under P, originating during the compaction of sed. rocks, are the cause of karst and min. forms. in the limestone of the south-western part of the Donets basin. Similar features are possible in other limestones of the basin. T_H of incs. in calcite = 110-115°C. (Authors' abstract)

ZARITSKY, P.V. and STREMOVSKY, A.M., 1973, Some results of a study of fluorite deposits of the Donbas basin: L'vov. Univ. Mineral. Sborn., v. 27, no. 3, p. 282-286 (in Russian, with English abstract).

Structural, chem., min. and genetic peculiarities of the fluorite deposits of the Donbas basin are given. T_H range is 120-60°C. (Authors' abstract)

ZATSIKHA, B.V., KUROVETS, M.I., and LYUBINETSKAYA, A.V., 1974, Typomorphism of quartz of Zakarpat'ye, in Typomorphism of Ukrainian Quartz, edited by Ye. K. Lazarenko, Acad. Sci. Ukr. SSR: Kiev, Kaukova Dumka Pub. House, p. 74-78 (in Russian; translation courtesy A. Kozlowski). Authors at Ivano-Frankovsk Inst. of Oil and Gas, Ivano-Frankovsk.

Quartz from Zakarpat'ye, assoc. with sphalerite, siderite and cinnabar or occurring in flysch as "Marmarosh diamonds" formed under the following conditions, on the basis of fluid incs.: I. Vyshkovskoe ore field, T_H = 150-275°C, P = 200-300 atm, pH = 6.5 (most) - 7.7, comp. of sol., in mg (per kg? A.K.): Na - 0.27, K - 2.39, Ca - 0.50, Mg - 0.25, Cl - 1.18, SO_4 - 1.59, HCO_3 - 5.43, F - 0.06; gas comp. in %: CO_2 - 30.3-55.6, N_2 - 33-62.02, H_2 - 7.65-16.0, CH_4 - 0.03-4.2, C_2H_6 traces, C_3H_8 traces; II. Uglyanskoe ore field, T_H = 90-140°C; III. Rakhov region, T_H = 165-170°C; IV. Flysch Carpathians, T_H = 85-180°C, heterogenous systems with oily fluids; V. Chernogolovo, T_H = 90-225°C. Chromatographic dets. of hydrocarbons (from Flysch Carpathians? A.K.) showed: CH_4 - 43.0, C_2H_6 - 8, C_2H_4 - 17.5, C_3H_8 - 26, C_3H_6 - 25.5, C_4H_{10} - 0.1, iso-C_4H_{10} - 0.9, iso-C_4H_8 - 1.5, C_4H_8 - 0.5. Paper also summarizes previous data on fluid incs. in quartz from Zakarpat'ye (A.K.).

ZATSIKHA, B.V., PETRICHENKO, O.I., DOLYSHNY, B.V., and LAS'KOV, V.A., 1973, Genetic pecularities of mineral formation in the Slaviansk mercury deposit: L'vov. Mineral. Sborn., v. 27, no. 4, p. 326-332 (in Russian; abstract courtesy T. M. Sushchevskaya).

Slaviansk Hg dep. is confined to a circular breccia of a Devonian salt stock. The dep. formed in 6 stages. Detailed mineralogical and fluid inc. studies were made on fluorite, siderite, quartz, dolomite, pyrite, pyrrhotite, calcite, and cinnabar. Data are given on T_H for various inc. types in all main minerals, comp. of gas in fluorite-I, quartz-II, pyrite, calcite-I, calcite-II, and cinnabar, the chem. comp. of water leachates and ultramicrochemical anal., and the pH-values for inc. solutions. It was found that high-T and intermediate-T pre-ore stages of mineral formation took place at 415-250°C, P 600-400 atm, pH 6.2; high-T ore stage (with metacinnabar) - at 250-210°C; low-T pre-ore stage - at 150-200°C, P 200 atm; main ore stage (with cinnabar) - at 150-70°C, P 150-100 atm; and post-ore stage - at 70-45°C. Cinnabar, in close assoc. with calcite, formed from alkaline sols.

ZEN, E-an, 1974, Burial metamorphism: Canadian Mineral., v. 12, p. 445-455. Author at U.S. Geol. Survey, 959 Nat. Center, Reston, VA 22092.

Burial meta. rocks as defined by Coombs (1961), are mainly of low grade and have been meta. without being affected by penetrative deformation, i.e., without devel. of schistosity. Many burial meta. rocks show zeolitic assemb., whereas others have the clay min.-carbonate assoc. The validity of these two trends is confirmed by a study of modern active meta. in geothermal areas and in deep sed. basins where progressive diagenesis can be observed. The primary control of min. assoc. with depth appears to be T rather than P. The diff. between the two trends may be controlled in part by the ratio of $^{\mu}co_2/^{\mu}H_2O$ of the assoc. fluid phase, and in part by the nature of the protolith — volcanic and volcanogenic rocks tend to become zeolitic.

Exper. data on the phase equil. of laumontite and analcime give the maximum stability fields of these two typical zeolites; in nature other factors may enter, all of which tend to restrict the stabilities of these zeolites to even lower Ps. Under such low-P conds. massive volcanic rocks and possibly also greywackes are not likely to develop penetrative schistosity. It may not be valid to use zeolitic assembs. and lack of schistosity in a rock to deduce simple burial metam. With this in mind, the occurrences of zeolitic rocks in orogenic belts can be simply explained as meta. at shallow depths. (Author's abstract)

ZHIROV, K.K., FEDOTOV, Zh.A., KRAVCHENKO, M.P. and SUROVTSEVA, L.N., 1974, Occurrence of excess primordial trapped argon in basic dikes in

North Pechenga, Kola Peninsula: Geokhimiya, 1974, no. 11, p. 1856-1861 (in Russian; abstract translated in Geochem. Intern., v. 11, no. 6, p. 1335, 1974).

ZIBOROVA, T.A. and NEKRASOV, M. Ya., 1973, IR spectra of borosilicate solutions of system $La_2O_3 - B_2O_3 - SiO_2 - H_2O$: in Contrib. to Physico-Chem. Petrology, V.A. Zharikov, et al., eds.: Moscow, "Nauka" Pub. House, v. 3, pp. 240-246 (in Russian; abstract courtesy A. Kozlowski).

Peculiarities of structure of polyions of Si in $Na_2SiO_3.9H_2O$ sols. were studied depending on pH. During pH increase $Si(OH)_4$ gives polymers with max. at pH 5-8. Following increase of pH leads to depolymer. and at pH 11 only disilicate ion is stable. Structure of borosilicate polyion in sols.: increase of acidity causes the increase of $B_{(3)}$ and decrease of $B_{(4)}$. In borosilicate sols. prepared at 300 and 500°C and measured at room T the same tendency of changes of Si polyions type and coordination of B was stated as in separate Si and B sols. Si-B ions are absent, forming individual Si and B ions in sols. (Author's abstract).

ZIMMERMANN, J.L., 1974, Fluid in quartz from tin-copper deposits of Lanmeur-Kerprigent (Finistère): Sci. Terre 1974, v. 19, pt. 1, p. 65-79 (in French). (Author at Cent. Rech. Petrog. Geochim, CNRS, Vandoeuvres-Nancy.) C.A., v. 84, no. 3, p. 7570d, 1976.

The fluid incs. were anal. by mass spectrometry. Small incs. in quartz from veins contain 5-10 vol. % gases. Quartz from coarse-grained rocks contain larger incs. that contain 20% gas by vol. Trapped gases include CO_2, org. cpds., HF, and HCl. The more abundant gas phase in the coarser rocks suggests a higher T. of form. for them.

ZNAMENSKIY, V.S., 1974, At Meeting on Fluorite: Geol. Rudn. Mest., v. 16, no. 5, p. 123-125 (in Russian; abstract courtesy A. Kozlowski).

Main topics of fluid inc. data presented at the meeting (Moscow, March 1974): revealing of stages of deposition process; T range of form. of fluorites are from 340°C (greisens) to 70°C; data on changes of comp. and conc. of parent sols.

ZOZULENKO, L.B. and ZLOBIN, V.A., 1974, Temperature, pressure, and composition of solutions in Precambrian rocks of the Enisei Ridge based on gas-liquid inclusions in vein quartz: Geol. Geofiz., 1974, no. 1, p. 96-100 (in Russian). (Authors at Inst. Geol. Geofiz., Novosibirsk, USSR.) C.A., v. 81, no. 6, 1974, 66596c.

In the Precambrian layer of the Einesei Ridge the T of the hyd. meta. sols. forming quartz veins decreases from 460° to 100° starting from the most meta. bottom part of the cut up to the top part, showing a 37°/m gradient. At the same time the P decreased from 1800-1000 to 200 atms. or less, and CO_2 concn. decreased from 95 to 2 wt. %. The high T (≤400°) sols. reached the level of the phyllite-like sericitic chloritic schists, where the majority of the Au ores and Sb deps. are located. The T of the hot sol. decreased gradually to 60°. The Ps were 12-18 atm. at 200-10°, and 3-9 atm. at 100-80°, and the CO_2 conc. decreased and the sol. acquired a NaCl comp. which was assocd. with the extension of saline halite-bearing incs. and often albitization in the rocks.

ZORIN, B.I., KARSKIY, B.Ye., AND DEVYATOV, V.Ye., 1973, Decrepitometric investigations of minerals from Mama pegmatites and their application for prospecting for blind mica-bearing veins and zones: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, p. 253-255 (in Russian; translation through the courtesy of A. Kozlowski). Authors at Mineralogical - Geochemical Research Inst., Moscow.

1. Quartz, microcline and plagioclase are the main minerals of the Mama pegamtites. Quartz has the highest decrepitation activity (up to 1200 impulses in T interval 0-700°C), usually with 3 distinct peaks: 1) 120-300°C; 2) 300-480°C; 3) 480-600°C. Primary inclusions decrepitating in the third interval, gave 10% (rarely 30%) of the total impulses. T_D for quartz from sub-contact fine-grained pegmatites 520-560°C, for quartz of graphic intergrowth zone - 500-540°C, for quartz from massive blocky zone and quartz inner core - 480-520°C. Decrepitometric activity of plagioclases is very low (up to 60 impulses), they have one peak, at 320-380°C. Albite from cavities is the exception. For microcline three peaks are typical, similar to the peaks of quartz, but the activity is lower - up to 40 impulses.

2. Apatite, garnet and tourmaline are the main accessory minerals of the Mama pegmatites. Apatite has high activity (up to 7000 impulses) and wide peak of decrepitation: 140-600°C. Some apatites from the blocky zone of plagioclase veins have a second peak at 520-700°C, thus seemingly being the early generation. Garnet from pegmatitic veins has intensive decrepitation at 200-620°C and sharply differs from garnet of wall paragneisses with T_D 440-600°C (sic.). Activity of tourmalines is up to 1300 impulses, T_D for tourmalines from pegamtitic zones 180-200°C, from wall rocks 680-760°C.

3. There is a regular correlation between intensity of development of industrial mica mineralization and amount of low-temp. inclusions. Industrial mica-bearing pegmatites at T interval 120-280°C give 25-60% of impulses, pegmatites without industrial mica mineralization - 6-25%, and those without mica - less than 6%.

4. Around pegmatitic veins one may recognize a near and a distant aureole of decrepitometric activity in wall rocks. Distant aureoles occur at distances of 10-40 m, near ones at - 5-15 m from veins, and depend on intensity of industrial mica mineralization.

5. Decrepitometric studies of Mama pegamtites permit searching for mica-bearing zones in veins as well as mica-bearing pegmatites on the basis of aureoles of impregnation, and thus was supported by positive results of prospecting on anomalies found decrepitometrically. (Authors' abstract)

ZWANN, P.C., 1974, Garnet, corundum and other gem minerals from Umba, Tanzania: Scripta Geologica, no. 20, p. 1-41.

In addition to detailed studies of many types of solid incs., liquid incs. are described in tourmaline. (ER)

ZYONG, Pham Van and OREKHOV, S. Ya., 1973, Vacuum-decrepitometric investigations of phosphates of various genetic types: Abstracts of papers at Fourth Regional Conference on Thermobarogeochemistry of Mineral-Forming Processes, 24-30 Sept., 1973: Rostov, Rostov Univ. Press, pp. 132-133.

1. Vacuum-decrepitometric investigations of phosphate gravel from Paleogene age deposits from Middle Don Basin, and plate and secondary phosphates from the Dzhany-Tas deposit (Kara tau), were made by use of the VD-2 decrepitometer under pressure 1.10^{-2} to 1.10^{-3} mm of Hg.

