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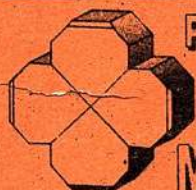
# Romanian Journal of MINERALOGY

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This journal follows the rules of the Commission on New Minerals and Mineral Names of the IMA in all matters concerning mineral names and nomenclature.

The **Romanian Journal of Mineralogy** (Rom. J. Mineralogy) is now at its first volume in the new form. However, the publication goes back to 1910, as the first volume of the "Dări de seamă ale Şedinţelor" (D.S.) has appeared as proceedings of geologists working with the Geological Institute of Romania. The journal (D.S.) appeared initially as a single volume (till volume 54, 1969), then with five series, the present issue being a direct continuation of the D.S./series 1 (Mineralogy-Petrology).

The editor has changed the name as follows: Institutul Geologic al României (vol. I-XXXVI, 1910-1952), Comitetul Geologic (vol. XXXVII-LII/1, 1953-1966), Comitetul de Stat al Geologiei (vol. LII/2-LV/1, 1967-1969), Institutul Geologic (vol. LV/2-LX, 1970-1974), Institutul de Geologie şi Geofizică (vol. LXI-74, 1975-1990).

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## INTRODUCTORY TALK

G. Udubaşa

The First National Symposium on Mineralogy in Romania was primarily intended to estimate the "state of the art" of the mineralogical research in Romania as well as to record the development level of mineralogy in different parts of the country. The responses to the circulars were unexpectedly large. More than 60 papers were announced covering a great number of topics. In addition, some invited speakers from abroad kindly accepted to spend a part of their time in order to give us some lectures in several modern topics of mineralogy.

The abstracts presented below include data on more than 50 minerals, some of them being rare species or representing first occurrences in Romania, e.g. margarite, pyroaurite, tellurantimony, tschermigite etc. For the first time some data on the Nb-Ta mineral occurrences in the Sebeş Mountains are presented, including the description of columbite, fergusonite and aeschynite (-Y) (priorite). Unfortunately, no papers on U and Th minerals were received. Thus an important part of the mineralogical knowledge in Romania still remains obscure.

Studies on the Bi minerals, typically developed in relation to the Upper Cretaceous-Paleocene magmatism, are now in progress; more than one half of the known members of the aikinite-bismuthinite series are now reported from Romanian occurrences. The search for the "rezbanyite" still remains successful, and the discreditation of the mineral by Mumme and Žak (1985) seems to be correct, although no holotype material was available at that time. More data exist also on the endogene borates from the same geological environment; new occurrences are added to the classical ones, too.

Much data were collected in the last time concerning the manganese minerals, especially of regionally metamorphosed occurrences. The manganoan fayalite from Răzoare and Răskoala ranges in composition from nearly pure fayalite to "knebelite"; this is the first report of fayalite in such occurrence type in Romania. The first occurrence of margarite is also reported here; it occurs in dynamically metamorphosed micaschists in the Sebeş Mountains being formed by replacement of kyanite.

High-grade metamorphic rocks occur in the Romanian Carpathians only as anisofacial bodies in medium grade metamorphics; they include eclogites, granulites and ultramafics, bearing superposed parageneses, progressively re-equilibrated to lower grade metamorphic events. The high grade assemblages such as garnet+omphacite+kyanite+rutile are now found only as relics within the hornblende+plagioclase+titanite associations. The chrome spinels in the ultramafics show gradual iron enrichment towards the grain margins leading to the formation of secondary magnetite.

Thoroughfully carried out studies on zircon morphology cover now the most important source rock types in the country (especiall granitoids) and contributed to the unraveling of their formation conditions (temperature and magma type).

An unusual member of the hematite-ilmenite solid solution series was recently found in some heavy mineral concentrates collected on the southern slope of the South Carpathians. The grains of uncommon high homogeneity show compositions approaching a 1:1 hematite to ilmenite ratio. It is presumed that such compositions, stable at temperatures exceeding 650° C, can be stabilized by Ta and V.

Several papers are devoted to the gold: its fineness and parageneses both in primary and secondary (alluvial) deposits. In some deposits of the Baia Mare mining district the gold fineness varies between 570 and 785 whereas the fineness of alluvial gold exceeds the value of 900.

Some common minerals such as quartz and pyrite have been found to be further bearer of genetic information. The pyrite from the well-known ore deposit of Baia Sprie exhibits interesting relationships between morphology, minor elements, sulphur isotopes and the deposition level within the vein system. New data are also available for some tellurides some of which being for the first time reported in the occurrences studied, e.g. coloradoite and tellurantimony at Săcărimb. Thus, this classical gold-silver telluride ore deposit includes now about 13 telluride species. The papers on alabandite covers all the occurrence types of the mineral so far known in Romania as well as comparison with some French occurrences. Various data on the tetrahedrite group minerals are presented for the Baia Mare occurrences pointing out their peculiar chemistry (high contents of Ag,





Zn, sometimes of Fe as well). A new occurrence of idaite is described, in which the gradual transformation of bornite can be observed; the idaite lamellae become more and more frequent, approaching and then exceeding the 1:1 bornite:idaite ratio.

The study of the clay minerals is perhaps one of most advanced, specific analyses pointing out a great frequency of regular and random mixed layered structures in the hydrothermally derived mineral associations. Alunite-rich assemblages, a new occurrence of zunyite as well as the presence of opal-CT lepidopaeres in areas with hydrothermal alterations of volcanic rocks are also reported.

The status of "monsmelite" is now finally cleared up. It is not a new mineral species but a thallium-rich variety of voltaite. The first occurrence of tschermigite in Romania belongs to the curiosities of mineralogy; its presence in a terrace deposit is not a common occurrence feature of this mineral.

Consistent and up-to-date results were obtained in the field of fluid inclusions in minerals from different geological environments. Low-salinity aqueous solutions, hydrosaline melt inclusions and mixed carbonic-aqueous fluids were thus recorded characterizing base-metal ores, porphyry copper ores and the "Marmorosch diamonds", respectively. In addition, gas chromatographic and mass spectrometric analytical data are presented, as well as a microthermometric device completely projected and built up in Cluj-Napoca. Neutron activation analyses are currently used in various mineralogical studies as well. The index of minerals includes the minerals and the main topics contained by this volume and to be presented at the symposium. No mention has been made on the associated minerals and secondary topics. To the about 550 mineral species and varieties presented in the review paper of Udubaşa et al. (1992) as characterizing the Romanian occurrences, the following species must be added (partly presented in this volume):

- aeschynite(-Y) (Luduşan, this volume)
- axinite (Pavelescu, 1988)
- coalingite (Strusievicz, this volume)
- cronstedtite<sup>x</sup>
- datolite (Cornu, Himmelbauer, 1905)<sup>xx</sup>
- glauconite<sup>xxx</sup>
- hydrotalcite (Strusievicz, this volume)
- hydrotungstite (Ilinca et al., in preparation)
- kalinite (Petrescu, 1948)<sup>xx</sup>
- margarite (Stelea, Stelea, this volume)
- nimitzite (Strusievicz, this volume)
- pyroaurite (Marincea, Cristea, this volume)
- tellurantimony (Popescu, Şimon, this volume)
- theophrastite (Strusievicz, this volume)
- tschermigite (Marinescu et al., this volume)
- "titanian-hematite (-Ta, V) (Udubaşa et al., this volume)

<sup>x</sup> Known at Herja as cm-sized hemispherical aggregates but not previously reported in any paper

<sup>xx</sup> Recently identified literature data

<sup>xxx</sup> Many occurrences (!) but overlooked in the paper of Udubaşa et al. (1992).

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## HEAVY MINERAL ASSEMBLAGES IN THE UPPER NEOGENE SANDS AND SANDSTONES IN THE GETIC BASIN

*N. Anastasiu (Bucureşti)*

Heavy mineral assemblages in the Upper Neogene siliciclastic deposits have a large spectrum containing magnetite, garnet, hornblende, actinote, epidote, zoisite, hypersthene, tourmaline, staurolite, kyanite, sillimanite, andalusite, spinel, rutile, zircon, titanite. Systematic stratigraphic and areal variation in the mineralogical composition is evident: from Sarmatian to Romanian, and from western to eastern part of the Getic Basin. Petrofacies studies prove the recycled orogenic character (uplifted subduction complexes) of source areas, and it is equivalent with "supracrustal terranes". Grain size and shape parameters prove that detritus was transported on relatively short distances before accumulating in the fluvio-deltaic, shorelines and inner shelf environments. The ZTR index is a function of a changing paleoclimate, probably associated with the overall global climatic change.

## LA DIVERSITÉ DES PARAGENÈSES "ÉXOTIQUES" DANS LES MONTS DE FĂGĂRAŞ

*Aneta Balaban, C. Costea, I. Vanghelie (Bucureşti)*

La diversité des paragenèses métamorphiques et des types structuraux permet de décrire plusieurs stades de l'évolution des minéraux et des roches à l'est des monts de Făgăraş. Des accidents trop redressés pour être de pures failles inverses sont effectivement accompagnés des associations minéralogiques particulières: amphibolites, élogites, granulites, gneiss pyroxéniques une caractéristique remarquable, un facteur favorable pour établir des corrélations régionales rigoureuses. Les données de la répartition sur la carte indiquent la rareté des élogites et des granulites; elle correspond à un dispositif structural généralement situé à la partie inférieure de l'empilement des failles inverses (probablement hercyniennes, réactivées).

Les résultats de l'étude minéralogique (les grenats, les pyroxènes) mettent en évidence les caractères des principales formations, la typologie des associations:

- grenat (+ symplectite à néo-clinopyroxène) + olivine + serpentine (vallée de Crucişoara);
- grenat (symplectite à néo-clinopyroxène + plagioclase) + chlorite (Cr-amesite) + jadéite résiduelle + dysthène + acmite + amphibole incolore calcique + quartz (exceptionnel) + zoisite (élogites à dysthène, vallée de Crucişoara);
- agrégats polycristallins: grenat relique, amphibole rétrograde, symplectite grossière, rutile + ilmenite reliques ± pyrite ± chalcopirite (élogite et amphibolites associées, mylonitisées, vallée de Crucişoara);
- grenat relique + amphibole rétrograd + reliques de rutile et ilmenite (élogite rétrotransformées, vallée de Vulturi);
- grenat corrodé + agrégats polycristallins mylonitisés (élogites à quartz, vallée de Borii);
- grenat corrodé + agrégats polycristallins mylonitisés (vallée de Răchitea);
- grenat + clinzoisite (vallée de Bîrsa Fierului - élogite ?)
- grenat + feldspath potassique + chlorite + ilmenite (granulite, vallée de Vulcăniţa)
- grenat + clinopyroxène → amphibole (ferro-hornblende) + plagioclase + quartz + calcite + minéraux accessoires (titanite, épidote, apatite, allanite) (gneiss pyroxénique et amphiboliques, vallée de Lupu, vallée de Neagra).





Il est difficile de déterminer l'origine des roches amphiboliques. Au microscope, la minéralogie de ces roches est déterminée par le: grenat corrodé, les associations symplectitiques secondaires.

Les études microscopiques et les analyses au moyen de la microsonde électronique ont mis en évidence une modification de la teneur en Fe, Mg, Ca, une séparation en zones évidentes dans la périphérie du grenat (grenat - symplectite + augite).

## LE QUARTZ FILONIEN DE CAVNIC

Aneta Balaban, C. Costea (București), Rodica Ciobanu (Sibiu)

Le quartz filonien constitue une véritable carte d'identité pour le gisement de Căvnic - région minière de Baia Mare. Chacun des échantillons analysés (collection de Brukenthal et les filons 40, 61, 85 - en exploitation) diffère des autres par un certain nombre de caractères tels l'épaisseur, la limpidité ou la forme, selon les conditions de la genèse. Dans l'étude, l'accent a été mis sur l'illustration photographique.

Les principaux caractères typologiques rencontrés sont les suivants:

- pour les échantillons des collections de Brukenthal: cristaux généralement automorphes, incolores (rarement rose au blanche), avec les faces des divers types - prismes  $\{10\bar{1}0\}$ , pyramides  $\{01\bar{1}1\}$   $\{10\bar{1}1\}$ , rhomboèdres  $\{10\bar{1}1\}$   $\{21\bar{1}1\}$ , trapézoèdres  $\{6\bar{1}51\}$   $\{51\bar{6}1\}$ ; abondent les macles Dauphiné et Japonais; les arêtes des formes sont légèrement arrondies; les formes dihexaédriques parfaites "fenestrées" peuvent résulter d'une corrosion ou d'une croissance difficile; gradins de croissance en relief et en creux spécifiques;

- pour les échantillons représentatifs dans les filons 40, 61, 85 (l'horizon -300 m; -400m): des formes automorphes et subautomorphes incolores ou blanches définies par des développements des faces prismatiques avec gradins de croissance en relief et des faces pyramidales; les aspects cristallographiques particuliers - l'association des faces  $\{10\bar{1}0\}$   $\{01\bar{1}1\}$   $\{11\bar{2}1\}$ ; les formes de grande taille abondants, les macles Japonais et les petits cristaux  $\{10\bar{1}0\}$  -  $\{01\bar{1}1\}$  tardivement développés sur les faces  $\{10\bar{1}0\}$  sont caractéristiques; une pellicule siliceuse et les dépôts de globules recouvrent les surfaces des cristaux prismatique (filon 85, horizon -300 m) analysés avec la microsonde électronique.

## LA SYNTHÈSE DE QUELQUES ROCHES PYROXÉNIQUES PAR DES PROCÉDÉS PETRURGIQUES

I. Bedelea, V. Duca, Mihaela Duca, H. Bedelea (Cluj-Napoca)

Cet exposé présente les résultats des recherches dont le but principal est la synthèse des roches pyroxéniques à des propriétés préétablies par la réalisation d'une microstructure dans laquelle les dimensions des cristaux soient proches de celle optimale ( $1-1,5 \mu$ ). Les masses sont intégrées dans le système  $\text{SiO}_2\text{-MgO-CaO} + y \text{ Al}_2\text{O}_3$  auquel on ajoute  $+ x \text{ Na}_2\text{O}$ . Lorsque la concentration en  $\text{Na}_2\text{O}$  dépasse 2,5 % il mène à la formation de la jadéite. L'isomorphisme pleinement manifesté dans le groupe des pyroxènes a déterminé une seule phase cristalline, ce qui assure des propriétés physiques, chimiques et mécaniques supérieures par rapport aux masses polyminérales telles celles obtenues par la fonte du basalte. La résistance à l'agression chimique, déterminée par l'ébullition pendant un intervalle de 3 heures dans  $\text{HCl}(1N)$   $R = 0,35 \%$ , dureté Vickers = 720, poids





spécifique 2,7929 g/cm<sup>3</sup>. Les produits obtenus des masses pyroxéniques monominérales couvrent des domaines très vastes: placages résistants aux agents chimiques et à l'abrasion, corps de broyage, substituts d'agate, isolateurs électriques, etc.

## MINERAL ASSEMBLAGES IN THE CONTACT METAMORPHIC ROCKS FROM THE BÎRGĂU MTS

*I. Bedelcan, I. Ureche, N. Har (Cluj-Napoca)*

The phenomena of contact metamorphism in the Bîrgău Mts have a large distribution but the transformation intensity is rather low. The mineralogic parageneses discovered in these formations point to the existence of several types of metamorphism: (1) - dislocations metamorphism (dynamic), (2) - contact metamorphism (thermic and metasomatic).