2. Decrepitometric investigations of kurskite, francolite, fluoroa-

patite and dolomite proved as follows: emanation of CO_2 from kurskite and francolite takes place in stages at temp. about 200°C lower than at normal pressure (P = 1 atm). Emanation of significant amount of CO_2 from kurskite takes place at 200°C, from francolite at 300°C, thus agrees (as indicated by x-ray data) with the degree of crystal lattice perfection of those minerals.

Fluoroapatite and dolomite taken from the same hypsometric level in the Dzhan-Tas deposit gave the same interval of temperature of gas emanation (300-420°C); this indicates that the same changes of those minerals (occurred) during the metamorphic processes of (formation of) phosphate-bearing rocks.

3. Emanation under vacuum of hygroscopic water from glauconites present in phosphate gravel was observed in the temp. interval 20-100°C; constitutional water escapes at 260-460°C with a maximum of gas emanation at 360°C for the grain fraction 0.25-0.60 mm, and at temp. 240-400 and 260°C respectively for grain fraction 0.20 mm. Grain size of glauconite (increases with) the perfection of its structure.

4. Terrigenous quartz from phosphate gravels and from sands of Paleogene age has similar decrepitometric characteristics. Hygroscopic water from microfractures escapes at 20-100°C, maxima of gas emanation from inclusions ranges from 220 to 430°C. Polymodal character of gas emanation proves that the clastic material was recycled many times. (Authors' abstract, abbreviated by A. Kozlowski.)

ZYRYANOV, V.N. and DOROGOKUPETS, P.I., 1974, Equilibria of solid solutions of nepheline and alkali feldspar at T = 800-1000°C in alkali chloride melts: in Contrib. to Physico-Chem. Petrology, V.A. Zharikov, et al., eds.: Moscow, "Nauka" Pub. House, v. 4, pp 72-81 (in Russian; abstract courtesy A. Kozlowski).

Isotherms of distribution of components (P = 1 atm) between ordered and disordered feldspars, and melts of salts as well as between nepheline and melts of salts, were found. The influence of ordering of feldspars on distribution isotherms was evaluated. The diagram constructed of phase state for ordered and disordered alkali feldspar can be used as geothermometer. (Authors' abstract, shortened by A.K.).

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.

DOLOMANOVA, E. I., LOSEVA, T. I., and TSEPIN, A. I., 1974, On the chemical composition of solid precipitates in the vacuoles of cassiterite, tourmaline, and quartz from tin ore deposits, in Problems of Endogenetic Ore Deposits, N. V. Pavlov, ed.: Moscow, Izdat. "Nauka," p. 138-149 (in Russian; translation by Mary Michael Hobson, courtesy Colin Barker). (See also previous item, this volume.)

Earlier E. I. Dolomanova and coauthors determined the composition of the gas phase in vacuoles (Dolomanova and others, 1971b, 1972), the composition of the liquid phase and the solid components dissolved in the water (Dolomanova and others, 1969a, 1972). It was demonstrated for the first time that it was possible to determine the composition of the solid precipitate by X-ray microanalysis (Dolomanova and others, 1966b). In the present article the latter problem is given much consideration. A study is made of the chemical composition of the solid precipitates in inclusions of three principal minerals from a tin ore deposit. In contrast to the analyses of the gas and the liquid phases, the determination of the chemical composition of the solid phase is carried out on individual vacuoles. It is also possible to obtain an indication of the degree of homogeneity and variations in the composition of the precipitates in different inclusions. In each sample from 10 to 40 inclusions, sometimes 50 to 60, were examined. The results of these studies are presented below. Finally, for a complete understanding of the composition of the hydrothermal solutions, the chemical reactions occurring during mineral formation and the forms of transport of the elements, a simultaneous determination of the gas and the liquid phases and the solid precipitates is necessary; but, for now, such analytical methods do not exist. We were limited to a separate determination of the composition of the phases examined, which, nonetheless, gave important new information--supplementing that obtained during a study of the mineral paragenesis of the ores and rocks--for a better understanding of the processes of mineral formation.

Methods for the study of the solid precipitates in inclusions

The chemical composition of the solid precipitates in exposed inclusions occurring in cassiterite, tourmaline and quartz from tin ore deposits were studied at IGEM in the Academy of Sciences, USSR, using a model MS-46 electron microprobe, built by the firm "Kameka." Transparent sections, polished on both sides with diamond paste AM-3, were prepared from the above minerals. The chemical composition of the diamond paste according to the abrasives firm "Il'ich" is as follows: (1) synthetic fatty acids, 41%; (2) oleic acid, 18%; (3) mineral oil, 31%; and (4) synthetic diamond, 10%. The paste was checked as to its concentration of nitrogen in the laboratory of the Institute of Mining. The amount of nitrogen in different samples of the paste varied from 0.00 to 0.02%. This concentration of nitrogen lies at the limit of sensitivity of the X-ray spectroanalysis. Spectroanalysis of the paste by the IGEM Laboratory by A. S. Dudykinoy gave the following values:

Element	Composition, %	Element	Composition, %
Fe	0.1	Ti	$n \cdot 10^{-3}$
Si	0.1	Al	$n \cdot 10^{-3}$
Ca	$n \cdot 10^{-2}$	La	$n \cdot 10^{-3}$
Mg	$n \cdot 10^{-3}$	Ce	$n \cdot 10^{-3}$
Ba	$n \cdot 10^{-3}$	Cu	$1 \cdot 10^{-4}$

The low concentration of these elements does not affect the determination of the distribution of elements in inclusions obtained with the microprobe.

The analyses were carried out using an accelerating voltage of 20 kv and a sample current of 20 to 100 nA. The spectra of the characteristic x-radiation of the individual elements were recorded using the K-series for the elements having atomic numbers below 40 and the L- and M-series for the heavier elements. The size of the electron beam was about 2 microns. It should be noted that during this study of the solid precipitates in inclusions, it is not always possible to give a complete chemical composition. Some of the difficulties include these:

(1) A larger depth of the vacuole, due to which the characteristic X-ray radiation may be completely absorbed by the sample (however, the composition of precipitates located at the bottom of such inclusions were not determined).

(2) Unfavorable shape of the walls of the inclusions, and their orientation relative to the electron beam.

(3) The layered build-up of the precipitates, one on another, giving a thickness of the surface precipitate which exceeds the depth to which the electron beam penetrates.

(4) The small (0.n micron and less) size of the minerals.

Some of the above restrictions to this method (point 2) may be overcome by examining the inclusions in different locations, achieved by rotating the sample. Figure 1 demonstrates the heterogeneity of the distribution of precipitates containing iron for two locations in the sample. The actual distribution of the precipitate seems to be a superposition of the two figures (Figure 1, b, c). Difficulties in the diagnostics of the precipitates (point 4) are partly overcome by the study of the same samples using the electron microscope and the removal of the minerals from the inclusions using a replica with the subsequent determination of their crystallographic parameters by the micro-diffraction method developed by R. V. Boyarskoy.

A study was made of the chemical composition of the solid precipitates in the inclusions of cassiterite from the Erenfridersdorf (GDR, samples 82, 83); and from the ores of Kiren'go (sample 1) and Avianga (sample 28) from Central Africa. Similar studies were carried out on tourmaline from the deposits of Zabaikal'ya: Zun-Undurskoe (sample 398), Ushmunskoe (sample 111), Sherlovaya mountains (sample 1314, 795) and in quartz from the deposits of Adun-Cholon (sample 3241) and from the Sherlovaya mountains (sample 2014).

The solid precipitates in inclusions under the optical microscope appeared as single crystals of different sizes or as a mixture of powder-like crystalline compounds. The electron microprobe was used to determine the elemental composition of the precipitates.

In hydrothermal solutions, as has been demonstrated (Shcherbina, 1972), the elements occur in the form of cations and anions and in the majority of cases, their transport and deposition as minerals is divided into two phases.

(1) The precipitation of compounds occurring during the normal crystallization of the solution. The composition of the precipitates corresponds to the composition of the dissolved components.

(2) The precipitation of compounds resulting from the chemical reactions. This results in the formation of new chemical compounds which may be in the solid, the liquid or the gaseous state.

Results of the studies

Determination of the mineral form of the precipitates when the minerals are separated is particularly easy to work out; however, in the case when they occur superimposed on one another, their determination is much more difficult. But a study of some inclusions having such precipitates may help in the elucidation of these mixtures. In addition, a determination of the mineral form of the precipitates is useful in its application to earlier studies on mineral paragenesis of mineral-host rock and the composition of their trace mineral impurities.

In view of this, the mineral form of precipitates in vacuoles may be analyzed with a high degree of confidence. For example, the studies performed have shown that in the inclusions in cassiterite from the deposits of the Sherlov mountains there is a wide distribution of chlorides of K, Na, Fe, Ca, and Al. The presence of sylvite (KCl) in the inclusions was confirmed by the work of R. V. Boyarskoy using the electron microscope by a micro-diffraction method. Sulphur and zinc were also often seen in these same inclusions. Thus, it may be proposed that the formation of ZnS in the inclusions of sample 225 occurred according to the reaction $ZnCl_2+K_2S \rightarrow ZnS+2KCl$. At the same time, however, the zinc is also partially associated with aluminum. Apparently, in this case, the precipitate corresponds to the composition of the gahnite $ZnAl_2O_4$ (Figure 2) which may be observed in the ores from the Sherlov mountains also (Dolomanva, 1963). At the same time, sulphur also often shows an association with sodium. In this case, the problem is clearly whether the composition of the precipitate corresponds to Na_2SO_4 or Na_2S. The solution is difficult and only an indirect method consisting of a knowledge of the physical-chemical conditions for the formation of the minerals observed in the vacuoles may be used. Often ilmenite ($FeTiO_3$) is observed in the composition of the precipitate, the presence of which in the form of a trace mineral impurity was observed earlier in cassiterite (Dolomanova and others, 1966a). In separate vacuoles, there were observed minerals containing K, Al and Si or Ca, Al and Si, apparently having a structure similar to feldspar and mica. Other precipitates, most commonly, represented a mixture of mineral compounds containing the above-mentioned elements plus small traces of Mn and Mg.

It should be emphasized that, in the precipitates of the inclusions in cassiterite from the deposits of the Sherlov mountains, Ta and Nb were not observed. The chemical analysis of this cassiterite showed an insignificant concentration of these elements: Nb_2O_5=0.02 to 0.10%; Ta_2O_5=0.006 to 0.02% (Dolomanova and others, 1969b).

In contradistinction to the inclusions described above, sulphur was not observed in inclusions of the higher temperature cassiterites from pegmatites and cassiterite-quartz deposits of GDR and Central Africa. The precipitates contained Fe, Nb, Ti and also noticeable traces of Ta and often W and Mn (Figure 3). Their composition, actually, corresponded to that of columbite or tapiolite (Fe, Mn) $(Nb, Ta, Ti)_2O_6$. As is known, columbite and wolframite have analagous structures (Minerals, 1967) and may form intimately intermixed growths. Such regular growth of both minerals was observed in the form of inclusions in cassiterite from the Etykinsky deposit (Dolomanova and others, 1966a). In this mineral iron strongly predominates over Mn, and Nb over Ta. In some similar precipitates Ti was not observed.

In the composition of the precipitates in the inclusions in cassiterites, the chlorides of Na, Ca, Fe and Al were also widely distributed. Compounds of the type potassium or calcium feldspars and ilmenite were frequent components in solid precipitates. In addition to precipitates of the above-enumerated, individual compounds, some were observed having a mixed elemental composition. In inclusions there were also observed precipitates containing aluminum, titanium or titanium plus calcium which, apparently, have the structure of corundum, rutile and sphene (oxygen was not determined as it was in the SnO_2). Other elements were absent in these precipitates. The enumerated minerals were encountered in the form of micro-inclusions in cassiterite from different deposits (Dolomanova and others, 1969b). For example, rutile occurs in many cassiterites which are found in veins which crystallized in sandy schistose rocks containing traces of Ti (the Privalovsky deposit).

The initial phases of the study on the chemical composition of the solid phases in the inclusions in cassiterites from deposits of different formations demonstrated both similarities and differences in the composition of the precipitates. One similarity was that in all cases the solid phases contained a predominance of lithophilic elements - Si, Al, Ca, K, Na, occasionally Mg, Mn, Cr, and of the siderophilic, usually Fe. The chlorides of the lithophilic elements are widely distributed and those of the siderophilic elements are more restricted. Fluorides, however, were not observed. One difference was that in the inclusions of cassiterite from pegmatitic deposits and cassiterite-quartz formations, in particular, tantalum-niobate and tungstates were observed. However, inclusions in cassiterite-quartz-sulfide formations most often contained sulphates or sulphides of the lithophilic elements and sulfides of the chalcophilic.