The individual existence of minerals or their association in characteristic parageneses is determined by the nature of contact between the two types of rocks, by the lithologic nature and the dimension of the magmatic bodies with which they come into contact. The most intense transformations are noticed in the xenoliths of sedimentary or metamorphic rocks included in the Neogene andesitic magmatites (Valea Strejii, Pîriul Rodnei) and in the pelitic fragments incorporated in the breccias developed at the their contact with the surrounding sedimentary rocks (Măgura C.F.R. Quarry, Pîriul Rece). These transformations can reach the thermo-baric values characteristic of all the facies of the hornfels. Transformations of lower intensity (hornfels facies with albite and epidote) develop in case of the contact between eruptive bodies and sedimentary formations. The main minerals specific to the contact metamorphism in this area (determined by microscopic and diffractometric analyses) are: (a) - Biotite-microlamellar in form, with brown pleochroism, fresh, marked idiomorphism, disseminated in the contact areas; here it increases quantitatively if compared to the magmatic rock where it occurs as a relict. It is also associated with the other neof ormation minerals; (b) - Cordierite, quantitatively the second mineral after biotite, is present as nests along the contact areas, in association with sillimanite which may penetrate it in a sheaf form: It exhibits processes of transformation into sericite; (c) - Sillimanite has prismatic needle-shaped habit, yellowish colour, gradual extinction and occurs in sheaf-form or as isolated crystals in cordierite, feldspar, andalusite and biotite mass; (d) - Andalusite forms prismatic crystals, sometimes square-shaped, extensively developed, with weak yellowish-pink pleochroism, sometimes containing sillimanite, biotite, etc. Processes of pinitisation were frequently noticed. (e) - Kyanite appears sporadically in nest-form or as isolated crystals associated with biotite; (f) - Garnets occur in two forms: (1) isometric crystals, largely developed, intensively fissured, chloritized, indicating its belonging to the primary xenolithic rock. The diffractometric analysis indicated an almandine (with main lines at (d/I): 2.58/100; 1.53/41; 2.87/31). (2) Isolated euhedral grains of smaller dimensions which appeared as a consequence of metasomatic processes; (g) - Staurolite appears only in dislocation areas either as euhedral prismatic crystals, with brown-yellowish pleochroism or as crystals fragments in longitudinal breach parallel to the dislocation directions; (h) - Pyroxenes appear in the transformation products in nest form, isolated crystals with marked idiomorphism and optic characteristics which indicate the presence of the diopside or diopside-augite; (i) - Parageneses are completed by feldspars-quartz, chlorites, carbonates, minerals of the epidote group, iron oxides and sulphides.





## CLAY MINERALS IN THE HARGHITA BĂI HYDROTHERMAL AREA

*I. Boboș (Timișoara), Lucreția Ghergari (Cluj-Napoca)*

The pervasive argillic alteration in the Harghita Băi hydrothermal area represents the effect of meteoric hydrothermal solutions; it was controlled during the first stage of the porphyry copper systems evolution in the andesite and/or microdiorite intrusions. The second tardive stage was controlled by postvolcanic tectonic movements which facilitated the circulation of meteoric hydrothermal solutions and amplified the intensity of the argillization process. X-ray, DTA, SEM investigations and bulk chemical analysis made on the phyllosilicates fractions of 2 microns led to the identification of the neoformation minerals which were formed in thermodynamic equilibrium. Eight clay mineral assemblages were separated taking into account the ratio of alkali earth ion activity to hydrogen ion activity, roughly estimated from the experimental data. They are: kaolinite-halloysite, dickite, pyrophyllite, montmorillonite, random mixed layer clay minerals, regular mixed layer clay minerals, illite and chlorite dominated assemblages.

## THE ILLITE-SMECTITE REACTION IN THE HYDROTHERMAL SYSTEM OF HARGHITA BAI

*I. Boboș (Timișoara)*

X-ray investigations and bulk chemical analyses of interstratified structures clay minerals assemblages of pervasive argillic alteration in the Harghita Băi hydrothermal area indicate the presence of multiphase illite-smectite (I-S) with random mixed layer ( $R=0$ ) and regular ( $R=1$  or  $R=3$ ) mixed layer minerals. Fluctuating temperatures of hydrothermal convective system was thermodynamically controlled and produced a multiple reaction series by which I-S clays may form. The random stacking of layers ( $R=0$ ) contains more expandable layers; if they are less expandable then they become ordered. During the reaction smectite-illite random and regular mixed layer minerals can coexist if the expandability is between 60–40 %. Estimated contents of expandable layers (smectite) were obtained by using the method proposed by Watanabe (1983); the measured peak position differ from those characterizing pure I-S minerals. Assemblages containing illite-smectite minerals cannot belong to the same chemical solution.

## Bi-MINERALS IN PALEOCENE ORE DEPOSITS IN ROMANIA: THEIR SPECIFIC MINERALOGICAL FEATURES

*G. Cioflica, R. Jude, M. Lupulescu, Gr. Simon (București), Gh. Damian (Baia Mare).*

Bi-minerals in the ore deposits related to Paleocene magmatites on the Romania territory are to be found at Băița Bihorului (North Apuseni Mountains), at Tincova (Poiana Ruscă Mountains) and also at Ocna de Fier, Dognecea, Oravița, Ciclova, Sasca Montană and Moldova Nouă (Banat). They can constitute: important bismuth mineralizations, often generating Bi+Mo±W or Bi+Cu+W assemblages, when they are connected with granodioritic intrusions (e.g. Băița Bihorului); bismuth sequences, locally developed in the copper or copper-molybdenum and in base metal mineralizations, when they are found in genetical relations with monzodioritic or granodioritic intrusions. In these ore deposits, the Bi-minerals generally form impregnations, veinlets





and nests, more rarely zones with massive ore, in the Ca- and Mg-skarn bodies, as well as in the stockworks with hydrothermal mineralizations centered on the apophyses of the main intrusion.

Till now some 25 Bi-minerals were described, out of which several species were found for the first time in Romania. The detailed investigations of ores in the above-mentioned deposits have revealed the existence of new Bi-minerals, such as: pekoite, krupkaite, hammarite, aikinite, Cu-pavonite, and padëraite. At the same time, some minerals previously described were reconsidered, and others were confirmed; some of these minerals were identified in other ore deposits, too, as for example at Tincova, Sasca Montană and Moldova Nouă. For all the studied Bi-minerals some new quantitative data are given such as spectral reflectance, Vickers microhardness and chemical composition. The formula of each analyzed mineral was calculated and the analyses were plotted on triangular diagrams such as S-Bi-Te, Cu(Ag)-Bi(Sb)-Pb, PbS-Cu<sub>2</sub>S-Bi<sub>2</sub>S<sub>3</sub>, Bi<sub>2</sub>Te<sub>3</sub>-Bi<sub>2</sub>S<sub>2</sub>-Bi<sub>2</sub>Se<sub>3</sub> in order to establish the compositional variability of the identified phases.

## HYDROTHERMAL CLAY MINERALS IN VEINS OF THE NISTRU-BĂIȚA MINE FIELD

*Floarea Damian (Baia Mare)*

In the upper part of veins having predominantly a quartzous matrix, monomineral pockets of clay minerals have been frequently identified. They are represented by kaolinite and halloysite beside small amounts of illite and montmorillonite. DTA and DTG curves of kaolinite show a strong effect at 550-590° C, that brings about a weight loss of 14 % and a huge exothermal effect at about 980° C. DTA and DTG curves of halloysite show two endothermal effects: at 100-110° C and 560-575° C, corresponding to a weight loss of 5 % and 7 %, respectively. Halloysite also presents an intense endothermal effect on the DTA curve. These curves are the same as those from literature. The main diffraction lines for kaolinite and halloysite have "d" values which prove the purity of the examined samples. The intensity X-ray diffraction lines of kaolinite suggest a reduced crystallinity level. The IR spectra of the Nistru kaolinite and halloysite are the same as these from literature. Oxides are SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub> with addition of H<sub>2</sub>O<sup>+</sup> and H<sub>2</sub>O<sup>-</sup> (halloysite).

## NATIVE GOLD PARAGENESES OF BORZAȘ GOLD ORE DEPOSIT – SĂSAR MINING FIELD

*Gh. Damian, E. Oșan (Baia Mare)*

The Borzaș gold deposit is situated in Pannonian quartz bearing andesites that are highly brecciated and triturated along the roof and floor of Borzaș VII vein. Within the Borzaș ore there has been identified a simple mineralogical association that includes pyrite and native gold; subordinately are also appearing: marcasite, sphalerite, galena, chalcopryrite, arsenopyrite, tetrahedrite and jamesonite, disposed along fissures and veins within andesite, beside quartz, adularia, calcite and clay minerals. Pyrite appears as fine impregnations within the hydrothermally affected andesites. Gold appears in native form and is associated especially with pyrite (92 %) that forms small veins. Native gold is very rarely associated with quartz, sphalerite and galena. Native gold grain size is between 0.008 and 0.047 mm.

Reflectivity of gold has the following values: 67-74 % (486 nm); 76-81 % (551 nm); 81-83 % (589 nm); 84-86 % (656 nm). Fineness of gold, based on the reflexion capacity values, ranges between 640 and 730. The





electron microprobe assay values provide the following contents: Au = 57-64 % and Ag = 36-43 %; some samples contain in addition Cu (0.23 %) or S (0.28 - 0.32 %).

## NATIVE GOLD PARAGENESES OF CREMENEVA VEIN - ȘUIOR ORE DEPOSIT

*Gh. Damian, Floarea Damian (Baia Mare), L. Puiu (Șuior Mine)*

Cremeneva vein of Șuior has an obvious vertical zonality, the upper gold-silver bearing part gradually passing into a lower lead-zinc bearing zone with gold content. Native gold forms different associations within the vein. In the upper gold-silver bearing zone, gold is mostly associated with quartz (80 %) and less with common sulphides. The grain size is small, ranging approx. between 0.004 and 0.024 mm. In the lead-zinc bearing zone and in the transition zone as well, the native gold is predominantly associated with common sulphides, presenting the following distribution: in pyrite 25 %, in sphalerite 34 %, in galena 24 %, in arsenopyrite 0.5 % and in tetrahedrite 0.5 %. A remarkable decrease of the gold content in association with quartz can be observed. The grain sizes of gold in these parageneses range between 0.004 and 0.194 mm. Both in the upper zone and in lead-zinc bearing one, the presence of two native gold generations can be stressed.

Spectral reflectance in blue light domain suggests the presence of native gold with a high silver content. The absolute reflectivity values range between 62 and 65 % (486 nm); 70-72.3 % (551 nm); 75-80 % (589 nm); 79-84 % (656 nm). The estimated gold fineness based on the absolute reflectivity varies between 730 and 785. Electron microprobe X-ray images provided an homogenous gold and silver distribution within the native gold grains.

## FREIBERGITE AND ARGENTIAN TETRAHEDRITE IN NEOGENE VEINS FROM BAIJA MARE MINING DISTRICT

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Whithin several Neogene hydrothermal mineralizations of Baia Mare mining area there have been identified tetrahedrites that contain silver and belong to the group of argentine-tetrahedrite and freibergite. Such tetrahedrites have been identified within Nistru, Ilba, Herja, Băiuț and Toroioaga ore veins. They appear as milimetric grains associated with common sulphides, sulphosalts or as mm-sized tetrahedra disposed in geodes. Electron microprobe analyses show major element contents that corresponds to the standard formulae of these two varieties of tetrahedrite. Beside the major specific elements, they contain small amounts of Zn (0.82-4.61 %), Fe (1.36-5.87 %), and As (1.5-4.3 %). The Vickers microhardness values for freibergite are between 270 and 230 kg/mm<sup>2</sup> and for argento-tetrahedrite between 334 and 220 kg/mm<sup>2</sup>, all these values being situated within the limits confirmed by literature.

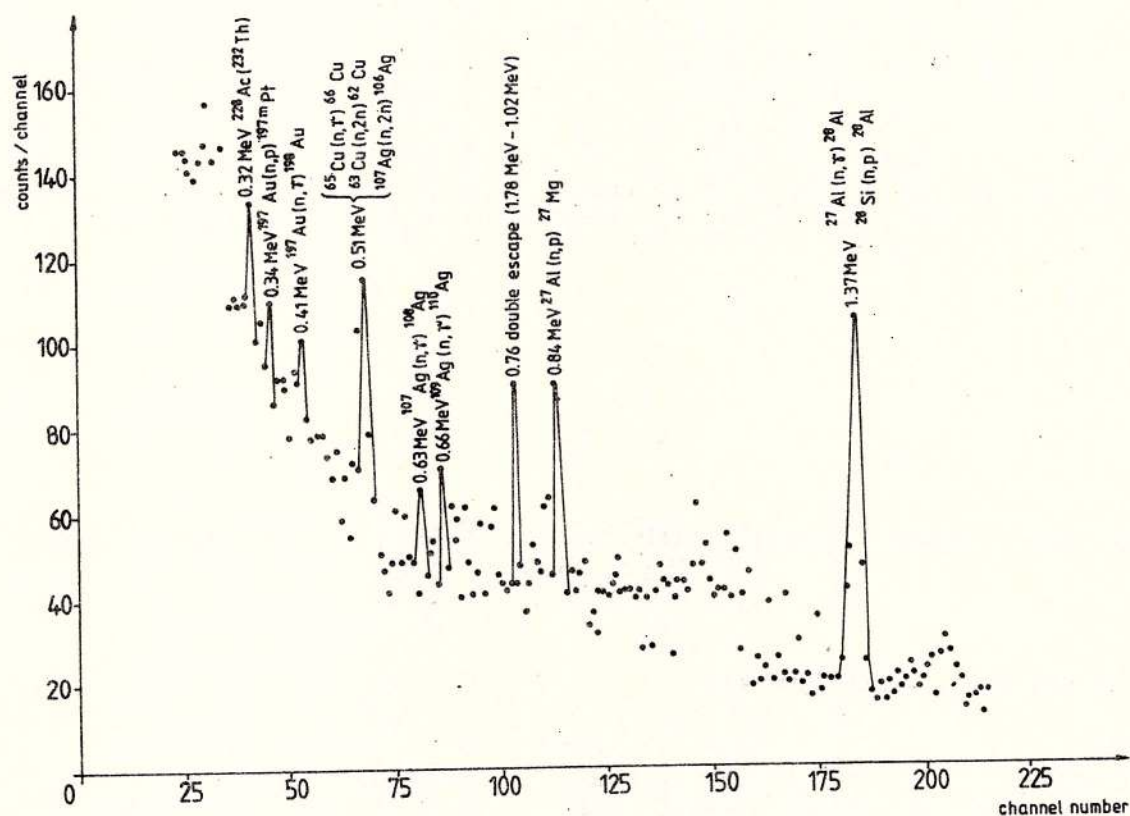




# ACTIVATION ANALYSIS WITH ISOTOPIC NEUTRON SOURCES OF GOLDEN SANDS

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A method of elemental nondestructive analysis was used for minerals and especially for golden sands deposits to identify elements such as Au, Cu, Ag, Mn, As, Al, Si, and also to determine their concentration. For irradiation, two isotopic neutron sources  $^{241}\text{Am}-^9\text{Be}$  and  $^{239}\text{Pu}-^9\text{Be}$  with a total flux  $6.6 \times 10^7$  n/s were used. Neutron activation assembly is a paraffin block containing the sources in the centre and the holes where the samples for irradiation are introduced. The induced radioactivity was analysed with a high resolution gamma spectrometer containing a semiconductor detector type Ge(Li) and a multichannel analyser. The samples were collected from the alluvia of the Someşul Mic River proving the presence of gold and copper in small concentrations. This result was correlated with previous data showing the existence of some gold mines at Someşul Rece. The analyses made on quartz samples from this zone point out the presence of gold and copper but also of other accompanying elements. This paper largely presents the method of processing gamma spectra and obtaining information concerning the elements identification on the basis of nuclear reaction with neutrons to improve quantitative analysis. The paper also presents results concerning the analysis of sand, pyrites, pyrite-bearing limestones etc. The figure below presents the gamma-spectrum from a sand sample. Nuclear reactions which lead to the corresponding gamma peaks can also be noticed in the diagram. It is a nondestructive, rapid and highly-sensitive method of chemical analysis which can be used to control industrial processes and prospections.





## QUELQUES ASPECTS CONCERNANT LA SYNTHÈSE DES MASSES PYROXÉNIQUES À SPODUMÈNE

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Dans la série des roches pyroxéniques synthétiques les masses contenant des minéraux de Li occupent une place singulière. Pendant les expériences effectuées, on a introduit dans la recette le spodumène provenant des pégmatis de Conțu. La microstructure obtenue est identique à celle d'une masse spoduménique produite dans l'Ukraine, utilisée comme modèle de référence. Pour l'identification des phases cristallines, on a utilisé la microscopie optique, RX, IR et l'analyse thermodifférentielle. Les matériaux obtenus ont des perspectives remarquables dans la céramique de ménage tout comme dans les secteurs industriels qui emploient des dispositifs à dilatation thermique réduite.

## CRYSTALLINITY OF KAOLINITE OF STEJERA

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Different genetic types of kaolinite were investigated from the point of view of crystallinity. The measurements were carried out by different methods of thermal analysis, infrared spectroscopy and X-ray diffraction. The different parameters of crystallinity degree based on a series of samples were critically studied. The estimated parameters of different methods show a relatively bad correlation. The reason for the difference in the data come from the fact that the methods give information about different parts and/or features of the mineral structure. The result is much better if several parameters are simultaneously used. Different localities of kaolinite were investigated first of all by computer controlled thermal methods. Observation of fine change in certain parameters such as corrected temperature of thermal decomposition or activation energy for dehydroxylation etc. can be useful for genetic interpretation. One of the model areas was the kaolinite occurrence at Stejera.

## ALLUVIAL GOLD IN THE MIDDLE FLOW OF THE MUREȘ, STREI AND CRIȘUL ALB RIVERS

*V. Galcenco, Gh. Velciov (Deva)*

This paper sums up all the geological and mineralogical data concerning the gold found in recent alluvial deposits of the Mureș, Strei and Crișul Alb rivers. The data were obtained between October 1989 and June 1992, from 16 ballast-pits (12 on the Mureș, 3 on the Strei and one on the Crișul Alb).

The mineralogical composition of these gold-bearing alluvial deposits (0.0246 g/t gold on an average for all the 16 ballast-pits) consists of: quartz, feldspar, amphiboles, muscovite, biotite, pyroxenes, garnets, iron oxides (magnetite, maghemite, martite, hematite) and titanium oxides (ilmenite, rutile, anatase), zircon, monazite, gold etc.

Generally the mineral grains of the alluvial deposits are free, showing only partly polymineral intergrowths. However, the following aspects are to be considered: a) the fraction greater than 3 mm contains fragments of rocks and minerals in which the concentration of useful minerals is low or very low; b) the fraction less than





1 mm consists of quartz, amphiboles, garnets, magnetite, ilmenite, mica, feldspar, pyroxenes, rutile, zircon, hematite, gold etc.

Three types of mineral associations can be observed under the binocular microscope (magnification 20 x): (1) gold + quartz grains which may reach 3 mm in length (or diameter). This quartz has mostly violaceous (amethyst) and/or light brownish – golden colours ("Madeira topaz"); they have probably developed during two distinct periods of hydrothermal mineralization; (2) gold + mercury. It is most probable an artefact; (3) gold + iron oxihydroxides formed in a natural way by the deposition of a film of iron oxihydroxides on the gold nuggets in acid-rich surface waters.

It is of note the presence of some lead grains, sometimes elongated or wiry. As to their origin we have to consider two hypotheses: a) they are traces of a hunting-activity; b) they are natural products which have developed by decomposition of galena; both possibilities are, however, possible.

Gold is the most important component of the alluvial deposits; it is the element most frequently discussed by the geologists of the 19<sup>th</sup> century; it can be found mostly at the fine sandy levels of the alluvial deposits; it can be found in all the 3 hydrographic basins (Mureş, Strei, Crişul Alb); at a global average content of 0.0246 g/t (0.0198 g/t in the 3 mm group and 0.0295 g/t in the 1 mm group; 0.0227 g/t in the Mureş, 0.0049 g/t in the Strei, 0.0188 g/t in the Crişul Alb); taking into account a sample with an exceptional content of 1830 g/t the average content is of 0.0373 g/t; aprox. 95% consist of fine powdery gold and only 5% are nuggets and crystals; the nuggets are as big as 4/2 mm in size, but their great majority is smaller than one millimeter. The nuggets may have the following forms: leaflets, fine threads, grains, wires, spheres, including man-made chain links. Earlier papers point out the presence of nuggets up to 467 g in the Pianu Valley. Their shape, size and general aspect vary considerably depending on transport conditions, speed and flow of the river, distance of transport, morphology and hardness of the river bed, their initial composition and their transitional stages etc.

Gold crystals can also be found; dendrites, moss-shaped, octahedrons, cubes, cube-octahedrons, dodecahedrons, were often encountered showing curved faces or deformations. The most frequent forms are the plates with lustrous or scratched surfaces.

The colour of gold varies depending on its composition and on the age of the alluvial deposit from golden-yellow or light yellow-silvery to reddish-golden or even greenish (new gold); the secondary one is always present, but we have very few data about it;

The purity of gold varies between wide limits; earlier papers mention 21 carat gold in the Pianu Valley (Northern Sebeş Mts).

## L'ANALCIME DU TUF DE COLINE (CLUJ-NAPOCA)

*Lucreția Ghergari, T. Lázár (Cluj-Napoca)*

Le tuf de Coline, qui affleure sur le territoire du municipe de Cluj-Napoca, dans le versant gauche du Someş, est connu comme tuf dacitique vitroclastique allant du moyen-grossier au fin, avec des intercalations tuffitiques. Dans le cadre de cet horizon de tuf, on a identifié des séquences minces de tuf cristallocalastique. Les cristallocalastes sont constitués surtout de plagioclases frais (zonés et maclés polysynthétiquement), à côté desquels on reconnaît, d'après la forme, des amphiboles et des pyroxènes complètement altérés. Parmi les minéraux magmatiques accessoires on remarque une teneur élevée en ilménite, fréquemment sous forme de cristaux idiomorphes tabulaires-hexagonaux.

Dans le cas des séquences cristallocalastiques, intéressants sont les produits diagénétiques (halmyrolitiques) qui cimentent les cristallocalastes. Le ciment est formé de cristaux idiomorphes d'alcime et de sulfures de fer: pyrite, marcasite, sous forme de cristaux singuliers inclus dans l'alcime. Le sulfure ferreux s'est formé par l'action du H<sub>2</sub>S sur les minéraux contenant du fer (pyroxènes et amphiboles), auxquels il s'est substitué presque totalement. La présence des minéraux signalés est confirmée par les analyses microscopiques et diffractométriques (alcime: d/I – 5,58/45; 3,41/58; 2,92/27).





## DONNÉES MICROCHIMIQUES SUR L'ANDRADITE À IRISATIONS DE OCNA DE FIER (BANAT, ROUMANIE)

*Lucreția Ghergari, Șt. Nicolescu, I. Mârza, C. Gruescu (Cluj-Napoca)*

Les grenats à irisations du gisement pyrométasomatique de Ocna de Fier (Banat) réalise des cristaux idiomorphes aux dimensions qui ne dépassent pas habituellement 15 mm Ø, de teinte brune et sur les faces cristallographiques desquels on surprend d'intenses réflexes verdâtres.

En section minces, on reconnaît des reliques arrondies (< 1 mm Ø) de carbonate paléosomatique présentant des creux marginaux provoqués par la corrosion du grenat. Le microscope révèle l'affection épithermale des grenats, manifestée par des dépôts de quartz (0,006 – 0,015 mm) sur la surface de ceux-ci et sur les fissures, accompagné de calcite et d'un peu de chlorite (ripidolite); en même temps se sont déposés de l'hématite (0,004 – 0,007 mm) et des sphérules de goëthite – todorokite (0,007 – 0,02 mm Ø).

Le spectre de diffraction des rayons X, obtenu sur les grenats à irisations analysés correspond à l'andradite, ayant la constante réticulaire:  $a_0 = 12,029 \pm 0,005$ . La composition chimique du grenat obtenu au moyen de la microsonde électronique (intervalles de 0,05 mm sur un profil transversal, au total 180 points analysés) est andraditique avec  $Al_2O_3 < 0,1\%$  (< 0,5 % moléculaires grossulaires), correspondant aux zones de grenat isotrope, alors que dans les bandes anisotropes la teneur en  $Al_2O_3$  varie entre 1,19 et 0,10 % (61 points). La teneur la plus élevée en  $Al_2O_3$  (1,19%) correspond à un mélange isomorphe avec 6% de moléculaires grossulaires. Parmi les éléments mineurs investigués, on a mis en évidence:  $Cr_2O_3$  (0,02 % dans 5 points),  $Bi_2O_3$  (0,06 – 0,08 % dans 4 points),  $SnO_2$  (0,04 – 0,05 % dans 3 points),  $MoO_3$  (0,05 – 0,07 % dans 4 points),  $CuO$  (0,02 % un point),  $ZnO$  (0,03 – 0,04 % dans 3 points),  $PbO$  (0,06 – 0,07 % dans 5 points) et  $AuO$  (0,07 % dans 3 points);  $TiO_2$  (< 0,01 %).

En ce qui concerne le phénomène de l'irisation réfléchie sur la surface des cristaux d'andradite du gisement de skarn d'Ocna de Fier, nous consignons ce qui suit: les grenats à irisations contiennent, hormis les fissures non-orientées, des fascicules parallèles de fissures aux longueurs différentes, imitant le clivage très bon, causées par des impuretés pelliculaires (sans doute initialement biphasiques: liquide – solide), orientées parallèlement aux plans de croissance ou dans des positions quelconques. La densité de ces plans est maximale à proximité des fissures et des vides à l'intérieur des grenats ou à la surface de ceux-ci. La présence des plans de discontinuité à proximité des surfaces des grenats détermine le phénomène optique de diffraction et d'interférence de la lumière blanche, produisant les irisations caractéristiques de l'andradite de Ocna de Fier.

## ARSENIC MINERALS AT ȘARUL DORNEI, SUCEAVA REGION

*Lucreția Ghergari, Ghizela Olaru, V. Trandafir (Cluj-Napoca)*

The arsenic mineralization from Șarul Dornei, occurs in the right slope of Șărișor Brook, within the chloritographite schists of Tulgheș Seires. The mineralization develops as veins (1x10x20-10x100x150 cm) or impregnations. The bulk chemical composition ranges between 5.15-29.25 % (S), 18.77-44.27 % ( $As_2O_5$ ), 4.65-12.40 % (AsS). The main arsenic minerals are orpiment and realgar.

Orpiment forms aggregated or individual crystals, of short prismatic habit, with rounded faces, of 0.008-0.02 mm in length; exceptionally they show long prismatic habit of 0.01x0.03 mm. Orpiment penetrates along schistosity and cleavages and substitutes quartz from the wall-rock. Open diclases filled with orpiment are rare. In transmitted light, the mineral is almost opaque, with very light birefringency; reflected light examination reveals a white-gray colour, visible birefractance, a reflectivity of about 23 % and strong, light-yellow internal reflections.

Realgar – the second deposited mineral – develops along fissures. The crystals show a long-prismatic habit (0.25 mm), with longitudinal striations and an obvious cleavage along (010) and (001). They are transparent, vermillion-red coloured, with visible pleochroism and very high birefringency. In reflected light, realgar is gray with brown or violet tints and show minium-red internal reflections.





Realgar substitutes orpiment within diaclasses, – the latter being-preserved as inclusions. Subsequently realgar is altered to orpiment.

Both arsenic minerals are associated with low-temperature, collomorph-textured quartz which ends the epithermal depositional sequence at Șarul Dornei.

## CRYSTALLOGRAPHICAL STUDY OF CALCITE FROM PIATRA ALTARULUI CAVE, BIHOR MOUNTAINS, ROMANIA

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The recently discovered Piatra Altarului Cave is situated in the carstic region of Ic Ponor (North-eastern Bihor Mountains), at an altitude of 1112 meters, on the right side of the Ponor Valley, a left tributary of the Someșul Cald River. It is carved in Jurassic limestones that fill the so-called Someșul Cald graben. Besides very interesting and beautiful speleothemes (i. e. stalactites, stalagmites, draperies), it is characterised by the presence of several sectors completely covered with perfectly white to yellowish-transparent calcite crystals. Three sites in the cave, i.e. (1) the wall of Lake Hall, (2) the crystal-coated stalactites in the Lake Hall and (3) the "Geode", were chosen for a statistical crystallographical study. A total of 21 crystallographical forms were identified: the trigonal prism (10 $\bar{1}$ 0), the trigonal bipyramid (8.8.16.1), 13 rhombohedrons and 6 scalenohedrons. The measurements were performed in place, with an application goniometer on the large crystals, and in the laboratory, with a 3-circle goniometer, on the small crystals collected from the cave.

The general persistency diagram for the 460 measured crystals shows values over 10% only for the trigonal prism and for 8 rhombohedrons, the most persistent forms being (10 $\bar{1}$ 1)–85 %, (10 $\bar{1}$ 0)–67 %, (05 $\bar{5}$ 1)–45 %, (04 $\bar{4}$ 1)–44 %, (50 $\bar{5}$ 1)–32 %, and (04 $\bar{4}$ 1)–17 %. The crystals from the three sites were divided into populations, considering upper and lower levels to form a single site. Frequency diagrams for the number of forms on one crystal show a very clear zoning of populations with one generation of crystals in the upper levels and of populations with two generations of crystals in the lower levels.

## MODERN PHYSICAL METHODS FOR THE STUDY OF MINERALS

*St. Hafner (Marburg)*

## TRACE ELEMENTS AND FLUID INCLUSIONS AND MICRO-INCLUSIONS IN PYRITE AS DISCRIMINATING PARAMETERS AND PARAGENETIC INDICATORS

*D. Hallbauer (Stellenbosch)*





## THE MANGANOAN FAYALITE-MAGNETITE ASSEMBLAGE AT RĂSCOALA, SEBEȘ MTS

*Paulina Hârtopan, G. Udubaș, I. Hârtopan, Gabriela Stelea (București)*

A small body (20 x 1 m) of magnetite is known since a long time at Răskoala, in the eastern part of the Sebeș Mts. Although very small, the occurrence is interesting as the mineralogical composition severely contrasts that of the big manganiferous belt in the South Carpathians, which is about 40 km long and practically covers the Răskoala occurrence. The Mn-belt contains a nearly pure tephroite, associated with other manganese minerals, whereas at Răskoala only manganoan fayalite was identified. Earlier known as "magnetite-bearing schists" or "pyroxene-bearing marbles with magnetite" the ore body at Răskoala proves to contain an interesting assemblage consisting of manganoan fayalite, magnetite, spessartine, pyroxmangite, dannemorite, manganoan biotite (manganophyllite), pennantite, and rhodochrosite; thus it belongs to the carbonate-oxide-silicate type of Mn-Fe ores.

The manganoan fayalite forms either monomineralic aggregates or isolated grains within a rhodochrosite matrix. It is as frequent as the magnetite and contains higher amounts of iron.

The associated spessartine forms grains up to 1 cm in size and contains MnO up to 30 wt % and a reduced amount of FeO. The dannemorite is locally largely developed (pegmatoid-like aggregates) forming two varieties with different contents of iron as a function of its position against the magnetite grains. Similar features exhibits the manganophyllite which, in addition, forms veins cutting across the Mn-Fe ores. The pyroxmangite was more rarely encountered.

The rhodochrosite matrix contains fine bands of magnetite and manganoan fayalite, as well as small lenses of spessartine and dannemorite.

Relics of a gedrite-like mineral were observed within the manganophyllite aggregates. Very typical is also the presence of monazite and xenotime, closely associated especially with manganophyllite and magnetite, but also with rhodochrosite, spessartine and manganoan fayalite. Graphite and molybdenite form locally epitaxial-like intergrowths, appearing as inclusions in magnetite. Pyrrhotite and chalcopyrite, as well as pyrite were frequently encountered but in small amounts. Accidentally fine gold grains were observed as inclusions in magnetite.

The ores at Răskoala is presumed to be of sedimentary origin, lately metamorphosed under conditions of almandine-amphibolite facies. The presence of manganoan fayalite and of monazite and xenotime is a typical feature of the Răskoala occurrence, pointing out significant variations across the manganiferous belt in the Sebeș-Cibin Mts.

## THE MANGANOAN FAYALITE AT RĂZOARE, PRELUCA MTS

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The Precambrian Mn-Fe deposits at Răzoare, Preluca Mts, Romania, display a well-developed layering with a lower carbonate (rhodochrosite)-dominated part and an upper silicate (dannemorite)-rich part (Udubaș et al., in press). The most typical features of the deposits are the abundant presence of some manganese-bearing humites closely associated with tephroite and jacobsonite (Hârtopan et al., in press) and the coexistence of two olivines, i.e. tephroite and manganoan fayalite (labelled knebelite in the earlier papers). However, the two olivines show distinct positions within the Mn-Fe rock sequence and different associations.

The manganoan fayalite is a feature characteristic of both main parts of the layered Mn-Fe sequence; as a result of better preservation it may now be observed more frequently in the lower, rhodochrosite-rich part; in the upper, silicate part the manganoan fayalite was largely transformed into dannemorite. Lenses and thin beds rich in manganoan fayalite, locally reaching several dm in size, typically occur in a rhodochrosite-rich matrix. The fayalite-rich parts contain also abundant apatite, calderitic spessartine as well as pyroxmangite, magnetite and/or pyrrhotite, forming alternating bands of metamorphic origin; the banding is locally enhanced by the development of dannemorite at the expense of manganoan fayalite.