In addition, evidence is presented for the similarity of the chemical composition of the solid phases in inclusions with the composition of the micro-mineral impurities in cassiterites and with the compositions of the minerals crystallizing together with the cassiterite. The chemical composition of the precipitates in the inclusions reflects the specific (composition) of the hydrothermal solutions from which the cassiterite in the deposits of different formations was formed. This specificity was even more obvious if electron microprobe analysis was used to determine the elements lighter than boron and if the samples were coated not only with carbon but also with metals. For the reasons stated, it is impossible to predict the characteristics of the solutions from the composition of the solid phases in a single inclusions, but only from a group of them, whose composition is close to that of the solid phases.

In inclusions in tourmalines, the composition of the precipitates are the same as for those in the cassiterites - $CaCl_2$,KCl, NaCl, $CaTiO_3$, $CaTiSiO_5$, $(Fe,Mn)TiO_3$, Na_2S (or Na_2SO_4), K_2S (or K_2SO_4), and Al_2O_3. Most often the alkaline earth metals occur with the sulphide compounds, not with the sulphates, especially when H_2S is observed in the gas phase. Tourmaline crystallizes together with sulphides later than the principal development of cassiterite. However, in these inclusions specific precipitates are present, reflecting the shifts in the composition of the hydrothermal fluids. Among these are Ag_2S, CdS, Bi_2S_3, PbS, the phosphates of Na, K and Mg, and SnO_2 (Figure 4). Minerals of these or similar compositions are observed in the veins in the above-mentioned deposits (Grigor'yev, 1957). For example, in the Zun-Undur deposit bismuthite, galena, argentite, apatite, cassiterite, greenockite (cadmium sulphide) and alabandite have been observed. The latter two minerals were present as impurities in sphalerite (Dolomanova and others, 1971a). It should be noted that in the deposits of the Sherlovaya mountains the tourmaline (sample 795) and the cassiterite (sample 22) were crystallized together with sulphides, some primary and some secondary. In the inclusions of both minerals, sulphates (or sulphides) and chlorides of the alkalii and alkaline earth metals are widely distributed. This, however, is not typical for precipitates in fluid inclusions from the higher temperature minerals.

The chemical composition of the solid phases in inclusions of quartz were studied earlier (Dolomanova and others, 1966b, 1968; Troneva and others, 1971). However, the studied quartz showed a wider variation. It should also be remembered that up until now they have not been completely studied. In inclusions from quartz (sample 2014) from veins occurring in the granite massif of the Sherlovaya mountains, the elements Zn, Fe, Cr, Al, Ti, N (sic), Ni, P, Mn, S have been observed in powdered precipitates. Judging from the area of their distribution, the presence of the following compounds may be proposed: ilmenite with mixtures of Cr, chromohercynite - $Fe(Al,Cr)_2O_4$ (?) and compounds with the approximate formula $Al(NO_3)_3$ (?). Apparently, phosphates, nitrates and sulphates (or sulphides) are present but the actual composition is vague. Halite and rutile are present in the form of micro-minerals.

In the inclusions in quartz (sample 3241) from the Adun-Cholona "Core" pegmatitic vein, the following elements were observed in powdered precipitates: Ca, Al, Ti, Cu, Zn, Fe, Ni, Co, Cr, P, S, N. There is a very clear, spatial separation of precipitate containing Zn, Cr, P, S, Al (Figure 5) and micro-minerals containing Cr and S (chromium sulphate or sulphide) (Figure 6). It is quite true that in inclusions silicates and alumino-silicates may be present, but the determination of Si in the form of a solid phase in inclusions in quartz thus far has not been possible. Also until now, it has been impossible to determine the salts of carbonic acid which undoubtedly are present. This may be hindered by the spraying of the samples with carbon.

The following conclusions may be presented:

(1) The chemical composition of the solid phases in (liquid) inclusions in minerals agree closely with the composition of mineral paragenesis of the different stages of mineralization and the micro-inclusions of minerals in the studied or in analogous minerals.

(2) It may be asserted with confidence that the chemical composition of the solution occurring in the inclusions reflects the composition of the hydrothermal solutions from which the minerals crystallized.

(3) In addition, the presence was established of minerals which had not been observed during the study of the mineral composition of the ores due either to their high solubility (the chlorides and nitrates of different metals) or to their occurrence either very rarely or in very small amounts (phosphates, the simple and complex oxides and others).

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Figure captions

(The 44 photographs are not suitable for reproduction here, but as translations of the captions might be useful, they are given here.)

Figure 1: Distribution of iron in the inclusions

a - absorbed electron photograph; b - photograph in $Fe_{K\alpha}$ radiation; c - the same but with the sample rotated 180° (Ed. note: from the original photographs it looks as though all three photos now have the same orientation, i.e., photo c was rotated 180° again after photography.)

Figure 2: Chemical composition of precipitates in inclusions of

cassiterite (Sample 225) from the tin ore deposits in the Sherlov Mountains (the Zabaikal'e - area) from electron microprobe data; sample size is 60 x 60 microns

a - image of the inclusion generated by absorbed electrons e^+ (the light areas contain a greater amount of the light elements, the dark contain heavier elements; the remaining pictures were taken using the following radiation: b - K_{K_α}, c - Cl_{K_α}, d - S_{K_α}, e - Na_{K_α}, f - Zn_{K_α}, g - Si_{K_α}, h - Al_{K_α}, i - Ca_{K_α}; elements not detected were as follows: Ti, Mg, Fe, Mn, Cr, V, Co, Ni, Cu, Ga, Ge, As, Pb, Bi, Se, Te, Sb, Ag, Nb, Sc, Ta, W, F, N

Figure 3: The chemical composition of precipitates in inclusions in cassiterite (sample 83) from the tin ore deposit of Erenfridersdorf (GDR) from electron microprobe analysis; the sample measures 40 x 40 microns.

a - image of the vacuole from absorbed electrons (the light areas contain the lighter elements, the dark areas the heavier elements) the remaining images were made in the following radiation: b - Nb_{L_α}, c - Fe_{K_α}, d - Ta_{L_α}, e - Al_{K_α}; the following elements were not observed: Na, K, Ca, Cl, F, S, Mg, Mn, W, In, Cr, Cu, P, Ge.

Figure 4: The chemical composition of precipitates in inclusions of tourmaline (sample 398) from the tin-tungsten deposits of Zun-Undur (Zabaykal'ye, near Baykal) according to electron microprobe analysis; sample measures 30 x 30 microns.

a - image of the vacuoles from absorbed electrons (the light sections contain the lighter elements, the dark sections the heavier elements); the images are made using the following radiations: b - Si_{K_α}, c - Al_{K_α}, d - Ca_{K_α}, e - Cd_{L_α}, f - S_{K_α}, g - Ag_{K_α}, h - Cl_{K_α}, i - Sn_{L_α}, j - Ti_{K_α}, k - Fe_{K_α}, l - Pb_{L_α}, m - Bi_{L_α}, n - Cr_{K_α}, o - $K_{K_{\beta 1}}$, p - Na_{K_α}, q - P_{K_α}; the following elements and mineral micro-inclusions in tourmaline were not observed: As, Se, Te, Cu, Sb, F, In, Hg, W, Zn, Ni, Co, N, Pt, potassium feldspar and fluorite.

Figure 5: The chemical composition of precipitates in inclusions in quartz (sample 3241) from a pegmatitic deposit in Adun-Cholon (Near Baykal) from electron microprobe analysis; sample measures 60 x 60 microns

a - image of the vacuole from absorbed electrons; pictures were made using the following radiation: b - P_{K_α}, c - Cr_{K_α}, d - S_{K_α}, e - Zn_{K_α}, f - Al_{K_α}; the following elements were not observed: F, Cl, N, Sb, Ca, Te, Sc, Ti, Cu, Mn, Co, Sn, In, Cd, Ag, Mo, Ni, Ge, K.

Figure 6: The chemical composition of precipitates in quartz vacuoles (sample 3241) according to electron microprobe analysis; sample measures 30 x 30 microns

a - image of the inclusion from absorbed electrons; the remaining figures taken using the following radiation: b - Cr_{K_α}, c - S_{K_α}, d - Al_{K_α}.

DOLOMANOVA, E.I. and VLASOVA, E.V., 1974, Distribution of carbon dioxide in quartz of tin-ore deposits of Transbaikal (from data of infra-red spectroscopy): Zapiski Vses. Mineralog. Obshch., v. 103, no. 6. p. 711-714 (in Russian; translation through the courtesy of M. Fleischer).

Even recently the role of CO_2 during the crystallization of magmas and hydrothermal solutions has not been clear. During study of the genesis of tin ores, we turned our attention to the irregular distribution of carbonate in the mineral parageneses of tin ore deposits of different formations, and to the different contents of CO_2 in gas-liquid inclusions of individual minerals. Detailed study was made of vein quartz, and for comparison, of quartz from deposits of other genetic types.

We studied 61 samples of quartz of various genesis: quartz from pegmatite deposits of Adun-Cholon, Etyka, and Ononsk; vein quartz from tin ore deposits of cassiterite-feldspar-quartz formations - Imalka and Etyka deposits; cassiterite-quartz formations - Ononsk, Zun-Undursk, Aldakachansk, Molodezhny, Dedovogorsk, Badzhiraevsk, Privalovsk, Shumilovsk, Budyumkansk, and Ushmunsk deposits; cassiterite-quartz-sulfide formations - Sherlovogorsk, Tarbaldzheisk, and Sokhondo deposits; cassiterite-sulfide formation - South Kharatuish deposit; quartz from a geode in carbonate rocks of Podmoskov'ya; and synthetic quartz. The content of CO_2 in the quartz was determined by two methods: infra-red spectroscopy, and by gas analysis (Dolomanova and others, 1972a). CO_2 was found in most of the samples studied in vacuoles, containing solution. Thereby there arose the assumption that it might occur in defect - channels of quartz (Tsinzerling, 1964; Mineraly, 1965), occupying completely definite positions (size of molecules of CO_2 equals 3.32A.; Kratkii...., 1963); diameter of structural channels ∿2A; and of defect-channels 0.02-25 microns. To test this assumption we obtained infra-red absorption spectra of polished plates of quartz of various thicknesses (0.1-3 mm.) in the region 2200-2400 cm^{-1} on the UR-10 apparatus with an LiF prism. In this interval of wave length there also appear the characteristic vibrations of the Si-O framework (intense bands at 2270 and 2410 cm^{-1}), but they do not cross the CO_2 bands. The linear molecule CO_2 in the gaseous state has frequency of valence oscillation 2349 cm^{-1} (in the solid state at -190°, 2344 cm^{-1}, in aqueous solution, 2342 cm^{-1}). In quartz, the band of CO_2 is notably displaced: 2365 cm^{-1}. Analogous absorption is observed at 2365-2375 cm^{-1} in the infra-red spectra of glasses corresponding to alumosilicate melts under pressure of a mixture of water and CO_2 (G.P. Orlova, I.G.E.M., Acad.Sci.USSR). In distinction from quartz, the glasses do not have in the region 2200-3000 cm^{-1} absorption bands characterizing the fundamental vibrations of the SiO_2 lattice, and therefore the CO_2 bands in the spectra of the glasses are not overlapped and appear clearly. Comparing the position of the CO_2 band, one can assume that in quartz CO_2 occurs in a somewhat deformed state (the displacement in the high-frequency region indicates an increase of the force constants C-O). Measurement of the absolute intensities of the absorption bands of CO_2 is impossible because of the different thickness of the quartz plates. Attempts to unitize these thicknesses were unsuccessful, because it was difficult to attain micron accuracy in cutting and polishing the plates. Therefore we retained the usual method of measuring the relative intensities of the absorption bands. Of the different variants of this method (measurement of maximum and minimum transmission, the method of base lines, etc.), we selected the relation of the maximum absorption band of CO_2, 2363 cm^{-1}, to the total background of absorption in the region 2600-2800 cm^{-1}, as the most stable in the given series of spectra.

The results obtained permit one to judge the change of the content of CO_2in the studied samples of quartz according to the magnitude $I_o = I_{2365\ cm^{-1}}/I_{2600\ cm^{-1}}$. The maximum magnitude of I_o corresponds to the maximum content of CO_2 in the defect-channels of quartz.