Two varieties of manganoan fayalite have been observed, i.e. a black, fine grained variety and an olive variety commonly forming larger grains reaching 1 cm (or more) in size. The chemical composition is marked by a FeO:MnO ratio greater than the unit (from 26.83:25=69 to 31.01:22.74, the last one being typical of the black variety) and by relatively low MgO (2.05-3.42 %) and CaO (2.10-4.37 %) contents. Under the microscope the manganoan fayalite forms grains locally with well developed faces – (010, 101, 100, 110, 021, 120) – in which two cleavages, i.e. [101] and [100] may be observed, as well as twins and separations. The angle of optical axes is of about  $50^\circ$  and the optical sign is negative.

X-ray diffraction data and the IR spectra show patterns characteristic of fayalite, in accordance with the chemical analyses in which the FeO contents exceed (sometimes they are twice as compared to) the MnO contents. The cell parameters show a relatively wide variation from nearly relative pure fayalite to the manganoan fayalite:

	a	b	c	$V\text{\AA}^3$
fayalite	4.8220	10.4830	6.0950	308.096
Sample 60 Rz	4.8268	10.5265	6.1224	311.078
Mn-fayalite	4.8680	10.5880	6.1570	317.346
Sample 2B Rz	4.8588	10.5953	6.1703	317.653
tephroite	4.8780	10.5600	6.2260	320.712

The contents in the minor elements so far analyzed are low (e.g. 6-120 ppm Ni, 17-170 ppm Co, 100 ppm-1.2 % Al, 10-85 ppm Ti, mostly less than 5 ppm V, 3-26 ppm Cu etc), a feature contrasting the richness in minor elements of the magmatic fayalites.

The most frequent associates of the manganoan fayalite are the apatite and the calderitic spessartine. The latter forms together with fayalite and a rarely formed (relic) orthopyroxene the earliest assemblage, pointing out a high metamorphic event in the polymetamorphic evolution of the Mn-Fe-bearing rock pile. A common transformation of the manganoan fayalite is related to its replacement by dannemorite. The replacement begins with the development of a fine intergrowth of dannemorite + magnetite forming veinlets in, or coronas around, the fayalite grains. This magnetite represents the second generation, the magnetite-1 being related to fine bands altering with silicates.

The fayalite-bearing rocks of Răzoare bear similarities with the rocks called queluzites (low oxide silicate-carbonate rocks) and are believed to have formed in a sedimentary environment from a primary layered protolith. Sulphur isotope analyses of pyrrhotite and pyrite forming bands within the carbonate-silicate sequence show an interval of  $\delta^{34}\text{S}$  variation between -6.3 and 18.12 ‰, significantly different from the  $\delta^{34}$  values of magmatic sulphides.

## DOLOMITE NUCLEATION AND GROWTH IN DOLOCRETES OF AGÎRBICIU, CLUJ

A. Hosu, I. Bedelea (Cluj-Napoca)

## MINERAL ASSEMBLAGES OF A METAMORPHOSED IRON-COPPER-NICKEL MINERALIZATION FROM THE SEMENIC MOUNTAINS

O.-G. Iancu (Iași)

Nearby Silagiu village, on the Guranului Brook, a metamorphosed Fe-Cu-Ni mineralization was identified in a lense-shaped amphibolite body situated within the gneisses belonging to the Lotru Group.





The mineral assemblage consists of fifteen ore minerals in which nickeliferous monoclinic pyrrhotite prevails. In addition, hexagonal pyrrhotite, chalcopyrite, pyrite, pentlandite, millerite, marcasite, covellite, and magnetite were microscopically identified. Molybdenite and gold were identified by XRD. Chemical analysis on the host rock gave an average content of 0.4 ppm Au.

The host rock sequence contains metagabbros (massive amphibolites) and foliated amphibolites with biotite. The chemical analysis of massive amphibolites indicated values of 37.80 %  $\text{SiO}_2$ , 1.61 %  $\text{TiO}_2$ , 7.10 %  $\text{Al}_2\text{O}_3$ , 8.42 %  $\text{Fe}_2\text{O}_3$ , 3.33 %  $\text{FeO}$ , 0.26 %  $\text{MnO}$ , 8.45 %  $\text{MgO}$ , 23.80 %  $\text{CaO}$ , 0.52 %  $\text{K}_2\text{O}$ , 1.60 %  $\text{Na}_2\text{O}$ , 2.10 %  $\text{P}_2\text{O}_5$ , and 5.01 % l.o.i. As to the foliated amphibolites, the chemical analysis indicated higher values for  $\text{Al}_2\text{O}_3$  (15.71 %),  $\text{Fe}_2\text{O}_3$  (13.28 %),  $\text{FeO}$  (3.77 %) and lower values for  $\text{MgO}$  (6.70 %),  $\text{CaO}$  (16.86 %) and  $\text{TiO}_2$  (0.93 %).

Also, the way of occurrence of this mineralization is different as function of the rock type; in the metagabbros the Fe-Cu-Ni sulphides (mainly pyrrhotite) occur as fine disseminations whereas in the foliated amphibolites they occur dispersely or as fine bands disposed parallel to the foliation. An important transformation within the ore as the whole, related to the metamorphic deformations is marked especially by the pyrrhotite pyritization.

The quantitative spectrographic analysis done on the magnetic concentrate, prevailingly consisting of hexagonal and monoclinic pyrrhotite from the two types of amphibolites, shows values ranging between 3500 and 5100 ppm Ti, 700 and 1700 ppm Ni, 500 and 1500 ppm Cu.

The result of one sulphur isotope analysis performed on the pyrrhotite from the foliated amphibolites is 7.61 ‰ for  $\delta^{34}\text{S}$ .

As regards the ore genesis, one can acknowledge the existence of a liquid-magmatic (synmagmatic) Cu-Ni sulphides mineralizations hosted by gabbros. The presence of many calcite veinlets and of Ba (about 1000 ppm) in the amphibolic rocks, indicate the existence of active hydrothermal activity in the final stage, after the crystallization of silicates and sulphides, when replacement of the nickeliferous initial sulphides by Fe-Cu-Ni sulphides often occurs. Thus, one can explain the occurrence of the secondary monoclinic pyrrhotite from the primary hexagonal pyrrhotite.

Taking into account the classification made by Godlevski and Lihacev (1979), which is based on the Mg concentration of the host rock, the Ni:Cu ratio and the  $\delta^{34}\text{S}$  value of sulphides, the mineralization from the Guranului Brook can be assigned to the medium temperature group of the Ni-Cu magmatic ore deposits.

## SUPERPOSED PARAGENESES IN HIGH-GRADE METAMORPHIC ROCKS OF THE SOUTH CARPATHIANS (ROMANIA)

Viorica Iancu, M. Mărunțiu (București)

High-grade metamorphics of the South Carpathians are tectonic inclusions (lenses, slices, slabs) in Precambrian crustal and supracrustal litho-structural assemblages (Sebeș, Lotru, Cumpăna Groups) disposed as a complex pile of ante-Paleozoic nappes.

The main types of high-grade metamorphic rocks, with paleogeotectonic significance are:

1. *Anisofacial exotic rocks constituting an obliterated regional deep-seated shear zone: eclogites, granulites, metaultramafics.* Country rocks are crustals of the Sebeș and Cumpăna Groups. Eclogitic stage parageneses (in eclogites and metaultramafics) are partly re-equilibrated in high-pressure granulitic stage (table) sometimes under dynamic conditions (oriented and flattened microstructures). Medium-pressure granulitic parageneses from the coronitic and symplectitic microstructures reflect a decompression stage before amphibolitisation.





**Tabel**  
 Paragenetic diagram of anisofacial high-grade metamorphic  
 rocks of Sebeş Group (South Carpathians)

	Stage Phase	Eclogitic	Granulitic		Amphibolitic	
			HP	MP	M <sub>1</sub>	M <sub>2</sub>
eclogitic rocks	clinopyroxene	omph	cpx <sub>1</sub>	cpx <sub>2</sub>		
	garnet	Mg				
	kyanite					
	rutile					
	zoisite					
	quartz					
	orthopyroxene					
	plagioclase					
	spinel					
	amphibole			Mg hb.	hb.	hb.
	ilmenite					
	sphene					
granulitic rocks	garnet					
	clinopyroxene					
	zoisite					
	rutile					
	plagioclase					
	K-feldspar					
	kyanite					
	spinel					
	sillimanite					
	quartz					
	biotite					
	muscovite					
	staurolite					
ultramafic rocks	olivine					
	clinopyroxene					
	orthopyroxene					
	garnet					
	spinel					
	amphibole			Mg	trem.	trem.
	chlorite				antoph.	
	talc					

Abbreviations: HP-high pressure  
 MP-medium pressure





First stage parageneses of granulitic rocks (mafic, leucocrate and banded) are of high-pressure type, followed by medium-pressure granulitic parageneses (coronas, symplectitic replacements). All these rocks contain superposed parageneses and structural readjustment under amphibolitic facies conditions, in two successive stages, simultaneous with prograde thermo-dynamic events  $M_1$  and  $M_2$  of country rocks.

Successive retrograde re-equilibration of the exotic high-grade rocks under different PT conditions and in dynamic or static regime are related to ascendent tectonic migration of a recycled lower crust enclosed in prograde supracrustal complexes.

2. *Medium to high-grade metamorphic rocks from terranes of oceanic affinity.* High-grade parageneses are preserved in mafic rocks (garnet-bearing gabbros, eclogites) associated with ultramafic rocks representing dismembered oceanic crust blocks in crustal-supracrustal Lotru Group. Inherited magmatic parageneses co-exist with garnet-clinopyroxene parageneses. Eclogitic rocks contain the following succession of parageneses: garnet+omphacite± kyanite±quartz+rutile (eclogitic stage), garnet<sub>2</sub>+diopside+plagioclase+quartz+brown hornblende (granulitic stage), green hornblende+plagioclase+titanite ( $M_1+M_2$  amphibolitic stage).

The first prograde evolution of the protolith reflects a subduction-type evolution followed by a retrograde (obduction) type evolution.

3. *Low-pressure granulitic rocks in crustal complexes (Ursu Group).* The initial HT-LP parageneses are preserved in granuloblastic leucocratic lenses (garnet+Mg-cordierite+K-feldspar) and in mafic banded rocks (clinopyroxene+plagioclase). Retrograde partial re-equilibration is proved by sillimanite+biotite+cordierite<sub>2</sub>+plagioclase+K-feldspar and hornblende+plagioclase parageneses in a dynamic extensional regime (blastomylonitic gneisses). Amphibolitic facies reactivation has taken place in two regional compressive events, proved by biotite+plagioclase+spinel+quartz ( $M_1$ ) and andalusite+muscovite+biotite ( $M_2$ ) neoblasteses in felsic/pelitic rocks.

4. *High to medium metamorphism in granulite-gneissic domes (older terrains - Cumpăna group, Brebu gneisses).*

Dominantly magmatic protoliths (mostly of granitic-granodioritic-tonalitic compositions, subordinately gabbroic ones) contain mineralogic proofs of an initially progressive high-grade (granulitic) in situ metamorphism. Albești metagranites contain a well-preserved magmatic paragenesis (plagioclase, quartz, K-feldspar, biotite, cordierite, zircon, apatite, monazite) and biotite+plagioclase→garnet (+diopside+K-feldspar?) sub-solidus reaction in coronas; there is an intimate association with granulitic rocks of different compositions with which they subsequently underwent a dynamic retrogression to amphibolitic  $M_1$ ,  $M_2$  (biotite, muscovite, quartz, plagioclase) and greenschists facies (chlorite, muscovite, epidote/clinozoisite). In the Brebu gneisses relict granuloblastic lithons, the oldest parageneses consist of: garnet<sub>1</sub>+basic plagioclase+quartz, followed by retrograde parageneses: garnet<sub>2</sub>+biotite+plagioclase<sub>2</sub> (23–25An)( $M_1$ ) and muscovite+plagioclase<sub>3</sub> (14–17An)( $M_2$ ), well developed in marginal, foliated gneisses. Mafic granulites from these terrains preserve relict granulitic parageneses-clinopyroxene+plagioclase+garnet+rutile.

High-grade metamorphic rocks in the South Carpathians reflect interference proofs (parageneses and structures) of migmatic and anatexis processes in different successive events.





# BISMUTH SULPHOSALT ASSEMBLAGES IN COPPER ORE DEPOSITS AT ORAVITA-CICLOVA, SOUTH-WESTERN BANAT

Gh. Ilinca (București)

In the Oravița-Ciclova area, copper-rich ores located in the contact zone between Upper Cretaceous – Eocene magmatites (granodiorites, monzodiorites) and predominantly carbonate sedimentary deposits of Upper Jurassic – Lower Cretaceous age, contain various bismuth sulphosalts as ubiquitous, minute inclusions or individual grains associated with chalcopyrite, tetrahedrite, chalcocite, pyrite, arsenopyrite, hematite and magnetite.

The bismuth minerals were studied by optical methods, as bulk material for X-ray investigations was scarce. However, seemingly questionable diagnoses were supported by quantitative electron microprobe and reflectance data. The following species were identified: galenobismutite, cosalite, lillianite, pavonite, hammarite, krupkaite, wittichenite, emplectite, bismuthinite and native bismuth. A doubtful phase with a  $PbS:Bi_2S_3$  ratio of about 54:36 mol %, matching the composition of kobellite – but with no Sb – was also found. Main quantitative chemical and reflectance data available so far, are given in the tables 1 and 2.

The Pb-Bi sulphosalts display a general tendency towards increased  $PbS:Bi_2S_3$  ratio. The highest temperature phase – galenobismutite – commonly breaks-down to form cosalite and lillianite, both associated with bismuthinite and bismuth. Cosalite has been observed to pseudomorph fully or partially galenobismutite, or to contain tiny bladed inclusions of pavonite, bismuthinite and bismuth.

Table 1 – Electron microprobe analyses (in wt %) of some Bi-sulphosalts from Oravița-Ciclova<sup>1</sup>

Mineral	Ag	Cu	Pb	Bi	S	Formula <sup>2</sup>
cosalite		1.15	42.22	43.22	14.39	$Cu_{0.20}Pb_{2.24}Bi_{2.28}S_5$
lillianite		0.34	48.57	35.98	15.11	$Cu_{0.07}Pb_{2.99}Bi_{2.19}S_6$
pavonite	12.72			70.92	16.36	$Ag_{1.16}Bi_{3.33}S_5$
hammarite		6.66	25.65	52.07	16.52	$Cu_{1.83}Pb_{2.25}Bi_{4.35}S_9$
hammarite		7.20	22.74	53.66	16.40	$Cu_{1.93}Pb_{1.19}Bi_{4.52}S_9$
hammarite		7.82	18.61	54.95	18.62	$Cu_{1.91}Pb_{1.39}Bi_{4.07}S_9$
hammarite		7.92	19.74	54.36	17.98	$Cu_{2.00}Pb_{1.53}Bi_{4.18}S_9$
krupkaite		5.46	20.97	57.33	16.24	$Cu_{2.04}Pb_{2.40}Bi_{6.49}S_{12}$
wittichenite		39.32		41.25	19.43	$Cu_{3.06}Bi_{0.98}S_3$
wittichenite		40.20		40.86	18.94	$Cu_{3.21}Bi_{0.99}S_3$
wittichenite		40.43		40.09	19.48	$Cu_{3.14}Bi_{0.95}S_3$

1) weight percentages recalculated for 100 %;

2) analyses were normalized for a fixed number of S.

Table 2 – Measured reflectivities ( $R_{min}$ – $R_{max}$ , %) of some Bi-sulphosalts from Oravița-Ciclova

mineral	WL (nm)			
	488	553	590	650
galenobismutite	46.32–50.75	43.67–48.20	41.21–45.46	40.78–43.83
cosalite	34.20–39.73	32.87–38.21	32.10–35.73	28.56–30.66
cosalite	34.09–36.72	32.85–35.11	30.54–32.61	28.40–29.44
krupkaite	35.85–41.25	36.10–41.96	37.66–44.05	36.09–39.69
kobellite (?)	39.57–48.69	35.96–43.25	37.66–39.47	30.65–35.88
bismuthinite	41.38–49.10	45.15–53.46	45.50–54.91	37.43–46.99

A strong copper-metasomatism affecting the Pb-Bi-sulphosalts, might be stressed. It results in replacement products such as Cu-Pb-Bi (hammarite, krupkaite) or Cu-Bi (wittichenite, emplectite) sulphosalts. Beside the reaction product, wittichenite, occurs as a primary phase, forming lamellar exsolution intergrowths with chalcopyrite. Rather than the more common wittichenite-bornite exsolution, this paragenetic association points to a temperature of about 300° C. Bismuthinite is the most wide-spread Bi mineral. It occurs either as





reaction product between Pb-Bi sulphosalts and copper-rich phases or as a primary phase, forming myrmekitic intergrowths with chalcopyrite, most probably of metasomatic origin.

## REFBASE – A COMPUTER PROGRAM FOR HANDLING MINERALOGICAL REFERENCE DATA

*Gh. Ilinca (Bucureşti)*

The described program is intended to simulate and therefore to offer a good substitute for the classical reference card-file collections used by most individual mineralogists. It is in fact a small database, having all the basic functions of an application of this type, i.e. entry and storage of data, searching, sorting, browsing, editing, as well as a variety of output options. REFBASE offers a friendly, yet powerful user interface comprising dialogue boxes, text viewers, error messages, command menus and buttons, either accessible by keyboard or mouse action, all making the application very easy to deal with.

Among the basic elements of a reference file (authors, year, title, publication, source library, library code). REFBASE accepts three types of mineral-oriented key-words, which were successfully experienced by the author in current searching and sorting operations performed on mineralogical literature, i. e. (1) mentioned minerals (no descriptions available), (2) described minerals (diagnoses supported by physical and/or chemical investigations), (3) determinative methods and mineralogical data.

The data are stored in compact sequential ASCII files. Unlike most databases, REFBASE makes no predefinition of storage space for the records, resulting in significantly reduced disk-space allocation (no gaps whatsoever). The amount occupied on disk is practically the same with the volume of input records regardless of the very "elastic" structure shared by reference data (different number of authors, titles of variable length etc). Due to the simple structured storage files, it is possible to alter data using not only the REFBASE, build-in editing facilities, but any common, non-document text editor. A feature that proved to be useful in large-scaled modifications of stored data. The entry of data is performed within a standard form simulating a double-faced card-file. Long or frequently repeating names of authors and publications may be introduced in an abbreviated form, greatly reducing the typing efforts. Any abbreviated input is converted to its full form by an internal, maintainable dictionary, whenever this become neccessary. For users with limited access to computer units the program may provide printed collections of reference card-files to be handled in a classical way.

REFBASE performs single-key searching actions on individual or multiple data files; common options as "whole words only" and "ignore case" are also available. Found items are reported as alphabetically sorted lists (in fact, a reference-type ordering) which can be printed in a compressed form – useful for rapid identification of papers in the library – or as a ready-to-use reference chapter to be included in manuscripts. The latter option offers a wide range of printing controls such as face-types, line widths, indents etc. The number of items that can be brought simultaneously on screen, as a result of searching or browsing is limited only by the amount of available memory (e.g. about 500 items on a 1 Mb conventional AT):

REFBASE was written in TURBO PASCAL extensively using elements of TURBO VISION library. It runs on every PC-compatible, though one with a hard-disk is strongly recommended for realistic performance.

REFBASE has already proved its usefulness as a major time and effort saver especially regarding input operations and the editing of reference chapters.





## TYPIFICATION OF NATURAL DIAMOND

V. N. Kvasnitsa, A. A. Valter (Kiev)

The existing classifications of natural diamond take into account the most important genetical group, i.e. the mantle diamonds. However, there also exist other types of diamonds with a rather wide distribution, such as lower crust diamonds, shock-derived diamonds in crustal rocks and diamonds in meteorites as well. The "colloidal" diamond from chondrites is of cosmic origin.

The upper mantle diamonds form in silicate melts ranging in composition from peridotites to eclogites, and they reach the Earth's crust by kimberlite and lamproite eruptions. The geochemical environment of diamond formation may be reconstructed from the crystal structure of the diamond, isotopic composition of carbon, as well as from the composition of solid inclusions in diamonds; contrasting evidences provide the diamonds from xenolith in peridotites and eclogites. Stability of diamond crystals in the crustal rocks depends on the eruption velocity, the existence of  $\text{CO}_2$ ,  $\text{H}_2\text{O}$  etc.

Most of upper mantle diamonds form euhedral crystal with complex growth, which suggests a quite discrete process of diamond formation as well as changes of the growth mechanisms. The most probable parameters of diamond formation are: P of 4–6 GPa, T of  $1\text{--}1.5 \cdot 10^{30}$  C. Growth of crystals under such conditions means diffusion-induced chemical reactions and carbon isotopic fractionation.

Diamond crystallization seems to be possible at depths of about 100 km under conditions of a silicate-dominated mantle of composition near that of the carbon-bearing chondrites containing also a significant carbon content.

In the metamorphic rocks some small (tenth of  $\mu\text{m}$  in size) diamond crystals and/or aggregates may occur under conditions of lower P and T. The presence of cubic and skeletal crystals as well as of diamond aggregates suggests carbon supersaturation, rapid growth and, probably, a great rate of cooling. Sobolev et al. (1987, 1988) stated that such diamond have formed in the Earth's crust.

Shock induced, graphite-bearing rocks may contain also diamond as a result of the fall of giant meteorites. Paramorphs of diamond after graphite indicate pressures of about (or greater than) 60 GPa and residual temperatures of about  $1800^\circ\text{C}$ . Graphite undergoing shock metamorphic effects transforms firstly into lonsdaleite reaching one nanometer in size. After shock compressions of duration not greater than few tenth of second growth of the primary small crystals as well as the transformation of lonsdaleite into diamond occur, forming crystals up to one micrometer in size. The orientation of the crystals inherits the primary structure of the graphite matrix. In such paramorphs oriented nitrogen centers may appear.

The "colloidal" (condensing) diamond was discovered by Lewis et al. (1987) in some chondrites. It forms at pressures of about  $10^2$  Pa and temperatures of  $1\text{--}1.5 \cdot 10^3$  K. The formation of "colloidal" diamonds implies the existence of high activation energy allowing nucleation of diamond along with graphite.

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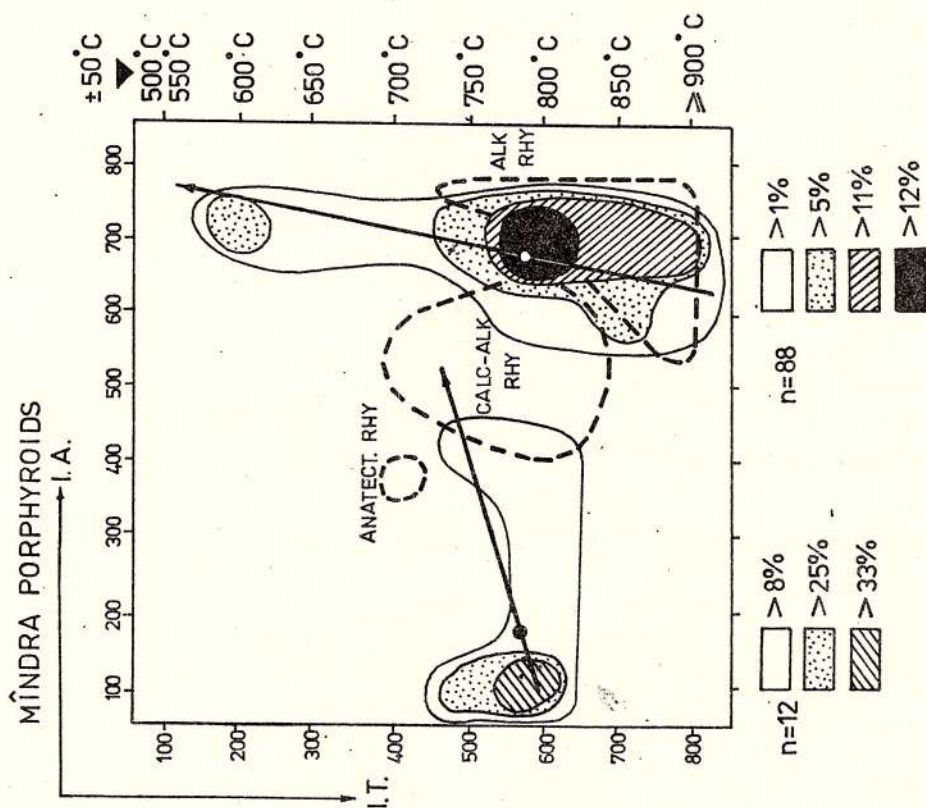
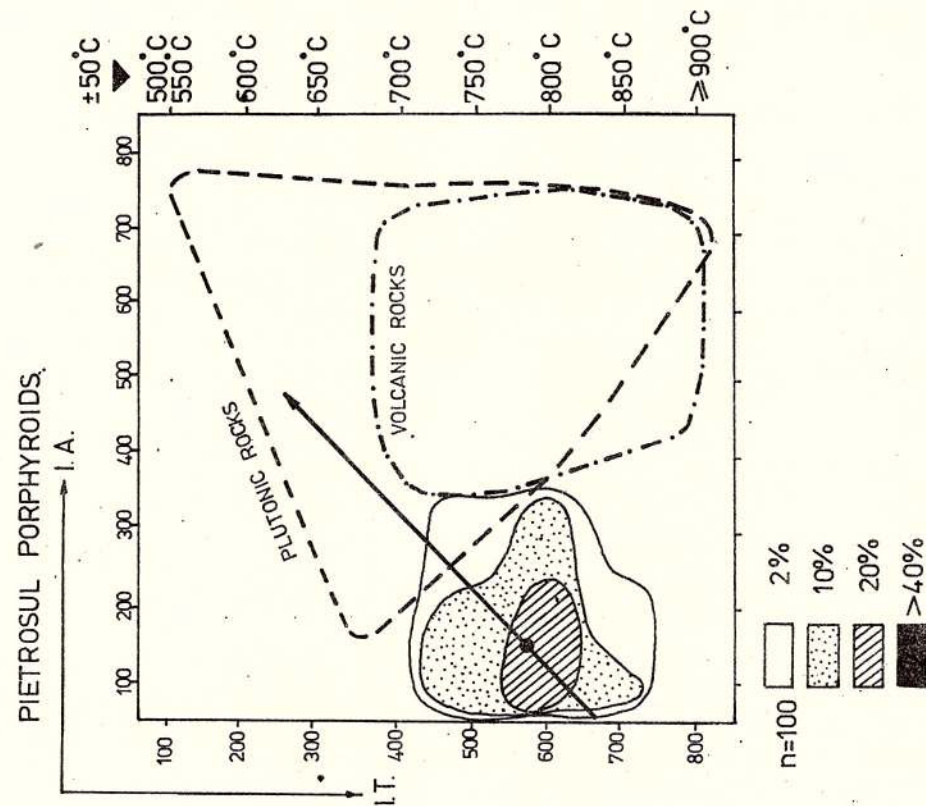
## ZIRCON TYPOLOGY IN PORPHYROIDS OF THE EAST CARPATHIANS

H. G. Kräutner, Lucia Robu, N. I. Robu, G. Bindea (București)

The two main porphyroid types of the East Carpathians, Mindra Porphyroids (Cambrian alkali-feldspar metarhyolites) and Pietrosul Porphyroids (metadacites) differ by the contrasting zircon crystal morphology. Zircons from the Mindra Porphyroids belong to two distinct populations. The most important one (88 %) suggests (according to Pupin's typological evolutionary trend diagram) crystallisation temperatures of  $750\text{--}850^\circ\text{C}$  in an alkali-rich environment of calc-alkaline magmatic series, typical of rhyolites. The second one, low-populated collectivity (12 %), is consistent with an Al-rich environment of crustal (SiAl) type and probably represents zircon crystals included during magma ascension from the gneissic envelope. From the Pietrosul Porphyroids a single homogeneous zircon population was recorded. Its typological evolutionary trend suggests crystallization temperatures of  $700\text{--}800^\circ\text{C}$  in an Al-rich crustal environment, pointing to an anatectic origin. The mentioned differences cannot be explained only by the chemical differences due to the rhyolitic and dacitic constitution of the rocks. Therefore, it seems that the Mindra and Pietrosul Porphyroids evolved in different geotectonic environments.









## LA MINÉRALOGIE DES OXIDES DE Nb ET Ta DES MIGMATITES AU NORD DES MONTS DE SEBEŞ

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Dans l'ensemble amphybolitique qui fait partie de la série mésométamorphique de Sebeş sont signalés quelques corps de migmatites qui ont dans leurs composition minéralogique une paragenèse complexe de minéraux rares et radioactives parmi lesquels les oxides de Nb et Ta. L'étude microscopique met en évidence la présence de ces minéraux dans les zones où se développent la magnétite et la biotite et ont été diagnostiqués le pyrochlore, la fergusonite, et, en quantité plus réduite la columbite et l'aeschynite (-Y) (priorite)

Le pyrochlore  $(Ca, Na, Y, U, Th)_2(Nb, Ta, Ti)_6O_6(OH, F, O)$  se présente en granules inaltérées, isotropiques, à des dimensions entre 0,01 et 0,17 mm. Les agglomérations de grains de pyrochlore se trouvent associées avec le zircon et se développent dans le feldspath ou à proximité des lamelles de biotite.

L'analyse des images de composition et la distribution des éléments chimiques dans les minéraux, qui ont été obtenue avec la microsonde électronique et avec les analyses en RX met en évidence la distribution uniforme du Nb et de la série Ca-Y-U dans les concentrations d'agglomérations granulaires. Ça signifie que le minéral de Nb est le pyrochlore uranifère avec un peu de Ta.

La fergusonite  $(Y, Ca, Fe, Er, Ce)(Nb, Ta, Ti)O_4$ , se présente en agrégats granulaires formés par des granules isotropes et anisotropes, quelque fois sur la bordure des granules s'observe le début d'opacification. La fergusonite est associée avec le zircon et la thorite ou se présente solitaire en quartz et biotite. Les analyses optoélectroniques et RX mettent en évidence la distribution uniforme du Ca, Y, Fe ce qui explique la formule chimique complexe de ce minéral.

La columbite  $(Fe, Mn)(Nb, Ta)_2O_6$  et l'aeschynite (-Y)(priorite)  $(Y, Ce, Th, Ca, Na, U)(Ti, Nb, Ta)_6O_6$  sont emplacés d'habitude sur la limite entre le quartz et le microcline; ils ont de petites dimensions ce qui fait très difficile l'étude microscopique.

La présence de ces minéraux dans les migmatites, au bord septentrional des monts de Sebeş est confirmé aussi par les analyses spectrales qui indiquent une concentration moyenne de 0,117 %  $Nb_2O_5$ . Le rapport Nb/Ta présent des valeurs entre 10/1 et 30/1. La présence du pyrochlore, de la fergusonite et de la columbite a été signalée, dans des concentrations moins importantes sur le territoire de la Roumanie, mais l'aeschynite (-Y) est signalé ici pour la première fois et, en association avec les autres, dans des accumulations d'intérêt industriel.

## LUDWIGITE, SZAIBELYITE AND PYROAURITE AT CACOVA IERII (GILĂU MOUNTAINS): NEW OCCURRENCES IN THE ROMANIAN BANATITIC PROVINCE

*Şt. Marincea, Corina Cristea (Bucureşti)*

On the eastern border of the Gilău crystalline massif (Apuseni Mountains), at Cacoşa Ierii, a new occurrence of magnesian borates (ludwigite and szaibelyite) and the first Romanian occurrence of pyroaurite were found. These minerals occur in some magnesian skarns developed at the contact between the Miei-Cacoşa granodioritic body (Danian-Ypresian in age) and the dolomitic marbles of the Baia de Arieş (Vulturese-Belioara ?) Series.

The mineral association includes, beside the above mentioned minerals: forsterite (with only 0.13-4.58 % fayalite in solid solution), clinohumite, calcite, dolomite, magnetite, crysotile, brucite, pyrite, pyrrhotite and marcasite. Both szaibelyite and pyroaurite were found as alteration products of the primary magnesian borates (i.e. ludwigite). Pyroaurite, the rarest of them, is restricted to high-altered zones.