In the pegmatite deposits of Adun-Cholon in the compact quartz of the coarse blocky zone, in large crystals consisting internally of the β-modification, having undergone inversion, and outwardly of the α-modification, in crystals of hydrothermal quartz from veins cutting the pegmatite body, in smoky quartz and colorless quartz (first generation), and also in doubly terminated crystals (second generation) of brownish-gray quartz, molecular CO_2 has practically not been found (Io = 1.00). Exceptions are only bluish-gray (sample 3241) and colorless (sample 3155) quartzes from the axial part of the pegmatitic vein, and colorless small crystals of hydrothermal quartz of the third generation (sample 3132) in which, respectively, Io = 1.15, 1.16, and 1.11. The method of infra-red spectroscopy has also not found CO_2 in quartz from the pegmatitic deposits in Volyn and Kent that have undergone inversion (β-modification), although it is noted in vacuoles of quartz (Kovalishin, 1968).

At the Imalkinsk deposit in vein quartz with "honeycomb" structure, CO_2 is present (I_o = 1.11, sample 3284), but it has not been found in comb-like, non-ore-bearing, low-temperature quartz.

At the Etykinsk deposit, the highest content of CO_2 was in quartz from pegmatoid lenses (I_o = 1.19, sample 3312); it is somewhat lower (I_o = 1.13, sample 3286) in quartz of a series of samples of pegmatitic bodies and from coarse blocky zone (I_o = 1.12, sample 3283). In vein compact hydrothermal quartz of the first stage of mineralization from the same deposit, there is less CO_2 (I_o = 1.10, sample 3320) than in quartz from pegmatitic bodies, but more than in quartz from the second stage of mineralization (I_o = 1.05, sample 3310).

In the Ononsk deposit, the same tendency is observed for lower content of CO_2 in quartz of hydrothermal genesis (I_o = 1.04, sample 46) than in pegmatitic (I_o = 1.07, sample 32). In quartz formed at the contact of the pegmatitic bein with phyllite CO_2 was not found.

In the Zun-Undur deposit, the content of CO_2 in quartz of the first stage of mineralization (I_o = 1.11, sample 396) is higher than in quartz of the third stage (I_o = 1.04, sample 415). In zoned columnar crystals from the axial part of the vein, CO_2 was not found (I_o = 1.00). In gas-liquid inclusions in the same quartz, the amount of CO_2 diminished from high - to low-temperature quartz.

A different picture was noted in the Addakachan deposit. Here compact quartz of the first stage of mineralization (I_o = 1.09, sample 3358) and crystals of quartz from the axial part and selvage veins contain less CO_2 (I_o = 1.09-1.05, samples 3365-3364) than quartz of the second stage (I_o = 1.23, sample 3361). Apparently this phenomenon is explained by the increasing content of CO_2 in the later portions of the hydrothermal fluid. This is confirmed by the crystallization of calcite, cementing fragments of sulfides and quartz of both stages of mineralization.

At the Ushmunsk deposit the content of CO_2 was studied in quartz of the first stage of mineralization of the same veins, in contact with country rock of different composition. It was shown that in the channels of quartz from parts of the vein in apophyses of the mother granite, the amount of CO_2 was the highest (I_o = 1.37-1.20, sample 55). In channels of the same quartz at the contact with greisen (Io = 1.08-1.10, sample 174), with sandy-shale (I_o = 1.09-1.05, sample 264), and with carlvnate rocks (I_o = 1.11-1.06, sample 1021), there is less CO_2. Even less (I_o = 1.01) is in the channels of comb-like quartz (sample 65) from non-ore-bearing veins cutting tin-tungsten veins.

There is a somewhat different distribution of CO_2 in the gas-liquid inclusions in the same samples of quartz. According to gas analyses (Dolomonova et al., 1972a), CO_2 is highest (89.8%) in vacuoles of vein quartz, in contact with essentially quartz greisens and with carbonaceous-clay limestones (89.8%). There is less CO_2 in vacuoles of the same quartz, collected at the contact with mudstones (50.7%), schists (49.8%), and dolomites (50.4%). Even lower contents of CO_2 are in comb-like non-ore-bearing quartz (41.0%) and in vein quartz at the contact with apophyses of granite (21.1%).

In the Budyumkansk deposit, most CO_2 is in quartz of the first stage of mineralization at the contact with feldspathized dolomite (I_0 = 1.38, sample 104) and mylonite (I_0 = 1.32, sample 2145), and notably less in the quartz at the contact with granite (I_0 = 1.17, sample 263). In the quartz, formed in dolomites (sample 36), CO_2 was not found in the channel samples.

In the gas-liquid inclusions of the same quartz, according to gas analyses, the highest content of CO_2 is in the vacuoles of vein quartz in dolomite (more than 90%). Considerably less CO_2 is in quartz veins in contact with granite (81.8%), feldspathized dolomite (75%), and mylonite (50.5%), i.e. the distribution of CO_2 differs from that in the quartz of the Ushmunsk deposit.

At the Molodezhnyii deposit, compact gray vein quartz contains somewhat less CO_2 in channels (I_0 = 1.21, sample 191) than in the high-temperature dark gray quartz from the part of the vein with pegmatitic structure (I_0 = 1.25, sample 76).

At the Shumilovsk (sample 17) and Privalovsk (sample 102) deposits the vein quartz contains less CO_2 (I_0 = 1.09) then the analogous quartz of the Badzhiraevsk (I_0 = 1.17, sample 124) and Dedovogorsk deposits (I_0 = 1.03, sample 180). CO_2 was not found in channels of the vein quartz of the Angatuisk deposits and in comb-like non-ore-bearing quartz from a vein cutting tin-bearing material in the Dedovogorsk deposit.

In the Sherlovogor deposit CO_2 was found in small amount only in channels of gray compact vein quartz of the first stage of mineralization (I_0 = 1.15, sample 2004). In vein morion, in crystals from its cavities, it is absent, but in gas-liquid inclusions of the same quartz, it is present. In gray quartz of the second stage its content is less (I_0 = 1.07, sample 6) than in the quartz of the first.

In vein quartz of the Konsomolsk and Bereinsk deposits and in transparent, colorless vein quartz from the Sokhondo deposit, CO_2 was not found, and in analogous quartz of the Tarbal'dzhei deposit, it is noted (I_0 = 1.12, sample 302).

In light-gray quartz of the first stage of mineralization, in amethyst of the fourth stage from stockworks in granite of the Khapcheranga deposit, and in quartz of early stages of mineralization from tin-bearing veins in hornfels in the same deposit, CO_2 was not found, although in hydrothermal solutions it will be associated with the studied quartz and sulfides, because it is present in the gas-liquid inclusions (10.1-25.3%) and in mineral veins as carbonate.

A small amount of molecular CO_2 (I_0 = 1.06, sample 3584) is contained in channels of comb-like and platy quartz of the South Kharatuisk deposit.

For comparative purposes crystals of quartz were studied from geodes in carbonate rocks of the Podmuskov'ya (Ozer, Podol', Rusavkino, Verey), rock crystal from Verkhoyan, formed under conditions sharply differing from those of the crystallization of quartz of tin-bearing deposits. In both types of quartz CO_2 was not found in the channels.

In synthetic quartz, grown in the presence of gaseous CO_2, kindly made available to us by V.S. Balitskii, the content of CO_2 is low (I_0 = 1.03, sample 1-C) and even lower (I_0 = 1.01, sample 2-C) in quartz grown in Na_2CO_3 - solution at the same temperature and pressure.

The data obtained permit one to draw the following conclusions:

1. The data of infra-red spectroscopy on the relative contents of molecular CO_2 in channels of quartz do not agree with data of gas analyses characterizing the content of liquid and gaseous CO_2 in vacuoles of quartz (Dolomanova et al., 1972a). The reason for this divergence is probably that in the infra-red spectrum there appear only the vibrations of the CO_2 molecules, entering by some means or other into the structure of quartz, i.e. in its channels. The CO_2 in the gas-liquid inclusions is contained in the gaseous and liquid phases in the associated state, and its absorption bands (one could expect them in a longer wave length region, in analogy to associated molecules of water) are overlapped by very intense bands of the characteristic vibrations of quartz.

2. The entry of molecules of CO_2 into channels of quartz depends not on the amount of CO_2 in the hydrothermal solution but on the temperature and pressure at which the quartz crystallized, and the form of entry of CO_2 into the solution. The lithological composition of the rock, amidst which the quartz crystallized, does not in this case have an essential influence, although on the whole it affects notably the composition of the hydrothermal solution (Dolomanova et al., 1971).

3. In typical, relatively high-temperature tin-ore hydrothermal deposits (Etykinsk, Imalkinsk, Zun-Undursk, Ushmunsk), there is noted a tendency for decrease of the amount of molecular CO_2 in channels of quartz from the first stage (or generation) of mineralization to the last. An exception is only that deposit (Aldakachinsk) in which in the last stage of the hydrothermal process there is observed introduction of CO_2 by the hydrothermal solution.

4. It appeared also that saturation by molecular CO_2 of the same sample of compact vein quartz, consisting of individual small grains, is larger in the direction of elongation of the grain, which agrees with the structure of quartz and the arrangement of channels in it.

5. It must be noted that heating the plates of quartz to 400-450° led gradually to the complete loss of CO_2 by the quartz. This can be explained by the fact that CO_2 enters not into structural channels, but into defect channels.

Previously (Dolomanova et al., 1972b) there were found by infra-red spectroscopy in channels of quartz various mono-halide compounds of methane (CH_4X) (sic, misprint for CH_3X (?) M.F.), where $X = Cl^{-1}$, F^{-1}, OH^{-1}. Thereby one can assume that in the channels of quartz there are included gaseous mixtures of complex composition.

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MOROZOV, S.A., MOGAROVSKII, V.V., AVER'YANOV, G.S., and FAIZIEV, A.R., 1974, Thermodynamic and chemical conditions of formation of endogenic deposits in southern Tien Shan and Pamirs (Tadzhikistan): Akad. Nauk SSSR Doklady, v. 217, no. 2, p. 449-451 (in Russian; translation courtesy Dr. V.V. Mogarovskii, who has also included material from an earlier publication, not previously abstracted in COFFI: Mogarovsky, V.V., Morozov, S.A., Novosemuyev, Yu. A., Faiziev, A.R., et al., 1971, Physico-chemical conditions of formation of the most important endogenetic ore deposits of Tadzhikistan, in Current status of study of ore deposits, Tashkent, p. 77-88, that covers some of the same subject matter.) Authors at Inst. of Geology, Dushanbe, USSR. (For table of data, see p. 147-148.)

This report summarizes the results of some invests. on the form. of endogenic deps. of Tajikistan: nonmetallic mins. (rock xls, gem spinel, celestite, fluorite) and metallic ores (Sn, W, Au, Sb, Hg, and polymetals).

The invest. of T_F of the deps. was carried out by homog. and decrep. of G/L incs. in ores and assoc. mins. (1). The estim. of P of min. form. was carried out using the method of Kalyuzhnyi (2). The data on min.-form. fluids and their chem. comp. were obtained by water extractions of incs. and their dry residues; some large incs. were also analysed. Min. assoc. were also considered.

Rock-xl deps. are represented by typical hyd. forms. and are genetically connected with Alpine age granitoids. Quartz xl-bearing veins tend to conc. at anticlines crossed by major fractures. The form. of early non-xl-bearing quartz veins took place at about 500°C and P $\gtrsim$ 1,500-1,000 bar. Second stage xl-bearing vein quartz formed at 450-350°C and ∿1,000 bar. Xliz. of 3rd stage rock xl started at 400-100°C and 800-300 bar, but the highest quality xls formed at 290-220°C and 900-650 bar (3).

Min.-form. fluids contained sodium silicates, CO_2 and the ions Cl, SO_4, HCO_3, K, Mg, and Ca. The conc. of the sol. in the process dropped from 280 to 4 g/l.

Silicic acid taking part in quartz vein form. had a magmatic origin, but rock xls. in them formed from country rock silicon. Gem spinel deps. occur in ultrameta. rocks of the pre-Cambrian Vachan xline. series and are represented by spinel-forsterite skarns at the contact of a magnesite marble lens with gneises and migmatites. Skarns consist of forsterite, spinel, and clinohumite, as well as graphite, phlogopite, etc. Skarn mins. were formed from hyd. sols. as can be seen from the homog. of G/L incs. in these mins. into the liquid phase. General T range of forsterite, spinel and clinohumite form. is 700-600°C; the latest dolomite formed at 450°C. P was $\geqslant$ 1300 bar. The regional meta. (with which the dep. is connected) in this area took place at ~650°C and 6-7 Kbar (4).