Ludwigite, previously supposed at Cacoşa Ierii by Lazăr et al. (1984), occurs in radiating aggregates of long prismatic or needle-like crystals. A practically opaque behaviour and mean reflectivities varying between 9.235 and 11.520 % indicate a medium vonsenite content in the solid solution. A relatively high ferricity can also be





supposed based on some peculiarities of the IR absorption spectrum (the  $\nu_5$  stretching of the  $\text{BO}_3^{3-}$  group was recorded at  $1248\text{ cm}^{-1}$ ). However, a least squares refinement of cell-parameters, based on the X-ray powder diffraction data, yielded for a ludwigite from Cacova Ierii the values:  $a=9.247\text{ \AA}$ ;  $b=12.319\text{ \AA}$ ; and  $c=3.041\text{ \AA}$ . These indicate, as well as the cell volume ( $V=346.41\text{ \AA}^3$ ), a magnesium rich member of the ludwigite-vonsenite series. Wet-chemical and microprobe analyses show that the mineral can be considered "magnesioludwigite" sensu Aleksandrov (1982). It displays limited quantitative variations in both octahedrally coordinated cations in M 4 sites ( $\text{Fe}^{3+}$ , Al,  $\text{Ti}^{4+}$ ) and in M 3 sites ( $\text{Fe}^{2+}$ ,  $\text{Mg}^{2+}$ ). The vonsenitic content is about 10–18 % and the contents of alumoludwigite and azoprite are minor, below 6% and 2% respectively.

Szaibelyite generally occurs beside magnetite in sheave-like or in radiating aggregates which represent pseudomorphs after ludwigite. The aggregates of szaibelyite have a mean index of refraction near 1.65, which indicates a low content of sussexite. Chemical analyses show that the mineral contains 2.32–5.89 %  $\text{Fe}(\text{BO}_2)(\text{OH})$  and 0.00–0.66 %  $\text{Mn}(\text{BO}_2)(\text{OH})$  in solid solution. Lattice parameters are  $a_o=12.570\text{ \AA}$ ,  $b_o=10.371\text{ \AA}$ ,  $c_o=3.136\text{ \AA}$ ,  $\beta=95^\circ 30'$ .

The presence of pyroaurite at Cacova Ierii was emphasized based on some strongest X-ray powder diffraction lines at  $7.782\text{ \AA}$ ;  $3.887\text{ \AA}$ ;  $2.605\text{ \AA}$ ;  $2.326\text{ \AA}$  and  $1.547\text{ \AA}$ . Indexing of these lines suggests that this mineral is the 3R polytype of  $\text{Mg}_6\text{Fe}^{3+}_2(\text{CO}_3)(\text{OH})_{16}\cdot 4\text{H}_2\text{O}$ . This conclusion is supported by average values of the discrepancies between calculated and observed spacings in both 3R and II hypothesis of symmetry. Microprobe analyses of the mineral indicate a common  $\text{M}^{2+}:\text{M}^{3+}$  ratio, of about 3:1, the  $(\text{Mg}+\text{Mn}^{2+}):(\text{Fe}^{3+}+\text{Al})$  ratio being 2.63:1. This could explain the values which were refined for the cell-parameters of the mineral:  $a_o=3.0933\text{ \AA}$  and  $c_o=23.347\text{ \AA}$ .

Based on the above-mentioned data and on some experimental topologies it might be established that the main physical and chemical conditions which governed the mineral evolution in the ludwigite – magnetite + szaibelyite + brucite – magnetite + pyroaurite + sassolite (?) sequence were the following: (a) – a continuous decreasing temperature, between  $650^\circ\text{C}$  and  $300\text{--}350^\circ\text{C}$ ; (b) – a persisting negative Eh (a low  $\mu\text{O}_2$ ); (c) – a low alkalinity of the "mineralizing" solutions.

## TSCHERMIGITE OF VOINEȘTI – FIRST OCCURRENCE IN ROMANIA

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Monomineralic aggregates of a milky-white, translucent and weak mineral have been recently found in a pit dug for water in terrace deposits of the Dimbovița River near Voinești, north of Tîrgoviște. The pockets may reach 10–15 cm in size and are enveloped in a clay matrix; the clay-rich rocks contain also fragments of micaschists and are overlain by sandy deposits. The mineral which proved to be tschermigite was found only over the hydrostatic level.

X-ray diffraction analyses, DTA and IR spectra are consistent with a pure tschermigite,  $\text{NH}_4\text{Al}(\text{SiO}_3)_2\cdot 12\text{H}_2\text{O}$ . No signals characteristic of K or Na were obtained at the electron microprobe. In addition, wet chemical analyses gave only 0.03 %  $\text{Na}_2\text{O}$  and 0.03 %  $\text{K}_2\text{O}$ , and 35.75 %  $\text{SO}_3$  and 11.49 %  $\text{Al}_2\text{O}_3$  comparable with literature data. The DTA gave three endothermal peaks at  $145^\circ$ ,  $590^\circ$  and  $900^\circ\text{C}$ , the final products being an amorphous white powder, which has a double volume as compared to the initial material. The mineral grew like a cake during heating in the DTA device.

As concerns the genesis of this tschermigite occurrence little is known now. The  $\text{SO}_3$  may originate in gypsum occurring in the underlying Tertiary deposits containing also coals. The  $\text{NH}_4$  derives from coals (?) and also probably from some recent organic material of unknown origin.





# L'ALABANDITE (MnS), SES ASSOCIATIONS, SES PARAGENESES COMPLEXES. CAS DES HAUTES-PYRINEES (FRANCE) ET DES MONTS METALLIFERES (TRANSYLVANIE-ROUMANIE)

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Les sites de Nabias, d'Adervielle (Hautes Pyrénées-France) et de Săcărimb-Nagyag (Monts Métallifères-Roumanie) présentent certaines associations, comparables toutes riches en manganèse. Il s'agit d'associations très complexes de sulfures (alabandite, millérite, violarite, pyrite, sphalérite, cuivre gris, galène, ...), de silicates de manganèse et de rhodochrosite.

Face à une telle variété de sulfures et de minéraux de manganèse, on peut se demander s'ils appartiennent à plusieurs générations ou à un système à l'équilibre c'est à dire compatible avec les mêmes conditions de température, de Eh, de pH, de fugacité d'oxygène et de soufre. Si de telles conditions existent, il convient de déterminer comment elles se situent par rapport aux histoires géologiques régionales.

Dans les Hautes Pyrénées les concentrations manganésifères imprègnent la lyonnaise carbonifère, souvent fortement plissée ou les calcaires du Dévonien supérieur. L'alabandite et son cortège apparaissent dans des filons et des veinules où les sulfures sont quelquefois remplacés par des carbonates et des silicates. Le métamorphisme régional explique l'apparition de certains silicates de manganèse. La présence d'une série de minéraux rares (la helvite, la welinite, la vuorilainite) mis en évidence par Ragu (1990) doit être mise au compte d'une phase tardive pneumatolitique en relation avec l'intrusion des massifs granitiques voisins. Les données géochimiques confirment le caractère "hydrothermal" du manganèse de ces concentrations des Hautes Pyrénées et sa relation distale avec le volcanisme. La tectonique régionale est essentiellement marquée par l'intensité de la compression, du plissement et des chevauchements successifs vers le Sud.

On rencontre dans les Monts Métallifères des associations identiques avec l'alabandite, mais on observe en outre sulfo-tellurures d'or et d'argent. Ces concentrations épigénétiques sont liées au processus de subduction du Néogène et au magmatisme andésitique associé. Le minerai remplit un vaste réseau hydrothermal. L'alabandite, premier sulfure dans la paragenèse des filons hydrothermal est associé à la sphalérite, à la pyrite, à la galène, aux cuivres gris, à la nagyagite et à la rhodochrosite.

Après l'observation en lumière réfléchie et la recherche des éléments présents à l'aide de la microsonde électronique (Camebax), l'analyse ponctuelle a été limitée aux seuls constituants dont la teneur soit significative, variable suivant les sulfures: S, Se, Te, Fe, Mn, Co, Ni, Bi, Zn, Cu, Ag, Au, Sb. Les résultats correspondent à des séries de 10 à 40 mesures exprimées en atome pour cent, ont été retenues que les analyses dont le total en poids est compris entre 99,9 et 100,1. L'écart type n'est donné que pour les éléments majeurs.

L'alabandite de Nabias, comme d'ailleurs celle de Adervielle (Hautes Pyrénées), fournissent des résultats qui montrent une légère dispersion, alors que ceux concernant les échantillons de Săcărimb (Monts Métallifères) sont bien groupés. Pour les éléments mineurs seuls les éléments Fe, Cu, Co, Zn, et Ni présentent une valeur mesurable qu'il convient de prendre comme seulement indicative. Aucune zonation n'a été mise en évidence ni pour les éléments majeurs ni pour les mineurs. On observe dans la quasi totalité des cas un léger déficit en soufre par rapport à la somme des cations et même par rapport au Mn; la valeur moyenne est en effet pour le soufre de 49,74 et de 50,25 pour la somme des cations.

L'analyse des résultats sur la composition ponctuelle des autres sulfures (pyrite, galène, millérite, sphalérite, violarite) permet de donner les conditions de formation des paragenèses: pH élevé de l'ordre de 8, Eh réducteur de l'ordre de -0,5 en accord avec la valeur estimée de la fugacité de soufre  $10^{-8}$  à  $10^{-5}$  et une fugacité d'oxygène faible de l'ordre de  $10^{-49}$  et enfin une température d'équilibre de  $300^{\circ}\text{C}$ . On peut donc imaginer un métamorphisme moyen sur des roches riches en manganèse associé à des venues profondes de soufre et peut être aussi apport de nickel et de cobalt. La présence de la violarite n'est pas due ici à une transformation de pentlandite. On notera aussi dans les sites étudiés la présence (très faible dans les Hautes Pyrénées, mais très nette dans les Monts Métallifères) d'or quelquefois associé à des tellurures.

Compte tenu de ces observations, on peut proposer un modèle de formation de ce type de dépôts: une formation marine riche en manganèse en milieu peu profond est reprise dans une zone de subduction dont l'activité volcanique associée apporte des éléments métalliques et du soufre. Cette activité hydrothermale couplée à un métamorphisme modéré conduit à des conditions physico-chimiques favorables au cortège des minéraux de manganèse observés et au dépôt conjoint d'or (Sidorov et al., 1980).





## CHROME-SPINELS OF THE TIȘOVITA-IUȚI OPHIOLITIC COMPLEX, ALMĂJ-MOUNTAINS, ROMANIA

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Early Caledonian Tișovița-Iuți ophiolitic complex (TIC) represents a pseudostratiform sequence of the harzburgites, dunites, pyroxenites, gabbros, devoid of volcanics. Four lithologic-textural units are reported: harzburgite tectonites unit, olivine cumulates unit, olivine-clinopyroxene cumulates unit and gabbroic cumulates unit. Lithologically, the lower tectonite unit consists of two rock types, harzburgite and dunite, with tectonic fabric. In the upper cumulate units, the most frequent rocks are dunites, wehrlites, clinopyroxenites, troctolites, gabbros and gabbro-norites with adcumulus textures. The rhythmic layering of cumulates consists of mineral-ratio, grain-size and phase layers. Cyclic phase arrangement in cumulate pile and crystallisation order of cumulus minerals, (i.)  $ol \pm chromite$ ,  $ol + plg$ ,  $ol + plg + cpx$ ,  $plg + cpx$ , and (ii.)  $ol \pm chromite$ ,  $ol + cpx$ ,  $cpx$ , provide evidence for multiple influx of different magmas.

Isolated, elongate lenses of chromite ore are related to the dunitic tectonic bodies associated with harzburgites in lower tectonite unit. Chromite occurs in disseminated, nodular, massive or banded textures with obvious primary cumulus feature. Microscopic studies show two chrome-spinel types. Massive interlocking to isolated euhedral primary chromite crystals are surrounded, penetrated and replaced by chlorite associated with secondary porous spinel-phases. Usually, chlorite occurs in reticular intergrowth with secondary spinels, or like coronas, crystal-fracture filling and massive chromite matrix. Primary chromite grains are homogeneous Al-rich ones ( $Cr/(Cr+Al)=0.25-0.45$ ) with constant  $Fe^{3+}/(Cr+Al+Fe^{3+})$  ratio ( $<0.25$ ). Secondary spinel-phases have ferritchromite compositions with progressively changes toward high  $Fe^{3+}/(Cr+Al+Fe^{3+})$  and low  $Mg/(Mg+Fe)$  ratio, up to magnetite compositions. The breakdown of primary magmatic chromite to form ferritchromite, magnetite and chlorite took place prior to the serpentinization of country rocks at temperatures above that at which lizardite-chrysotile serpentinization occurs.

## ASUPRA PREZENȚEI UNOR PSEUDOMORFOZE DE CALCIT DUPĂ ARAGONIT ÎN ZĂCĂMÎNTUL DE LA CACOVA IERII-BĂIȘOARA, MUNȚII APUSENI

I. Mârza, Lucreția Ghergari, Corina Ionescu, N. Har (Cluj-Napoca)

## MAGNETIT – DRAPERIE STALACTITICĂ – FORMAȚIUNE DE CARST HIDROTERMAL ÎN ZĂCĂMÎNTUL OCNA DE FIER, BANAT

I. Mârza, St. Nicolescu, C. Gruescu (Cluj-Napoca)





## L'ALABANDINE DANS LES GISEMENTS DE ROUMANIE

I. Mârza, Dana Pop (Cluj-Napoca)

La présente contribution représente la première synthèse concernant la répartition et les caractéristiques minéralogiques et roengen-structurales de l'alabandine des gisements du sous-sol roumain. La présence de l'alabandine est connue dans les gisements de Baia de Arieș, Săcărîmb, Căraci (Monts Apuseni), Cavnic, Curățel-Rodna (zone vulcano-plutonique des Carpathes Orientales) et Argeștrul (unité métamorphique de Tulgheș, Carpathes Orientales). On surprend la particularité de l'apparition du sulfure de manganèse dans les conditions suivantes:

- hydrothermales filoniennes (Săcărîmb, Căraci);
- hydrothermales-métasomatiques (Baia de Arieș, Curățel-Rodna);
- vulcanogène-sédimentaires avec épimétamorphisme superposé (Argeștrul, département de Suceava).

La paragenèse de l'alabandine est déterminée par les conditions géochimiques et thermodynamiques du milieu minéralo-génétique; elle est associée avec les suivantes minéraux:

- Baia de Arieș (alabandine, rhodocrosite, manganocalcite, quartz, pyrite, sphalérite, galénite);
- Săcărîmb (alabandine, rhodocrosite, calcite, nagyagite, pyrite);
- Căraci (calcite, quartz, pyrite, sphalérite, galénite);
- Cavnic (rhodocrosite, calcite, quartz, sulfures communs);
- Curățel-Rodna (rhodocrosite, calcite, quartz, sulfures communs);
- Argeștrul (associée au silicates et carbonates de calcium et manganèse, avec du quartz et des sulfures).

Les valeurs roentgen de l'alabandine des occurrences les plus importantes de la Roumanie sont consignées dans le tableau.

Tableau

Baia de Arieș		Săcărîmb		Căraci	
d/n	I	d/n	I	d/n	I
3,0173	3,5	3,0153	3,9	3,0153	4,8
2,6047	100,0	2,6047	100,0	2,6077	100,0
1,8433	27,5	1,8433	23,8	1,8433	35,7
1,7911	3,7				
		1,6310	3,0	1,5724	4,0
1,5050	7,8	1,5042	5,5	1,5060	5,9
1,3052	30,5	1,3034	40,3	1,3006	20,4

## CURRENT ORE PETROLOGY: PARAGENESIS, ANALYSIS AND EXPERIMENTATION

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Complex sulfide ores with well-analysed gold contents often cause problems during leaching processes, since gold recovery remains incomplete, unless the ores undergo prior to the recovery, alteration or heating treatment. The reason for this behaviour is that gold occurs partly as sulfide substituting, for instance, copper, silver and thallium in the crystal lattice of the respective minerals. Gold sulfide seems to be quite resistant and is not affected by aqueous cyanide solution. Result from an experimental approach show that gold sulfide is only stable in a narrow pH-range, where it can be precipitated at low temperatures under hydrothermal conditions. Mössbauer spectroscopy studies on natural ores as well as on synthetic products demonstrate the presence of gold as sulfide and for its alteration or breakdown due to subsequent heating procedures.

This facts make it necessary to revise at least part of our knowledge in the geochemistry of gold.





## A NEW OCCURRENCE OF HELVITE IN ROMANIA: OIȚA, BISTRITEL MOUNTAINS

M. Munteanu (București)

X-ray and infrared tests indicated the presence of helvite,  $\text{Mn}_4\text{Be}_3(\text{SiO}_4)_3\text{S}$ , at Oița. Previous papers have cited two occurrences of helvite in Romania: Căvnic and Roșia Montană, both in Tertiary volcanic rocks. Oița has a quite different geological setting as a manganese deposit hosted in rocks of the second member of epimetamorphic Tulgheș Group (black graphitic quartzites considered to be metalydites).

Helvite from Oița occurs as opaque light-green, irregular aggregates, less than 1 cm in size, in a groundmass of rhodonite and rhodochrosite. It has a resinous to vitreous luster, an uneven fracture and a poor cleavage. It seems to be bound to certain restricted shear zones enriched in spessartine, pyrite and galena, the host rock turning locally to mylonite. In thin section helvite from Oița is isotropic with a high relief and comprises an interlacement of phyllosilicatic acicular crystals. It fills the remaining space between the other minerals as if it had been the last to form. Both rhodonite and rhodochrosite yield larger crystals in its vicinity than elsewhere in the rock. The accompanying spessartine is strongly anisotropic and shows a zoned structure. These features might suggest crystallisation under low pressure conditions, the mylonitic pattern being subsequent. From X-ray powder data obtained with a DRON-3 diffractometer ( $\text{Cu-K}\alpha$  radiation) resulted a measured unit cell of  $a = 8.279 \text{ \AA}$  which is in full agreement with the data of Dunn (1976) and Clark (1976). Qualitative electron microprobe tests revealed a significant content of danalite,  $\text{Fe}_4\text{Be}_3(\text{SiO}_4)_3\text{S}$ , and a much lower one of genthelvite,  $\text{Zn}_4\text{Be}_3(\text{SiO}_4)_3\text{S}$ . Helvite from Oița is the first beryllium mineral to be recorded in the metamorphic formations of the East Carpathians.

## CONSIDÉRATIONS GÉOCHIMIQUES SUR LES MUSCOVITES DES PEGMATITES ALBITO-SPODUMÉNIQUES DE LA ZONE CONȚU-NEGOVANU (MONTES CIBIN)

T. Murariu (Iași)

Dans les pegmatites albito-spoduméniques étudiées (la zone de Conțu-Negovanu, Monts de Cibin), la muscovite est présente sous forme de cristaux largement développés et des lames fines, dans deux complexes minéralogiques: le complexe quartzo-muscovitique et le complexe albito-spoduménique. Dans les muscovites on a déterminé des teneurs proches de silice (45,33–46,63 %  $\text{SiO}_2$ ), ainsi que des valeurs élevées en aluminium (36, 39–36,86 %  $\text{Al}_2\text{O}_3$ ). La présence des éléments tels que Fe, Mg, Mn est le résultat de la substitution de Al dans les positions octaédriques. Les analyses chimiques ont mis en évidence des contenus réduits de Mn (0,06 % MnO) et la prédominance du  $\text{Fe}^{2+}$  sur le  $\text{Fe}^{3+}$ . La teneur en Na est en général constante (0,60–0,66 %  $\text{Na}_2\text{O}$ ) et vient en corrélation avec les données expérimentales d'après lesquelles la limite de la solubilité de la paragonite dans la muscovite est égale avec 24 mol %, ce qui correspond à un pourcentage de 2 %  $\text{Na}_2\text{O}$ . Le contenu en Ti (0,15–0,19 %  $\text{TiO}_2$ ) est caractéristique pour la muscovite des pegmatites métamorphiques.

Dans les muscovites étudiées, les relations Fe:Ti et Na:K ont un caractère positif.

La composition normative de la muscovite des pegmatites albito-spoduméniques montre des teneurs réduites en ferrimuscovite (0,9 %), ferromuscovite (2,8–3,3 %) ainsi qu'une valeur élevée de la "muscovite" (91,0–96,2 %). Dans la muscovite du complexe albito-spoduménique la phengite est absente. La composition normative et le degré de substitution du  $\text{Si}^{4+}$  par  $\text{Al}^{3+}$  en position tétraédrique ( $a_{\text{si}} = 22,0\text{--}23,7$ ) sont caractéristiques pour la muscovite des pegmatites. L'examen des formules cristallographiques relève la double position de l'aluminium ( $\text{Al}_{\text{VI}}$ ,  $\text{Al}_{\text{IV}}$ ) ainsi qu'une participation large des éléments alcalins de la position X (0,91–0,94). La distribution géochimique du Li dans les muscovites mis en évidence la concentration de cet élément dans la muscovite du complexe albito-spoduménique (456,2–684,2 ppm). La teneur en Li rencontrée dans les muscovites





s'explique par la capacité de cet élément d'occuper la place de Al. En même temps, les analyses confirment le comportement géochimique régionale du lithium.

Le diagramme de phase dans le domaine subsolidus pour le système muscovite-paragonite nous mène à la conclusion que la muscovite des pegmatites albito-spoduméniques a cristallisé dans un intervalle de température compris entre 410 et 420° C. Ces valeurs se rangent entre les températures de 280–580° C caractéristiques pour la muscovite des diverses pegmatites granitiques du monde.

## NEW DATA REGARDING THE SIGNIFICANCE OF THE PYRITE MORPHOLOGY AND OF THE FLUID INCLUSIONS IN QUARTZ CRYSTALS AT BAIA SPIE

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Pyrite of Main Vein at Baia Sprie displays eight characteristic crystallographic forms: cubic a {100}, octahedron o {111}, pentagonal dodecahedron e {210}, diplohedron {321}, {421}, {311}, {211}, {110}, combined in eight habits: cubic (C), cubic-octahedral (CO), cubic-pentagonal (CP), pentagonal (P), pentagonal-cubic (PC), pentagonal-octahedral (PO) octahedral (O), and diplohedron (D). Negative forms of pyritohedron {210} and negative and positive ones, superimposed on the same crystal, were also observed. The crystal morphologic trends of pyrite led to the separation in the straight plane of vein of two distinct domains: one situated at the upper part, representing cubic-pentagonal dodecahedron trend (C→P), the other at the lower part corresponding to cubic→octahedron→pentagonal dodecahedron trend (C→O→P). Both significant modifications of face microtopography (striae, growth beds, dissolution traces) and crystallographic habit are characteristic of these domains. The relationships between crystallographic forms of pyrite at Baia Sprie and sequence of pyrite forms obtained by experiments, which show the dependence of pyrite morphology on the temperature and degree of supersaturation (Murowchick and Barnes, 1987), allow only a qualitative estimation of depositional environment parameters. In this case some changes of parameters such as temperature and concentration have been deduced for the transition zone between the same two domains. This zone is marked both by the lack of isotopic equilibrium (i.e. isotopic fractionation of the sphalerite-galena pairs) and by the dissolution processes of crystal faces of pyrite and quartz. The last one contains many types of fluid inclusions representing distinct moments in the whole evolution of the hydrothermal processes at Baia Sprie. A positive relationship of distribution between these types of fluid inclusions and the diverse zones of crystal growth of quartz has been revealed. The fluid salinity, established by criometry, increases concomitantly with relative decreasing of homogenization temperature. The T<sub>mi</sub>-T<sub>h</sub> diagram indicates that with decreasing of temperature there is an obvious evolution of the initial fluid, poor in gases and of low concentration to a more concentrated final liquid phase. The relationship between homogenization temperature and quartz crystal zonality would suggest that the hydrothermal process at Baia Sprie is monoascendent. Fluid inclusion study renders also evident one transition zone superimposed on that established by changes produced in pyrite morphology. In this zone episodic boiling of fluids is the dominant process.

### Abbreviations:

T<sub>mi</sub>—melting temperature of last ice crystals

T<sub>h</sub>—homogenization temperature





## TYPOMORPH ASPECTS OF PYRITE IN THE HYDROTHERMAL ORE DEPOSITS OF THE EASTERN PART OF MARAMUREȘ

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The pyrite of Căvnic-Bolduț, Căvnic-Roata, Băiut-Brainer, Cisma, Văratec and Toroiața (Baia Borșa) hydrothermal ore deposits exhibits eight crystallographic habits resulting from the combination of cube, pentagonal dodecahedron, octahedron and other (hkl) type faces. There is a good correlation between the frequency of crystallographic forms and the tendency of the ore deposits to group in accordance with the pyrite morphology. Thus, pyrite of Bolduț, Roata, Brainer and Toroiața ore deposits is plotting in CP field, whereas that of Cisma and Văratec ore deposits in C field. According to the experimental results of Murowchick, Barnes (1987) the concentration and the temperature of hydrothermal solutions can be estimated. Consequently, the Bolduț, Roata and Toroiața ore deposits would correspond to high supersaturation-high temperature conditions, but the Brainer, Cisma and Văratec ore deposits to high supersaturation-low temperature conditions. The pyrite of the first group shows a high frequency of thick growth beds, with terraced and wavy shapes, pointing out their typomorphic character. This character is underlined by the grouping of respective ore deposits in the same field of the pyrite morphology diagram. Locally, pyrite exhibits anomalous contents of Cu, Pb, Zn, Ag, Bi, As, Co. If the As content is less than 2000 ppm, the Co-Ni correlation is positive (Bolduț ore deposit) whereas at As contents over 2000 ppm the correlation is negative (Cisma, Văratec, Toroiața ore deposits). At Toroiața pyrite a weak Au-As positive correlation can be observed, too. This would mean that the increasing As content in the pyrite lattice is followed by the addition of nickel and by catching of gold in nonisomorphic position. Thus, As would be a real geochemical discriminant, especially significant for this ore deposit association. The correlation between pyrite morphology and its Cu, Pb, Zn contents is suggested by the ternary diagram. CP habit of pyrite at Bolduț, Cisma and Toroiața ore deposits correspond to high Pb content in pyrite, CO habit of Bolduț and Cisma are related to high Cu contents and, finally, the (hkl) forms of Bolduț, Brainer, Cisma, Văratec, Toroiața suggest higher Cu and Zn contents.

In conclusion, it seems that the ores of Bolduț, Roata and Toroiața deposits have formed under conditions of higher concentration and temperature of solutions as compared with the other deposits of the area.

Abbreviations:

C – cubic habit

CP – cubic-pentagonal habit

## MINERAL ASSOCIATIONS AND PARAGENESES WITH NATIVE GOLD IN THE MĂGURA-FAERAG HYDROTHERMAL LODE DEPOSIT, METALIFERI MOUNTAINS

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The macroscopic investigation and the petro-mineralogical and geochemical study concerning the composition of the native gold containing veins in the upper zone of the Măgura Faerag hydrothermal lode deposit (six lode groups trending NNW-SSE, out of which the most important from the economical point of view is the Măgura West group) have pointed out the following main characteristics:

a) the wall rock of the lode mineralization – an andesite with amphiboles of the Barza type, Faerag subtype – is altered in the clayey facies especially in the immediate vicinity of the veins, whereas the newly-formed mineral association comprises clay minerals, carbonates, quartz and pyrite. It is most probable that the argillic alteration should follow a potassic one, traces of which are harder to notice;

b) the existence of a positive correlation between the presence of native gold and a fine blackish siliceous strip, up to 1–3 mm thick, situated at the margin of the vein, as well as the correlation between the presence of sphalerite and galena and the absence of the blackish siliceous strips.





The co-existence of these two situations along the vein leads to the idea of the presence of at least two mineralization stages.

c) the natural relations among the main ore minerals suggest the co-existence of at least three paragenetic associations, as follows:

1) pyrite-I+chalcopyrite-II+native gold in a milky-whitish, dull or semitransparent quartz gangue, which forms crystals up to 0.1–0.2 cm in length. Pyrite and chalcopyrite often form intergrown structures.

Gold forms plates, moss-shaped aggregates, thin sheets (often distorted) made up of flattened crystals, skeleton crystals in which the octahedral surfaces are clearly developed, whereas the tetrahedral surfaces can (in very few cases only) only be presumed. The quasi-parallel orientation of the gold crystals suggests their rapid growth in an ascensional dynamic hydrothermal system.

2) chalcopyrite-II+native gold+arsenopyrite in a violaceous or greyish semi-transparent or transparent quartz-II gangue forming prismatic-bipyramidal crystals up to 0.5 cm in length. As a rule, chalcopyrite is displayed solitarily or as small nests, whereas covellite and chalcocite – both secondary – often form on its account. The presence of arsenopyrite suggests the existence – at the moment of formation – of a mesothermal temperature. Sometimes – through oxidation – crust of scorodite ( $\text{Fe}^{3+}(\text{AsO}_4)2\text{H}_2\text{O}$ ) forms on arsenopyrite having a yellow-greenish colour and/or a coffee-brown one when it is naturally mixed with iron hydroxides. Native gold dendrites on the quartz crystals or it is intergrown with it or with the arsenopyrite; in both situations the gold presents an isometric form.

3) sphalerite+galena+pyrite-II+marcasite+native gold-III+quartz-III are present in a more ample context of mineral composition in the veins which do not contain visible native gold. Sphalerite and galena often replace pyrite-II which is usually xenomorph; isolated or heaped up as small nests. Marcasite forms small individual crystals or agglomerations as intergrowths with quartz-III and pyrite-II and locally presents – similar to pyrite – irisation colours. Native gold is to be found only as microscopic inclusions in the other metallic minerals of the parageneses.

In conclusion, native gold has formed out of mesothermal and partially (gold-III) epithermal hydrothermal solutions which have generated a mineral complex specific to the argillic facies with pyrite, chalcopyrite, arsenopyrite, sphalerite, galena and arsenopyrite in a preponderantly quartzeous gangue.

## THE REINVESTIGATION OF "BIHARITE" OF PETERS (1861)

G. Papp (Budapest)

"Biharite" was described by Karl F. Peters in 1861 from Băița Bihor (at that time: Rézbánya) in a systematical study on the geology and mineralogy of the deposit. The name of the mineral derived from Bihar Mts. Peters regarded "biharite" as an intermediate between the talc group and the microcrystalline and amorphous alkali earth aluminosilicates. The 5th edition of Dana's System of mineralogy (1868) listed "biharite" as a distinct mineral species but the 6th edition (1892) ranked it among the pyrophyllite varieties. This viewpoint has been accepted by all well known handbooks of systematic mineralogy (i.e. Hintze, 1897, and Strunz, 1982). The last investigation of "biharite" dates back to the end of the 19th century. The chemical data are inconsistent with those published by Peters; nevertheless all available analytical results suggest that "biharite" cannot be included in the varieties of pyrophyllite.

In order to solve these contradictions, several "biharite" specimens were reinvestigated. In addition to the two original samples of Peters, ten other specimens, labelled "biharite", were studied from the collections of the Eötvös Lorand University, Hungarian Natural History Museum and Hungarian Geological Survey (Budapest).

According to the X-ray investigations, the samples can be divided into two groups. The microcrystalline groundmass of the first group is composed of serpentine and/or talc, frequently associated with calcite. In the other group the groundmass consists of serpentine (occasionally with chlorite), while calcite is also frequent; instead of, or in addition to, calcite, dolomite also occurs together with humite-group minerals (clinohumite,





chondrodite, rarely norbergite). In both groups the "phenocrysts" include usually coarse-grained "sparry" calcite, small strings, patches or grains of ore minerals (chalcopyrite, galena), rarely pyroxene (diopside-augite), laths or chlorite flakes. Two samples proved to be definitely different from the other "biharite" specimens. The microcrystalline groundmass of these two samples consists of fluoborite, and pyroxene (diopside-augite) + plagioclase, respectively. The serpentine component of "biharite" was studied by transmission electron microscopy. Antigorite, crysotile, lizardite, polygonal serpentine and poorly crystalline serpentine minerals were also detected in the different samples. Consequently, "biharite" is not a massive and impure variety of pyrophyllite, but a mixture of variable composition consisting of microcrystalline Mg-(Al-) layer and neso-silicates, calcite, dolomite, and occasionally other minerals such as silicates, carbonates, and sulphide "phenocrysts".

The mineral assemblage of the "biharite" samples corresponds to the skarn and post-skarn hydrothermal (apokarn) paragenesis of the Băița Bihor ore deposits.

## MINERALOGY OF THE "MARMOROSCH DIAMONDS"

V. I. Pavlishin, D. K. Voznák (Kiev)

The so-called "Marmorosch diamonds" are some small, double-ended quartz crystals with strong luster and high transparency, formed from hydrocarbon-rich solutions. It is a special type of quartz, very characteristic of the Carpathians and the Balkans. The "Marmorosch diamonds" contain few or no hydrogen defect but show an intense thermoluminescence (several magnitude orders higher than the normal quartz) with a maximum at 280° C. Internal structure of crystals and composition of the fluid inclusions suggest growth of the "Marmorosch diamonds" in a flux of heterogeneous mixing of hydrocarbons, and H<sub>2</sub>O-rich solutions. Thus, the crystal growth has been favoured by CH<sub>4</sub>-rich solutions. The formation temperature of such crystals varies between 80° and 220° C and the pressure between 17.5 and 420 MPa (Kaliuzhni, Lomov, 1990, 1991). The "Marmorosch diamonds" may be used for oil and gas exploration. In the area of their distribution gas and oil field may be found, if suitable traps do exist.