Ore-form. sol. anions were mostly Cl; prevailing cations were Na, K and Mg. However, the presence of polyphase incs. with insoluble solid particles in the mins. indicates a more complicated comp. of the min.-form. fluids.

Epigenetic celestite deps. of Late Neogene - old Quarternary age occur as lenses and veins in Paleogene limestones and clays at their contact with anhydrite. Ore deps. are localized in the tops of anticlines and are limited by submeridional fracture zones. Celestite is assoc. with small quantities of quartz, calcite, and more rarely sphalerite, galenite, and greenokite. The form. of the main celestite body is connected with the first ore stage and occurred at 200-100°C and 300-800 bar (5). Min.-form. sols. were mixed Cl-SO_4 with a negligible amount of HCO_3; cations were Sr, Ca, Na, K and minor Fe, Zn, Pb, etc. The genesis of the dep. is vadose-hyd., not connected with magmatism. The sources of metals were Cretaceous and Paleogene seds. from which those elements were extrac. by infiltrating chloride waters heated to high T due to considerable depth of circulation. Alpine lead-zinc deps. of Tadzikistan have a similar origin and T_F.

Fluorite deps. of South Hissar consist of three groups, differing in min. assoc., structural position, age, component sources, types and stages of ore form. and, to a smaller degree, in physical conds. of form. (6,7). The oldest (Upper Permian) small quartz-fluorite deps. are located in thick sublatitudinal quartz veins assoc. with Upper Paleozoic granitoids. Larger sulphide-fluorite deps., formed on the Jurassic-Cretaceous border, consist of veins and lenses of fluoritized breccia zones overlapping Upper Permian quartz and Triassic-Jurassic lamprophyre dikes with which they are probably connected. A relatively high content of galenite, sphalerite and quartz is char. Orthoclase-form. in country-rocks and intensive post-ore movements were observed as well.

Late Alpine calcite-barite-fluorite deps. are separated in space from the above, and are located in granitoids of the Paleozoic basement, close to its borders with the overlying Mesozoic-Cenezoic seds. In some places ore bodies penetrate into red Lower Cretaceous seds. The char. features of these deps. are the presence of optical fluorite and barite in ores, almost total absence of quartz and sulphides, and minimal post-ore tectonics. Their origin is supposed to be vadose-hyd.

Fluorite ore form. in all these types of deps. took place at 250-50°C and 450-200 bar; for quartz-fluorite and sulphide-fluorite the higher P-T ranges are char. Min.-form. fluids were HCO_3-Cl-F (F>Cl>HCO_3); in cations, Ca prevailed over Na and K; some amounts of Pb, Zn, Ba, etc., were found as well.

Tin-ore deps. of Central Tadzikistan are observed in steeply dipping sub-latitudinal breccia zones in C_3 granitoids and hyd. altered schists and Paleozoic quartzites. Tin min. is mainly of the tourmaline-cassiterite-silicate-sulphide type. Quartz-type min. with cassiterite is minor. Ore dep. took place after intrusion of P_2-T_1 dikes with which it is probably connected. Tin min. formed at 450-300°C.

Skarn tin-tungsten deps. are located in limestone skarns at the contact of thick series of Middle Paleozoic carbonate-schists with C_3 granitoids. Schists, granitoids and, to a lesser degree, skarns underwent greizenization. Ore min. is superposed on skarns, while dep. of cassiterite-scheelite assoc. is accompanied by feldspathization, and form. of amphibole and biotite. The later chalcopyrite-sphalerite-pyrrhotite assoc. is accompanied by silicification, chloritization and epidotization. Permian Sn-W ore-form. took place at 450-300°C, and a sulphide one at 300-200°C. The source of ore body is supposed to be a crustal magma which formed the earlier granitoids.

Skarn-W deps. are controlled by fractures and are closely connected with vein limestone skarns, occurring in granitoids and monzonites of the Tchoruch granitoid complexes of P_2-T_1 age. It is interesting that the skarns do not show any connection with carbonate rocks. W ores formed from hyd., relatively highly conc. sols. at 350-200°C. Scheelite from an earlier calcite-andradite assoc. formed at 350-260°C, and a later one (from scapolite-albite-sulphide assoc) at 260-200°C. Min.-form. fluids were mainly Cl with some HCO_3 and F. Among cations Na, Ca, W, and Cu prevailed. The source of the metals was magmatic, and Ca could be brought from deep limestone horizons. According to the ratio N_2/O_2 in G/L incs., vadose waters were involved. Au-Cu-As skarn deps. are connected in space with Upper-Carboniferous granodiorites and quartz diorites. The deps. have complex ore min. due to a position in a zone of long-existing fractures. Min. is localized in listvenitization zones in skarns and dolomites and in berezitization zones in granitoids and schists. Au is connected with the products of two mineralization stages: earlier pyrite-arsenopyrite and later tetrahedrite-chalcopyrite forming at 350-250°C. On the basis of the min. of granitoids, skarns and dikes of main bodies, an Upper-Permian, Lower-Triassic min. age was established.

Au-Ag min. is found in silicified zones in Triassic limestones. Impregnation veins (gold, pyrargyrite, tetrahedrite, chalcopyrite) and accompanying quartz, barite, fluorite are superposed on siderite-ankerite and carbonate-quartz veins, and are connected with post-Paleogenic magmatic activity. Forming of sulphide Au-Ag assoc. took place at relatively low T (250-150°) and 500 bar or less. Carbonate and carbonate-quartz bodies formed much earlier at 450-400°C and 2000-1500 bar. Paragenetic connection of the min. with post-Paleogenic magmatism is supposed.

Hg-Sb deps. of Zeravshan-Hissar belt are limited by deeply penetrating regional fractures. They are represented by zones of layered mineralized jasperoid breccias, mainly at the contacts of a thick Paleozoic terrigenous and carbonate series and rarely by quartz veins. Ore bodies are both concordant and transgressive. On the basis of the major components we may separate out Sb and Hg deps. Quartz-vein deps. are of Sb. In some deps. an early sulphide min. is observed, As-Au for example, while in others the early stages are quartz-carbonate.

Hg and Sb min. in general occurred at 250-200°C to 150-50°C and 500 to 150-100 bar (8). The preceeding min. (As-Au) was at 450-300°C and 750-300 bar. On the basis of space and time similarity of Hg-Sb min. in this region to dikes of basic (often olivine) rock complexes of minor intrusions, a subcrustal origin of the ore-body and an Upper-Permian, Lower-Triassic (in some cases even younger) age of the deps. is supposed.

Recently Sb-Hg min. was discovered in the Pamirs as well (9). It is char. by a younger age (from Paleogene up to recent) and by a distinctly expressed tendency to occur in zones of old fractures. By their composition we can divide the complex zones into polymetallic (with Sb and Hg) and monometallic (Hg and Sb). Of the most interest are lenticular and nest-like bodies with high Hg content (calcite-cinnabar). In general, Sb-Hg min. took place at 200-50°C. Native Hg occurrences are char. by a somewhat narrower T interval - 150-50°C.

Upper-Paleozoic Pb-Zn deps., according to Sazonov (10) were formed in two stages. Pneumatolytic polymetallic ores of an earlier sulphide stage were formed from gas sols. at 500-350°C and are associated with tube-like skarn deps.; the earlier magmatite formed at 650-600°C. Polymetallic hydrothermal ores of a later sulphide-silicate stage formed irregular vein-like bodies. They were formed from liquid sols. at 350-80°C and at ∿100-10 bars. In min.-form. sols. Cl, S, HS, SO_4 prevailed as anions and Na, Ca, Pb, K, and Zn, etc., prevailed as cations. Although not attempting to arrange a strict classification of the investigated deps. according to their form. conds., we propose a scheme based on char. features common to all studied deps. All invest. deps. formed from liquid hydrothermal sols. Even gem-spinel deps., formed at 700-600°C, were made by such sols. As far as we can judge by water extracts. and min. assocs., ore-form. sols. had a rather uniform comp. They consisted mainly of Cl and HCO_3 and rarely of HCO_3-SO_4-Cl; they contained Na, K, Ca, and sometimes Mg, but those sols. naturally differed much in qual. and quan. comp. of ore components. T_F (except for spinel) range from 450-400 to 200-50°C and do not depend on the type, comp., age, geological and structural position, etc. The ore-body min. had two main stages: (1) 450-400°C to 300°C (T decrease is 100-150°C); (2) 300-250°C to 200-500°C (T decrease is 100-200°C) - such are the conds. for rock xl., Sn, W, Au, and some complex deps. of Sb and Hg. In some deps. min. took place during the first T stage (Sn), but in a number of others, only during the second stage (deps. of celestite, fluorite, and most Sb-Hg deps.) (see table). In the process of min. the most typical Ps were 800-100 bar. During spinel form. and form. of the quartz and carbonate-quartz veins preceding the form. of rock-xl. and Au-Ag min., P was 1000 bar.

According to the time of form. the investigated deps. are late-Hercynian, connected with the last Upper Paleozoic intrusive complexes, and Alpine, connected with the tectonic activity of the folded areas. The exception is for spinel, whose deposition was in the pre-Cambrian. Depending on the min., the granitoids and dikes of the main body, their age and geochemistry, chars. of sed. and meta. country rocks, etc., one may expect the existence of the following main sources of min. components:

(1) For celestite, spinel, and in part rock-xl and fluorite - country rocks and basement.

(2) For Sn, W, Au, Pb, Zn deps. and in part fluorite - crustal granitoid magmas.

(3) For Hg, Sb deps. and fluorite - subcrustal magmas.

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RODIONOV, S. M., and SHOPENKO, V. V., 1974, Gas-liquid inclusions in cassiterites of the Prodorozhnyii deposits (Komsomol region): Vestnik Mosk. Univ., Geol., 1974, no. 6, p. 96-100 (in Russian).

Cassiterite in the Komsomol deposits is associated with quartz, in veins and veinlets that cut pre-ore tourmaline- and quartz-tourmaline metasomatites. In the tin-bearing quartz veins, tourmaline, arsenopyrite, wolframite, and scheelite are present, besides the cassiterite.

Five plates were selected for study, with a thickness ≤ 0.03 mm. They were studied under the microscope at magnifications 400X and 700X. T_H of gas-liquid incs. was determined by means of the heating chamber constructed by A. R. Groshenko, and T_D on the B-1 apparatus constructed by V. V. Bogdanovich in the thermobarometric laboratory of the mineral resources group of the geological faculty of the Moscow Gosudarst Univ. The composition of solid deposits on the walls of opened vacuoles was determined by micro-X-ray spectrographic analysis (electron microprobe?) on the micro analyzer MS-46 (analyst A. I. Tsepin) in the X-ray spectrographic laboratory of I.G.E.M., Acad. Sci. U.S.S.R.

One can distinguish two types of incs. - primary and pseudo-secondary (1). The primary (P) incs. are usually located separately without apparent restriction to any specific plane. Their form is predominantly elongated, rarely rounded, with regular outlines; sometimes the vacuoles have the form of the including crystal. Incs. of 10-15 microns size predominate. Under normal conditions the gas phase occupies 20-40% of the total volume in the incs. Sometimes there are present in the liquid small, anisotropic crystallites of daughter minerals, which we were unable to determine. It is interesting that on heating the incs. to $>T_H$ above 450°, the crystallites are preserved without apparent change. The pseudosecondary (PS) incs. - rarely flat, having as a rule irregular, dendritic form and size 1 to 20 microns. Incs. of this type occur comparatively often, as many as 100 per sq. mm of grain, which imparts a "coralline" appearance to individual areas of the mineral. In character of filling, these are two- and three-phase gas-liquid, sometimes essentially liquid incs. The liquid phase, in the case of the gas-liquid incs., consists of one or two liquids; in the latter case, the boundaries between the two liquids and the gas phases are observed rather distinctly, especially at magnification X700. It is evident that the second liquid phase, occupying 3-10% of the volume of the cavity, consists of liquid

CO_2, examples of which have been found in analogous incs. repeatedly described in the literature (2,5,8). Besides liquid and gas bubbles, which occupy in most cases not more than 30% of the volume of the vacuole, crystalline material is present in incs. of this type.

Referral of incs. of the second type to PS is based on their limitation to small "healed" fractures. Not in a single case was there observed a trace of such a fracture to the boundary of the grain of cassiterite; they are sharply terminated within the crystal. Another fact permitting one to call such incs. PS is the identity of their composition with that of incs. that are sufficiently clearly diagnosed as P, as well as the correspondence of their T_H.

Among the PS incs., as already mentioned, some are essentially liquid. Their presence is explained, evidently, by the fact that at the beginning of the isolation of the inclusions, the form of the vacuole was irregular, dendritic. Further, during the healing of the fractures under conditions of decreased temperature, the incs. are closed off with the formation of several vacuoles. Thereby in one of them there may chance to be formed already a gas bubble, and in another only a liquid phase.

Thermometric Analysis

Observations of T_H of incs. in cassiterite were made at magnification X400. In most cases, there were recorded simultaneously the T_H of several incs., lying in the field of the grain. Homogenization occurred in the liquid phase. During the heating of the plates in the thermal chamber, the gas bubbles within the inclusions, in the interval 200-260°C gradually contracted to 30% of the original volume, and afterwards "pulsation" of the bubbles began, and at T_H (300-310°C) the bubbles disappear. On further heating the sample to 400-450°C, no additional changes were noted within the bubbles. Appearance of the gas bubbles was again recorded on cooling the sample to 10-20° below T_H. The measured temperatures for all incs. studied agreed completely and were in the range 290-320°C. Along with this, incs. with liquid CO_2 showed lower T_H (see Table) and in many cases burst below T_H.

T_H of gas-liquid incs. in cassiterites of the Pridorozhnyi deposits

Description of incs.	No. of measurements	T_H interval °C	T_H average °C
P gas-liquid two-phase	9	300-320	310
P gas-liquid with daughter minerals	4	300-320	310
PS gas-liquid of dendritic form	2	290-310	300
PS gas-liquid with liquid CO_2	5	180-200	190

It has been established that the minimum pressure for the deposits of the Komsomol region was close to 400-500 atm. (5). Considering this, and also the rather low mineralization of the ore-bearing solution (6), confirmed the conclusion of many investigators of the inapplicability of thermoacoustic analysis to judge T_F (2,7). On the one hand, the presence in the incs. of liquid CO_2 lowers T_D by 100° and more (2), on the other hand the unusually high stability of the mineral host permits considerable overheating of the sample without bursting the sample (not containing liuqid CO_2).

Micro-X-ray spectrographic analysis

Microanalysis permitted qualitative determination of the composition of the solid residue on the walls of the large vacuoles after their opening. The following elements were determined: Fe, S, Si, K, Mg, Na, Al, Cl, Ca, Ti, Zn. Among these, the principal ones were Fe, Si, and Na and the minor ones S, Zn, K, and Cl. Often there is a close interdependence of the distribution of some elements in the incs. Thus, the representation in the characteristic radiation of Si and Al are practically identical. Sometimes, with such a doubled maximum, there falls together an area of high intensity of other elements. The following "complex" maxima were recognized: 1 - Fe, Si, Al; 2 - Ca, Si, Fe; 3-4 - K, Al, Si, Fe; 5 - Ca, Mg, Si, Al, 6 - Na, S(Cl).

The presence of a close bond between the elements mentioned can be explained by their presence in the composition of one or several minerals. Starting from the composition of the solid residue, one can assume that in it there are alumosilicates of Fe, K, Ca, Mg, silicates of Fe and Ca, chlorides and sulfates (or sulfides) of Na.

Study of incs. of mineral-forming media in cassiterites permit one to draw the following conclusions:

(1) Among the incs. in all the samples studied, two-phase gas-liquid incs. predominate; sometimes individual crystals contain daughter minerals. A small number of incs. contain liquid CO_2. T_H of these crystals is lower than T_H of essentially aqueous incs.

(2) The overwhelming majority of incs. are P or PS and are useful for measurement of T_H. T_F of the cassiterites studied, measured by the method of T_H, with attention to the correction for pressure, is in the range 320-350°C. These data agree completely with thermometric data given by other authors for syngenetic cassiterite (and?) quartz (4,5).

(3) Decrepitograms of cassiterite often show anomalous peaks in the low-temperature range (150-250°C), explained by the bursting of PS incs. with CO_2, and in the high-temperature range (above 400°C), apparently due to considerable superheating of small incs. because of high stability of the mineral host. Consequently, accurate results can be obtained only by the simultaneous use of the methods of homogenization and decrepitation analysis.

(4) The presence in the incs. of minerals which do not undergo any notable change on heating even up to temperatures exceeding T_H permit one to call them mineral-precursors, trapped by the crystal along with a portion of the ore-bearing solution.

(5) Crystalline material, besides the mineral precursors, consists in the inc. of solid residues on the walls of the vacuoles. Starting from the elementary composition of the residues, determined by micro-X-ray spectrographic analysis, one can assume that in them minerals are present of the group of silicates, alumosilicates, and also sulfides (or sulfates).

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VOZNYAK, D.K., 1971, [Primary inclusions in Volynian topaz], p. 73-81 in Kalyuzhnyi, V. A. (Ed.), 1971, Mineral-forming fluids and paragenesis of minerals of pegmatites of the "zanorish" type in the Ukraine: Kiev, Naukova Dymka Press, 216 pp. (in Ukrainian). Ed. Note: This volume was abstracted extensively in Fluid Inclusion Research - Proc. of COFFI, v. 4, 1971, p. 129-132. Widely quoted early work by Lemmlein, Kliya and Ostrovskii (1962) detailed studies of the homogenization of inclusions in topaz from these pegmatites that entailed the melting of large amounts of silicate daughter crystals to yield a hydrous silicate melt at ∿700°C. In 1968, at the 3rd All-Union Conference, D. K. Voznyak reported verbally on some work that indicated that such inclusions contained not daughter minerals, but accidental solid inclusions, making a gross difference in the estimated composition of the fluids forming these pegmatite minerals. This important work has since been published, I have learned, only as pages 73-81 in this book, edited by Kalyuzhnyi, although individual authorship is not clearly indicated. Dr. T. M. Sushchevskaya has kindly translated it for COFFI.

P incs. in topaz - These may be G-L, with different solid phases, and L-G, without solid phases. Complex incs. containing CO_2 also occur.

Distribution of P incs. in the crystal - P incs. occur very rarely. Their investigation can provide precise information about the parameters of the mineral-forming environment and the changes of these parameters during the process. Grigoriev (1948) wrote: "In the study of liquid incs. in minerals the question of their P or S genesis must be considered most accurately. The conclusions must be well grounded. All indications used must be described in the most careful way, so that the reader can judge about the validity of the decision."

(1) Usually P incs. in this topaz are located in one of the former prism {110} faces. Often they are found near the edge, formed by the faces (110) and $(1\bar{1}0)$. These two faces usually grew at different rates: in one of the crystals growth rate of the (110) face was 2.2 times as great at that of $(1\bar{1}0)$ (fig. 26). Growth of the (110) face at a greater rate facilitates formation of many P incs., while a slow growth rate of $(1\bar{1}0)$ face does not lead to formation of incs. Pyramids of growth of (110) and $(1\bar{1}0)$ faces are easily seen for they are outlined by a light band due to a small difference in the index of refraction of adjacent regions of the topaz crystals. The angle between these two faces is 124°. Such distributions of incs. testified to a horizontal (along [001] direction) orientation of the crystal during its growth.

(2) Formation of P incs. of solution is sometimes connected with the enclosing of syngenetic solid incs. of protolithionite (fig. 24) or fluorite, trapped in growth pyramids of the prism {100}.

(3) P incs. of CO_2, stuck to well-formed phenakite crystals, were found (fig. 28). Such crystals may form a layer (30-40 little crystals

per cm^2) at about 1 mm from the surface of the (110) face. Primary incs. of such origin can be found easier if the plate is cut not along the cleavage planes, but parallel to the (110) face. Complex CO_2 incs. were stuck to 20 out of 500 phenakite crystals.

(4) In addition, P liquid incs. can be found in the growth pyramids of the two faces of the {110} prism - (011) and $(0\bar{1}1)$ (fig. 23). Such occurrence of the incs. testifies to an approximate vertical position of the crystal during its growth. It is very doubtful that P tube-like incs. can be associated with cleavage planes (Ivantishin, 1957). Evidently, most of the liquid incs. located along cleavage planes are S.

Form of the incs. - Usually P incs. have the form of negative crystals (fig. 30) or are tube-like, and sometimes their form is irregular. The latter form can be seen easier when studying plates can cut along former (110) planes, normally to the cleavage direction. When viewed in the other direction, these incs. can appear to have negative crystal or tube-like forms. The forms of P incs. formed on enclosure of a solid are irregular (fig. 28).

Filling of the incs. - (1) Most of the incs. (>95%) contain various solid phases $\leqslant$ 90% by vol. of the inc. cavity (table 12, type I). Average and most frequently found volume of solid phases is 70-75% (fig. 30). Sometimes this fraction is $\leq$40%. L/G P incs. (L = 40%) without solid phase are found still more rarely (table 12, type 2, and fig. 31). Inc. dimensions are 0.01-0.5 up to 1 mm. We think that sedimentation of solid particles on the growing faces of the crystals facilitated formation of these peculiarily filled primary incs.

It is quite possible that the P incs. we studied (located on {110}) are analogous to those described by Lemmlein, Kliya, and Ostrovskii (1962). Among P inc. data, obtained by several authors (but without necessary proofs), we could not find the two-phase type (without solid phases).

(2) The filling of complex incs. of CO_2 (see table 12, type 5), attached to enclosed phenakite crystals, is - $L_1:L_2:G = (5\text{-}7):(5\text{-}7):(86\text{-}90)$ at <18°C, where L_1 = water solution, L_2 = liquid CO_2, and G = gas phase. The composition of these incs. gives data on the mineral-forming solutions which took part in the formation of the latest (1-2 mm) zone of the topaz crystals. These incs. are analogous to P tube-like ones, typical for the base part of late quartz crystals (i.e., "D" type regeneration quartz.)

The characteristics of mineral-forming solutions - The solid phases of P liquid incs. are: quartz, albite, protolithionite (Li-biotite), cryolite, fluorite, and sometimes columbite. These minerals are also present in topaz, as solid phases, often in zones of P liquid incs. filled by solid phases. The relations among solid phases varies as noted before, the L/G incs. (L = 40%) without solid phases (see fig. 31) are found in zones with L incs. with solid phases. These facts show that all the solid phases in P liq. incs. are accidental solid inclusions (i.e., "mineralami-sputnikami").

Incs. with solid phases partly homogenize (without solution of solid phases) at 385-392° (min. T_H - 372-377°C). The incs. homogenize into the liquid phase, and their behavior during heating indicates near critical filling. It is interesting that P incs. (L = 40%), without solid phases, homogenize into the gas phase at 410-415°C, also near to critical. The homogenization into both liquid and gas phases indicate a heterogeneous state ("boiling") of the mineral-forming solution with a density near critical. On this basis, one may take T_H as the real temperature of trapping or formation (i.e., T_F). These observations don't coincide with the conclusions of Lemmlein, et al. (1962), about the crystallization of topaz, quartz, muscovite, cryolite and other minerals (solid phases of P liq. incs.) from melt incs. in Volyn pegmatites. The T_H of late P, complex incs. of CO_2 (<300°), and the similarity to the tubular incs. in regeneration quartz also do not suggest the presence of melt during formation of the peripheral part of topaz crystals.

S. liq. incs. in topaz - There are several groups of S incs. in topaz: *Liquid incs.* with many solid phases, analogous to type 1 P incs. in filling (see table 12). Their form is irregular, sometimes tubular (fig. 32). These incs. are rarely found. *Liquid-gaseous incs.* (L - 40-45%) of type 4 (fig. 33) are most frequent. T_H (into gas phase) is <390-410°C; the filling is close to critical as they often "boil" (Ermakov, 1950) on heating; the pH is acid (5.3±0.2). *Multiphase incs.* of type 5 were studied in detail by Kaluzhnyĭ (1958, 1960). These incs. homogenize usually into the liquid phase. We found refilling of primary liquid incs. of the first type by multiphase incs. of type 5. This shows that the highly concentrated solutions of the multiphase incs. formed later than the G/L incs. fluids (near critical density) of types 1, 2, 3, and 4, which possibly formed the main mass of topaz. *Complex incs. of carbon dioxide* (of tubular and irregular morphology) are analogous to the P incs. in filling. In time sequence they are the latest among the liquid incs. in topaz. S G/L incs. of type 4 have been found to be refilled with CO_2-bearing fluids. The presence of liquid CO_2 in refilled incs. indicates these sols. to be later. S incs. with liquid CO_2 are later than the highly concentrated solutions of multiphase incs.

Table 12 (p. 78-79)

Characteristics of liquid incs. in topaz crystals from "zanorish" zone of pegmatites

Type	Inclusions	Genetic type	Formula composition, %	T_H, homogenization type	P, atm.	pH	Chemical composition	Additional data
1	G/L, with solid inc. phases, negative crystals, tubular, or irregular	Primary	$\frac{S + L + G}{S = 50 - 75,}$ sometimes 90 $L \gg G$	400-370° liquid	--	5.3±0.2	--	Solid phases: quartz, fluorite, albite, protolithionite, columbite; their trapping took place under boiling of mineral-forming sols.
2	L/G, tubular or negative crystals	Primary	$\frac{G + L}{60 + 40}$	410-415° gas	--	5.2±0.2	--	Located with incs. of type 1.
3	L/G or G/L, with solid inc. phases; of irregular form	Early secondary	$\frac{S + L + G}{S = 30 - 90}$ $L \approx G$	--	--	--	--	Cross the zones of P incs. of types 1 and 2
4	L/G, tubular negative crystals, rarely irregular form	Early secondary	$\frac{G + L}{55\text{-}60+40\text{-}45}$	390°, 410 gas	--	5.3 to <6.2	--	Located, as a rule, in cleavage planes; boil on heating
5	Multiphase (solid inc. phases); irregular form	--	--	--	--	--	Much Fe^{2+}, NaCl KCl	Described in detail by Kaluzhnyĭ (1958); refilled the incs. of types 1 and 4
6	Complex incs. of CO_2; irregular form	Primary	$\frac{L_1 + L_2 + G}{5\text{-}7+5\text{-}7+90}$	<300°, gas	230-250	--	--	Located in peripheral parts of crystals
7	Complex incs. of CO_2; tubular or irregular form	Secondary	$\frac{L_1 + L_2 + G}{5 + 5 + 90}$					Refilled the incs. of types 1-5
8	Gaseous-liquid; irregular form or tubular		$\frac{L + G}{80 + 20}$					Located often with incs. of type 7

Thus, the changing mineral-forming solutions during formation of topaz crystals in the chambers ("zanorish") were the following: boiling G/L sols. (density close to critical) then heterogeneous highly concentrated sols. of multiphase incs., then heterogeneous mineral-forming solutions with much CO_2 in a gaseous phase.

VOZNYAK, D.K., and KALYUZHNYI, V.A., 1974, Decrepitated inclusions and their significance for reconstruction of P-T conditions of mineral formation (illustrated by quartz from pegmatites of Volhyn), in Typomorphism of Ukrainian Quartz, edited by Ye. K. Lazarenko, Acad. Sci. Ukr. SSR: Kiev, Naukova Dumka Pub. House, p. 18-24 (in Russian; translation courtesy A. Kozlowski). Authors at Inst. of Geochemistry and Physics of Minerals of Acad. Sci. Ukr. SSR, Kiev, and Inst. of Geology and Geochemistry of Fuels of Acad. Sci. Ukr. SSR, L'vov.

Studies of incs. of min.-forming environments permit dets. of conditions and time of formation of mins. bearing them, i.e., to evaluate mins. of various geological objects as typomorphic ones. However, although information available from incs. is significant, it is not the same in each individual case and its recognition may be difficult or ambivalent. One insufficiently investigated case is described below.

First, the idea of use of (naturally-A.K.) decrepitated incs. for evaluation of the T regime of formation of mins. was given by G. G. Lemmlein and M. O. Kliya (1954). Later such incs. were not studied in detail, and they were assumed to be unsuitable for thermometric analysis and it was recommended that they be excluded from invests. (Ermakov's opinion, A.K.). Studies of decrepitated incs. in quartz from Volhyn pegs. (Kalyuzhnyi and Voznyak, 1967; Kalyuzhnyi, 1971; Voznyak, 1971; and Mineral-forming fluids and parageneses of minerals of "zanorysh" type from Ukraine, 1971) proves that such incs. can provide valuable information about conds. of min. form.

A theor. basis for the use of decrep. incs. for reconstruction of P-T conds. does not exist. The physical sense of the origin of decrep. incs. is as follows: internal P around inc. causes tension, which causes fractures under defined conds. (Lemmlein and Kliya, 1954). Healing of the newly formed fractures by the solution from the decrep. inc. is marked by numerous incs. called daughter incs. From reference data, P needed for decrepitating an inc. depends on the size, shape, number and distribution of incs., physico-mechanical peculiarities of mineral, its dimensions, and the external P and T. Numerical relationships between all these factors have not been ascertained, although some of them have been discussed (Kliya and Lemmlein, 1951; Naumov, et al., 1966; Khetchikov, et al., 1968; Tugarinov and Naumov, 1970; Pal'mova and Dikov, 1970; Pashkov and Piloyan, 1973; and Shatagin, 1973). Probably the influence of some factors is large and that of the others very slight. Decrep. of a fluid inc. in a crystal is possible only when the difference between P of sol. of the inc. (P_{in}) and external P (P_{ex}) equals a certain positive value $\Delta P = P_{in} - P_{ex}$. This value is different for various minerals under $P_{ex} = 1$ atm (Tugarinov and Naumov, 1970).

The symbols used in description of decrep. incs. are as follows: T_o, P_o - T and internal P of sol., respectively, at the moment of homog. of non-decrep. incs.; T_1 - T_H of parent inc.; T', P'_{in} - T and P_{in} of sol. in inc. at the moment of breaking of vacuole under $P_{ex} = 1$ atm; T", P''_{in} - min. T and P_{in} in inc. at the moment of breaking under P_{ex} = P of min.-form. sol.; T'" - the highest T during existence of decrep.

inc.; d_0, d_1, d_2 - isochors of nondecrep. and decrep. inc., respectively.

Fig. 1 shows relations between T_0, T_1, T', T'' and T''' of water inc. of various F in xls under only P of mineral-forming sols. and formed during increase of T. Similar analysis permits reconstruction of P-T conds. of decrep. fluid incs. on basis of their changes.

Incs., which under $P_{ex} = 1$ atm decrep. above T_H $(T'>T_o)$.

1. Inc. decrep. before homog. in gas phase: $T'''>T''>T'>T_o>T_1$ (Fig. 1a).
2. Homog. of inc. before decrep. was in liquid phase: (a) during decrep. no phase changes of sols. in inc. (Fig. 1b): $T'<T''<T'''>T_1>T_o$; (b) at T_D sol. of inc. became heterogenous (Fig. 1c): $T_1>T'''>T''>T'>T_o$; (c) at T_D sol. in inc. became gaseous (Fig. 1d): $T'<T''<T'''>T_1$, T_o; where $T_1>T_o$, $T_1<T_o$.

Incs., which under $P_{ex} = 1$ atm decrep. before homog. $(T'<T_o)$.

Under $P_{ex} > 1$ atm, $T_D(T''', T'')$ can be higher than T_o and then above relations will be correct.

From analysis of conds. of decrep. of fluid incs. the following was derived:

1. Decrep. of fluid incs. in nature may occur for reason of either increase of T (overheating) or sudden decrease of P_{ex} of min.-forming sols.
2. T_{HS} of parent inc. (T_1) with small haloes of daughter incs. are close to T_{HS} of incs. before decrep. (T_o), depending on F, either $T_o>T_1$ or $T_o<T_1$.
3. T_{HS} of parent incs. (T_1) with large haloes of daughter incs., homog. in L phase may either be near to T''' or higher, but are higher than T_{HS} of incs. before decrep. (T_o).
4. Homog. of parent inc. in L proves that before decrep. this inc. homog. in L. However, it is necessary to verify the lack of refilling (Lemmlein, 1956; Kalyuzhnyi, 1971).
5. T_{HS} of daughter incs. may give data on true T_S of healing of fractures.

Decrep. fluid incs. in quartz of Volhyn pegs.

By studies of decrep. incs. in mins. it is possible to ascertain the relative time of their breaking, frequency of these phenomena, and sometimes the reasons of breaking, i.e., to study in detail the P-T conds. of min. form.

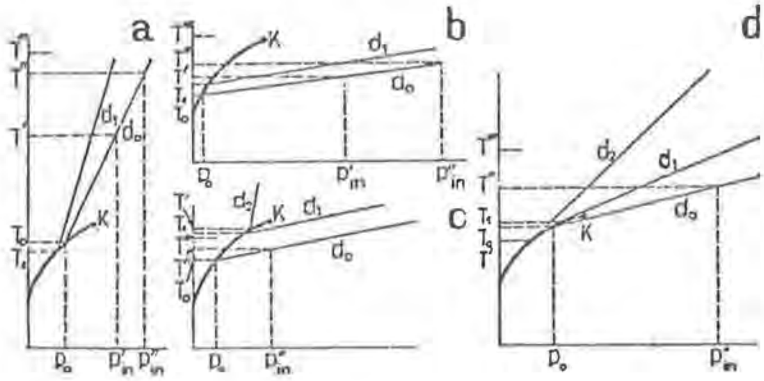
Morphology of incs. Around the incs. studied one may observe oriented and random healed fractures. The first ones usually bear submicroscopic daughter incs. and occur in planes parallel to faces of the prism $\{11\bar{2}0\}$, and the negative and positive rhombohedrons. Planes parallel to $\{11\bar{2}0\}$ are similar to trigonal figures and in the plane (0001) coincide with traces of faces of positive rhombohedron, and the axis of figure coincides with the optical axis of the min. Trigonal figure of the top of one inc. is turned 60° relative to the other. These figures are obs. around incs. with negative xl. habit (or nearly so). A second type occurs with incs. of irregular shape, formed during healing of irregular surfaces of fractures, more rarely of planes without specific orientation.

Dimensions and shape of fractures, dimensions of daughter incs., and shape of parent incs. depend on the scale of natural overheating, dimensions and distribution of incs. In addition, absolute dimensions of daughter incs. depend on their distribution in the fracture.

Det. of time and causes of processes, resulting in decrep. of incs.

In crystals from "zanorysh" (i.e., chambered) pegs. the following varieties of quartz (from early to late) were found: B-reticulate, C-laminated, D-ice-like, smoky, morion, E-late regenerated quartz. Each variety bears specific, individual solid and liquid incs. (Kalyuzhnyi and Voznyak, 1967; Kalyuzhnyi and Pritula, 1967; Mineral-forming fluids ..., 1971). The following is the sequence of origin of S fluid incs.: type 1 - L/G (L = 25-40%), occur in healed polygonal, reticulate fractures; type 2 - L/G with large amount of dms.; type 3 - L/G (L - 35-40%) occurring in parallel fractures, densely cutting laminated quartz; type 4 - L/G (L = 25-40%); type 5 - family of polyphase incs. with dms.; type 6 - P incs. composed of CO_2, with tubular shape, often found in early zone of late regeneration quartz; type 7 - P G/L incs. (L = 70-85%), occurring together with incs. of type 6; type 8 - incs. composed of CO_2; type 9 - G/L incs. (L = 70-80%); type 10 - essentially L (L = 90-95%) incs. The above sequence of origin of fluid incs. was verified by the refilling method. Distribution of fluid incs. in zoned quartz and schemes of filling are shown in Fig. 2.

Decrep. incs. were observed in all groups, excluding incs. composed of CO_2 (types 6 and 8) and incs. of type 10 (Mineral-forming fluids..., 1971). Two occurrences of natural decrep. phenomena were found. The first case - before xliz. of late quartz of regeneration, in the time of action of sols. of polyphase type 5 incs., at $Ts \geqslant 450-500°C$. Low Ts of healing of fractures of cracking around incs. of types 2 and 4 prove that after decrep. of incs. the high T in "zanorysh" decreased relatively quickly. The second case - in a period of growth of late regeneration quartz, at Ts = 300-320°C. In both cases the decrep. of incs. has been caused by an increase of T (Mineral-forming fluids..., 1971; Lazarenko, et al., 1973).



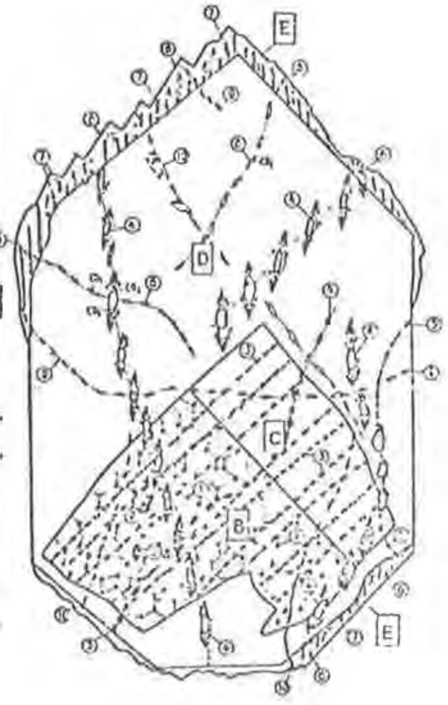


Fig. 1: Relationship between T_0, T_1, T', T" and T'" of water incs., whose decrep. was caused by increase of T.

Fig. 2: Scheme of distrib. of fluid incs. of various types (marked by ciphers) in zonal xl. of quartz (zones marked by letters).

Time of occurrence of sols. of polyphase incs. and character of their alteration prove that seemingly at $T \gtrsim 350$°C the general form. of fractures in granite took place; those fractures could reach great depths with high Ts. Opening of pegs. by contraction fractures resulted in rising high-T sols., (Kalyuzhnyi and Pritula, 1967; Kalyuzhnyi and Voznyak, 1967), seriously changing conds. of min. form. Data on mech. of forming of pegs. obtained from decrep. incs. ought to be taken into account in any theory of origin of pegs. Correct understanding of conds. of origin of pegs. permits successful prospecting for pegs. and, on basis of det. peculiarities, to predict their commercial value.

WAGNER, A., FREY, M., QUADRIO, F., SCHWARTZKOPFF, J., and STALDER, H. A., 1972, The mineral occurrences of Camperio and Campo Blenio, Canton Tessin: Jb. Naturhist. Museum Bern, 1969-1971, p. 277-360, plus 22 figures and 7 plates (in German). Ed. Note: This paper presents a very detailed and interesting study of the Tessin Alpine veins and their mineralogy. I have asked Prof. Stalder to make this extended abstract (including closely related supplementary material from another paper, Stalder, H. A., and Wagner, A., 1974, Scapolite, a fissure mineral from Camperio: Mineralfreund, v. 4 , p. 41-56), since both papers are of considerable interest to readers of COFFI, are in German, and are published in journals with small distribution.

The area is in the NE corner of canton Tessin, Switzerland, between the Gotthard massif to the north and the lower Pennine Lucomagno nappe to the south. The alpine (alpine = belonging to the alpine orogeneses) mineral fissures occur in the Upper Triassic quarten-schists and in the Lias (mostly garnet mica schists or plagioclase gneisses). Campo Blenio is in the high-grade greenschist facies, whereas Camperio is in the amphibolite facies.

More than a hundred fissures show the following mineralogy: Quartz ($\leqslant$60 cm steep rhombohedrons); chlorite (ripidolite, with variable Fe- and Mg-contents); muscovite (41 - 63 mol. % phengite); calcite (various habits); albite (rare); scapolite ($n_\omega + n_\varepsilon/2 = 1.565$), often altered to muscovite and calcite; rutile (various habits); anatase (small); brookite (rare, small); titanite; ilmenite; apatite (very rare); monazite; xenotime (very rare); ankerite (often altered to goethite and calcite); siderite (much less than ankerite, usually altered); pyrrhotite; cobaltite (as small inclusions in quartz); pyrite; marcasite; sphalerite; chalcopyrite; hematite; tourmaline (sporadically abundant); epidote (very rare); allanite (tiny crystals on chlorite); biotite; prehnite (sporadically abundant); laumontite (abundant); stilbite; and heulandite.

In the Camperio area scepter-quartz was found in 16 out of one hundred fissures. The fluid inclusions of the first and the second generation of these scepter quartz crystals are completely different: the early zone has aqueous inclusions plus two CO_2 phases, with 10-25 wt. % total CO_2. The outer zone has two-phase inclusions of aqueous solution plus liquid CO_2 (a gas bubble appears only below 10°C). Most have >50, up to ∿75 wt. % CO_2. This quartz also contains two-phase aqueous inclusions with a small gas bubble.

The CO_2-rich inclusions in the outer zone might represent a separation of supercritical CO_2 fluid from the first generation, but a new supply of CO_2 might have come in.¶ Three chapters describe specific fissures (particularly numbers 40 and 70) in terms of size, situation, mineralogy, paragenesis, mineral associations, country rock alteration (volumetric, weight, and mineralogical composition, qualitative and quantitative estimates).

These fissure minerals may not have formed in one episode. The oldest, scapolite (occurs only in the Camperio region), probably grew under the same PT conditions as the country rock minerals (lowest amphibolite facies). Frey estimated this to be 500-550°C and ∿5 kb. The latest species, stilbite and heulandite, crystallized below the stability field of laumontite, i.e., <170°C (Liou, 1971), assuming P<2 kb. Between these two extremes a succession of various mineral species formed, controlled basically by equilibrium with a changing partial CO_2 pressure. Some of the P-T-X estimates for specific mineral species are as follows:

The first Ti-mineral at Camperio is titanite, followed by anatase and rutile, and at the end, titanite formed again as the stable phase. Although titanite became unstable and altered to anatase and/or rutile, the titanium oxides do not show alteration. Schuiling and Vink (1967) concluded from the reaction: Calcite + quartz + anatase $\rightleftharpoons$ titanite + CO_2 that in most metamorphic environments titanite predominates because the CO_2 partial pressure was too low to form anatase or rutile. The older titanites at Camperio (i.e., fissure 40) formed at the beginning of mineral precipitation in the fissure. In this case titanite formation might not be caused by low CO_2 pressure, but rather by relatively high temperatures. Later, with decreasing temperature, the P-T conditions moved into the field of anatase and rutile, and then back to the titanite field with decreasing CO_2 pressure by the end of the mineral formation. However, the pure system calcite-quartz-anatase is not exactly appropriate at Camperio, as there are other elements present, particularly iron.

Schuiling and Vink indicate the free energy of the reaction anatase → rutile to be -0.2 to 0.3 kcal, so the P-T conditions for both species are very similar.

Poty (1967), on the basis of work of Hemley (1959) and Macnamara (1966), showed the formation of muscovite in alpine fissures is mainly controlled by the ratio K^+/H^+. At low pH, only muscovite is found at Camperio, and no adularia. The pH is mainly dependent on the dissociation of H_2CO_3. It seems that muscovite (and at the beginning also biotite) grew at relatively low values of K^+/H^+.

The CO_2-H_2O phase separation postulated from the scepter-quartz would have occurred at ∿260°C and 1.55 kb in one case. The other scepter-quartz samples indicate lower Ts. Additional measurements are needed.

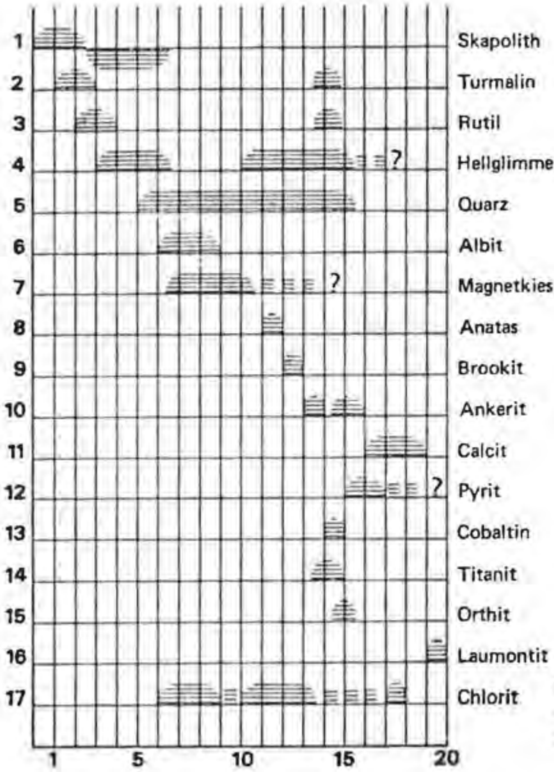
The CO_2 decrease with stage of formation is evident from analyses of fluid inclusions in a quartz crystal from fissure 70 and in massive quartz from fissure 40. This is characteristic for all Camperio fissures.

The early inclusions have a relatively high salinity (∿12 equiv. % NaCl), and this increases in later stages (e.g., in fissure 111 NaCl cubes could be observed). Following this it decreases slowly down to zero.

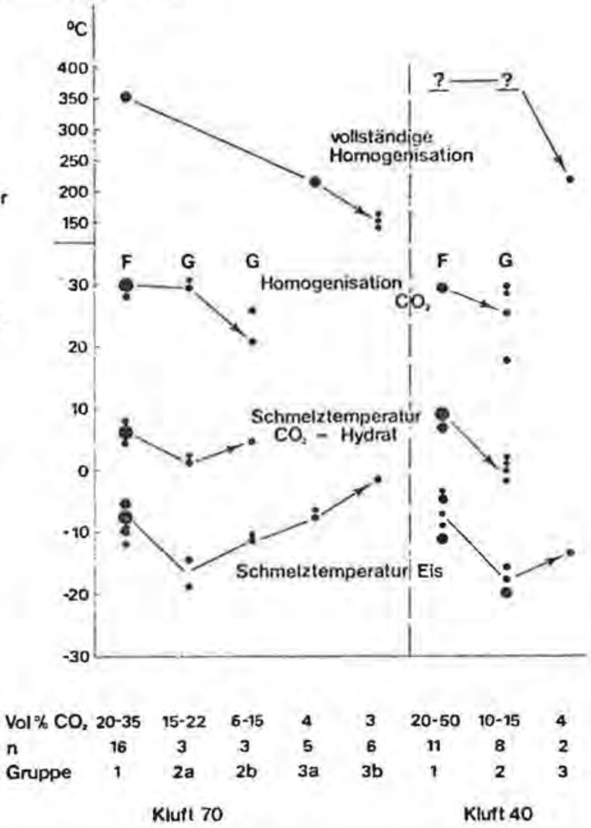
The period of mineral precipitation ended earlier in fissure 40 (without zeolites) than in fissure 70 (with zeolites).

The latest minerals at Camperio are the zeolites. Crystallization began with laumontite, followed by stilbite and heulandite. Liou (1971) studied the reaction stilbite → laumontite + 3 quartz + 4 H_2 (with excess fluid). The univariant curve crosses 183°C at 4 kb, 178° ± 10°C at 3 kb, and 170°C at 2 kb. Since the fissure solution at Camperio was very dilute at the end of crystallization and only zeolites could develop, this curve might be valid, assuming P<2 kb.

These estimates suggest a long growth history for the fissure minerals from Camperio/Campo Blenio. Using the calculations of Jaeger et al. (1967) the temperature decrease after Swiss alpine metamorphism from ∿500°C to 300°C lasted ∿8 m.y. The process of mineral formation was even longer in the fissures of Camperio, since nowhere else in the Swiss alps is such a complete mineral succession found. Most other alpine fissures have a much shorter succession.



Succession diagram for fissure no. 70 (Fig. 16, p. 339, from Wagner et al.).



Inclusion data for quartz from fissure no. 70 (Fig. 3, p. 48, from Stalder and Wagner).

Indices

The user should keep in mind the following features of these indices. The indexing procedures and entries are evolving and hence are not completely uniform from one volume of COFFI to the next, and even within a given volume consistency cannot be claimed (caveat emptor). Where several different items in the given category occur on the same page, the number of such items is put in parentheses after the page reference. Some items may continue on to following pages. Transliteration of Cyrillic has not been uniform in the various sources used, and hence the user must look under both possible spellings, e.g., Ye and E., ...iy and ...ii, etc. There are some known and some probable errors in the initials of some authors that could not be checked out in time; when in doubt, look up both. As all entries in the Translation section are also entered in the Abstracts section in alphabetical order, no Author index is needed.

SUBJECT INDEX

Editor's notes: See general notes above. I have tried to make this a user-oriented index rather than a documentalist's type index. Only data in the title and abstract are indexed, and then only if they appear to be of more than incidental mention. Misleading or erroneous translations may have resulted in occasional incorrect or omitted entries. Some entries are included under a given subject heading even though the index word does not occur in the abstract. The deposit type is indexed only where it is evident without research. The aim has been to err on the side of completeness and convenience to the user. Thus I have attempted to index some related or possibly pertinent items, and even ones involving negative data or evidence, under each category. The ore type terms such as porphyry copper and Mississippi Valley are used loosely. Analyses for specific elements are indexed only when they are particularly unusual or significant; thus semiquantitative spectrographic analyses are generally ignored. The mineral host for the inclusions studied is indexed except for decrepitation studies. Entries that would include too many page references (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 279. 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*

FLUID INCLUSION RESEARCH

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