## STRUCTURA DIVIZATĂ A GRANAȚILOR

I. Petreuş (Iaşi)

Conceptul de structură divizată a cristalelor, propus de noi în 1973, este aplicat cristalelor de granați, pentru a explica pe cale structurală anomaliile optice și așa numitele macle.

În concepția noastră, un cristal de granat este constituit din atâtea piramide câte fețe are cristalul dat. Toate piramidele sînt grupate cu vîrfurile în centrul cristalului iar bazele lor sînt chiar fețele reale ale cristalului. Fiecare piramidă este constituită la rîndul ei, dintr-o colecție de lineaje paralele între ele și alungite paralel cu direcția normalei la fața de cristal: toate lineajele unei piramide sînt perpendiculare pe baza piramidei. În lucrare se analizează dodecaedrul romboidal, în secțiuni paralele cu (001) și (011); trapezoedrul {211} în secțiuni paralele cu (001) și (111) și cristalul compus {211} {110} în secțiuni paralele cu (001), (011) și (111).

Este analizat, de asemenea, efectul de tăiere și zonarea granaților ca și zonarea metamorfică și structura divizată a cristalului. O atenție specială se acordă evoluției metamorfice a zonării granaților.





## MICROSCOPIE MODERNĂ ÎN STUDIUL CRISTALELOR

*I. Petreuş (Iaşi)*

Lucrarea prezintă o sinteză a microscopiei actuale care include: microscopia optică, microscopia acustică, microscopia de fluorescenţă, microscopia laser cu unde termice, microscopia fotoelectronică de emisie, microscopia cu unde termice, microscopia electronică cu scaner, microscopia electronică Auger cu scaner, microscopia electronică de câmp, microscopia ionică de câmp, microscopia de absorbţie a câmpului.

Sînt prezentate pe scurt destinaţiile acestor microscopae şi informaţiile pe care le procură acestea cînd sînt folosite pentru studiul mineralelor.

## UTILIZAREA CALCULATOARELOR ÎN CRISTALOGRAFIE ŞI MINERALOGIE

*I. Petreuş, B. Constantin (Iaşi)*

Sînt prezentate condensat, pachetele de programe de calcul utilizate în laboratorul nostru atît pentru chestiunile de rutină: distanţe interplanare, indici Miller, unghiuri dintre plane, reţea reciprocă, proiecţii stereografice, împachetarea atomilor în structuri, clase de simetrie şi grupe spaţiale, macle, cit şi pachetele de programe de calcul utilizate în analiza structurală evoluată. Programele de calcul sînt organizate pentru a răspunde următoarelor cerinţe:

- să permită funcţionarea automată a difractometrelor;
- să efectueze o prelucrare primară a datelor experimentale;
- să conţină metodele directe de determinare a fazelor;
- să permită interpretarea funcţiei lui Patterson;
- să calculeze factorii de structură;
- să efectueze sintezele Fourier;
- să permită analiza geometrică a structurii (distanţe interplanare, unghiuri, plane, etc.)
- să conţină metode de rafinare a structurii;
- să aibă facilităţi de reprezentare grafică.

În lucrare se prezintă pe scurt cîteva pachete de programe deosebit de performante existente în prezent pe plan mondial şi care au fost implementate în laboratorul nostru pe un calculator PC-AT 386 cu procesor matematic INTEL 387.

## ANALIZA CANTITATIVĂ A FAZELOR ÎN SISTEMELE MINERALE BICOMPONENTE ŞI MULTICOMPONENTE

*I. Petreuş, M. Rusanovschi, D. Pop, N. Timofte, B. Constantin (Iaşi)*

Folosind un difractometru de raze X de tip DRON-3, model 1980, am pus la punct cîteva metode de determinare cantitativă a mineralelor cristalizate ce provin din probe care conţin două sau mai multe faze. Metodele se bazează pe principiul după care, intensitatea integrală a unui maxim de difracţie, caracteristic unui mineral, este proporţională cu fracţiunea de volum ocupată de acel mineral în probă.





Am studiat amestecul cuarț+calcit+fluorină și am trasat dreapta de etalonare pentru determinarea conținutului de cuarț din orice probă. Performanța atinsă constă în analiza a cinci probe pe oră cu precizia de 1-3 %. S-a studiat, de asemenea, sistemul calcit-dolomit și câteva sisteme minerale din clasa sulfuri, cu doi și mai mulți componenți.

## TERMOINC-01, A MICROTHERMOMETRIC STAGE FOR FLUID INCLUSION STUDIES

*I. Pinte, T. Cherebeșiu, D. Iurian, A. Hiriș, L. Manoilă (Cluj-Napoca)*

The microthermometric stage TERMOINC-01 is adapted to work on Romanian microscopes manufactured by IOR-Bucharest (MC5, MC7, MC9). This allows the fluid inclusion studies in the temperature range of  $-180^{\circ}\text{C}$  to  $+750^{\circ}\text{C}$ .

Other characteristics:

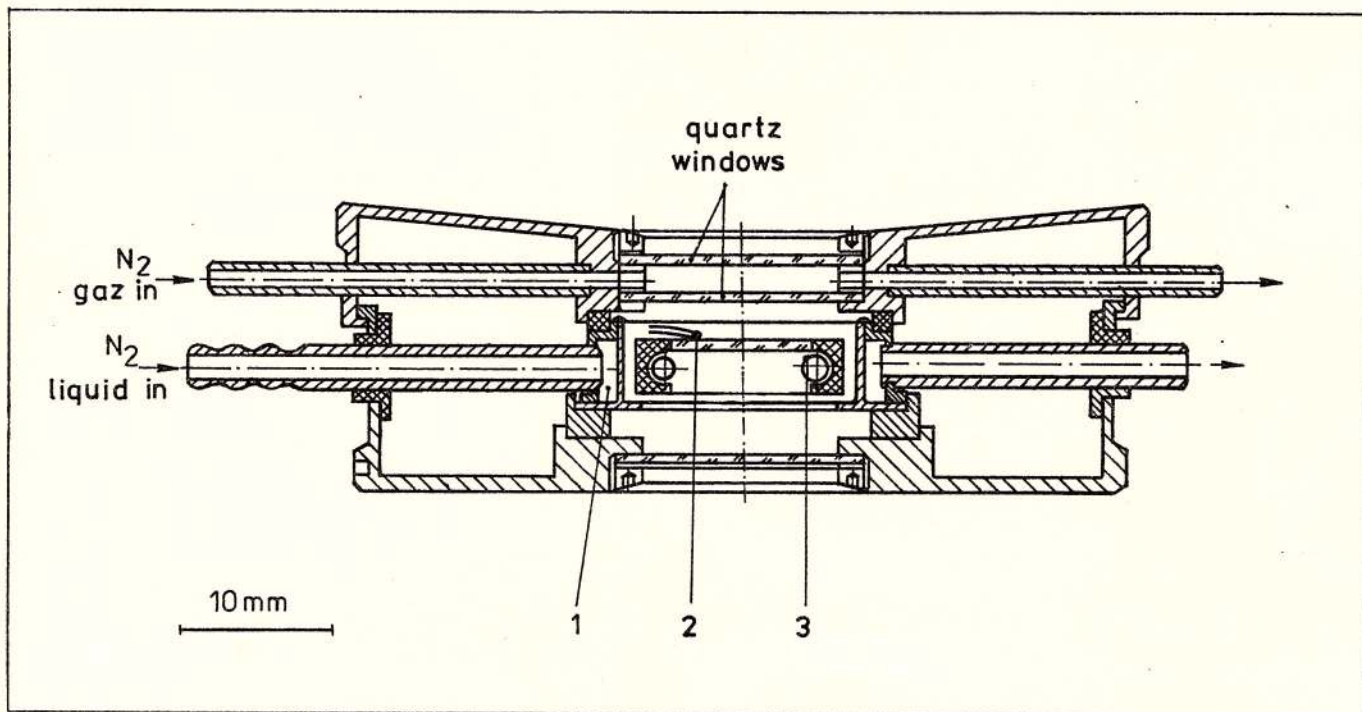
Precision:  $\pm 0.1^{\circ}\text{C}$  between  $-100^{\circ}\text{C}$  and  $+100^{\circ}\text{C}$ ;  $\pm 2^{\circ}\text{C}$  up to  $+750^{\circ}\text{C}$ .

Optic field: 15 mm.

The minimum size of fluid inclusion: 30 micrometers.

Other domains for use: Chemistry, Biology, Medicine, Agriculture, Metallurgy.

Notations: 1 - freezing coil, 2 - temperature sensor, 3 - heat resistance.

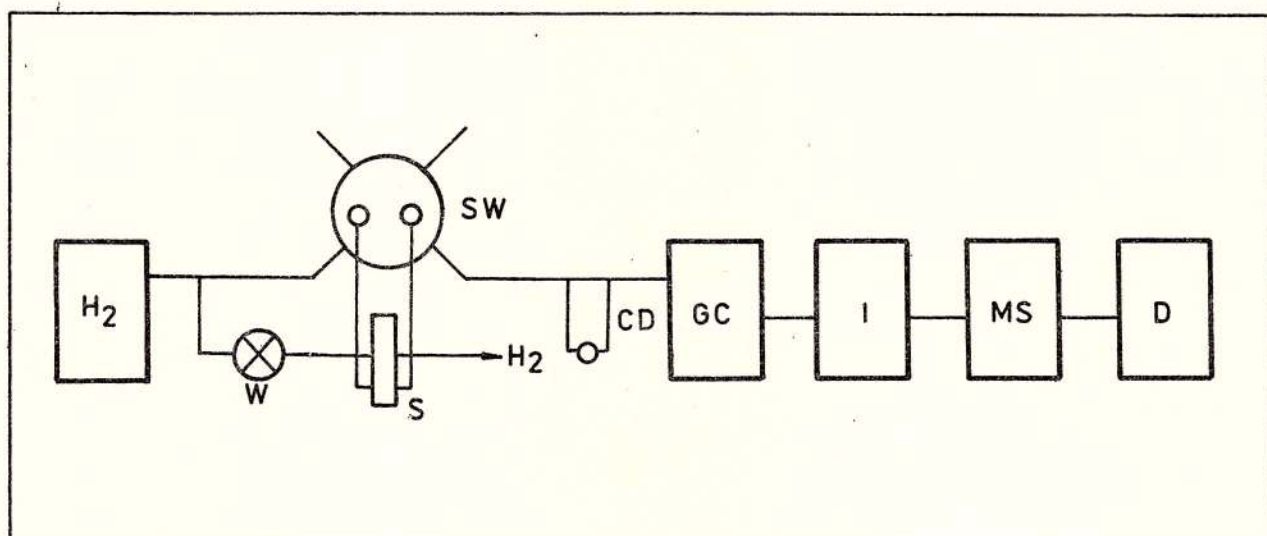




## GLOBAL GC-MS ANALYSES OF VOLATILE SPECIES RELEASED FROM FLUID INCLUSIONS BY CRUSHING METHOD

*I. Pintea, N. Palibroda, Stela Cuna (Cluj-Napoca)*

Gaschromatography and mass spectrometry couplet (Figure) allows the quantitative analysis of most gaseous compounds present in fluid inclusions up to  $10^{-9}$ g. The release and extraction of the gaseous species are obtained by an original crushing device (S) passing by a continuous eluent stream ( $H_2$ ). For each compound calibration is necessary to make standard gaseous mixtures with an exponential dilution vessel of constant volume (CD). Introduction of gaseous species in gaschromatograph apparatus (GC) is made by a special valve (SW) and in the mass spectrometer by an interface (I). The quantitative measurement of introducing gases is obtained by the fragmentogram method. Until now  $CO_2$ ,  $CH_4$ ,  $H_2S$ ,  $SO_2$ ,  $N_2$  amounts (ppm) released from fluid inclusions in various Romanian mineral occurrences have been measured.



## FLUID INCLUSION MICROTHERMOMETRY AND ITS APPLICATIONS IN MINERALOGENESIS. SPECIFIC EXAMPLES

*I. Pintea (Cluj-Napoca)*

The phase transitions recorded by microthermometric experiments in fluid inclusions offer the possibility to estimate the PVTX-properties of fluid phases involved in various mineral genesis conditions. Some of these applications are, as follows:

A. Low-salinity aqueous solutions.

i. Baia Mare district. Base-metal ore vein types.

1. Baia Sprie

Host mineral: quartz. Fluid inclusion types: biphasic; liquid-and vapour-rich; polyphasic; liquid, vapour and solid(s).  $T_h=200-360^\circ$  C. Salinity: min. 1.7 to max. 19.9 wt % NaCl. Fluid type: heterogeneous aqueous solution.

2. Herja

Host mineral: quartz. Fluid inclusion type: biphasic, liquid-rich.  $T_h=175-370^\circ$  C. Salinity: min. 4.9 to max. 19.5 wt % NaCl. Fluid type: homogeneous aqueous solution.





## 3. Cavnic

Host mineral: sphalerite. Fluid inclusion type: biphasic, liquid-rich.  $T_h=220-345^{\circ}\text{C}$ . Salinity: min. 4.7 to max. 13.7 wt % NaCl. Fluid type: homogeneous aqueous solution.

## ii. Metaliferi Mountains.

Bocșa-Săcărimb. Base-metal breccia type ore.

Host mineral: quartz. Fluid inclusion type: contemporaneous liquid- and vapour-rich, biphasic.  $T_h=180-340^{\circ}\text{C}$ . Salinity: min. 4.9 to max. 15.0 wt % NaCl. Fluid type: heterogeneous aqueous solution.

## B. Hydrosaline melt inclusions.

## 1. Vlădeasa granite (Apuseni Mountains). Mirolitic cavities.

Host mineral: quartz. Fluid inclusion type: multiphasic. Daughter phases: halite, sylvite, anhydrite, hematite, magnetite, unidentified opaque and transparent grains.  $T_h=630-745^{\circ}\text{C}$ . Salinity: 57-73 wt % (NaCl + KCl). Type of fluid: hydrosaline melt.

## 2. Roșia Poieni. Porphyry copper ore deposit.

Host mineral: quartz. Fluid inclusion type: multiphasic. Daughter phases: halite, sylvite, hematite, others.  $T_h \geq 750^{\circ}\text{C}$ . Pressure: 200-250 bars. Salinity: 60-90 wt % (NaCl + KCl) equivalent. Type of fluid: hydrosaline melt.

## C. Mixed carbonic-aqueous fluids.

## 1. Jolotea (NW Ditrău massif). REE and sulfide ore.

Host mineral: quartz. Fluid inclusion types: a.  $\text{CO}_2$ -rich, monophasic; b.  $\text{CO}_2$ - $\text{H}_2\text{O}$ , biphasic, various grade of filling; c.  $\text{CO}_2$ - $\text{H}_2\text{O}$ -NaCl (halite) + other solid phases.  $T_{m\text{CO}_2}$ :  $-55$  to  $-65^{\circ}\text{C}$ ,  $T_{h\text{CO}_2}$ :  $-2$  to  $+31.5^{\circ}\text{C}$ ,  $d_{\text{CO}_2}$ : 0.47 to 0.85 g/cm. Salinity: 0.3-35 wt % NaCl. Pressure: 800 to 1400 bars. Type of fluid: heterogeneous carbonic-aqueous solution.

## 2. Bocicoiul Mare. (Maramureș district).

Host mineral: "Marmarosch diamond" i.e. quartz crystals in trans-Carpathian flysch formations. Fluid inclusion types: monophasic with  $\text{CH}_4$ ; biphasic, liquid hydrocarbons and  $\text{CH}_4$  (gas); biphasic, aqueous liquid-rich.  $T_{h\text{CH}_4}$ : 66 to  $82^{\circ}\text{C}$ ,  $T_{h\text{H}_2\text{O}-\text{NaCl}}$ :  $150-250^{\circ}\text{C}$ . Salinity: 7-8.6 wt % NaCl. Pressure: 500-950 bars. Type of fluid: mainly liquid hydrocarbons.

Abbreviations:  $T_h$ -temperature of homogenization,  $T_m$ -melting temperature.

## IDAITE AT CIREȘU, MEHEDINȚI MTS

Gh. C. Popescu (București)

Originally described by Frenzel (1959) in a sample from South Africa, idaite is still an incompletely defined mineral species. Its status remained as such even after its identification in many occurrences in the world. The main cause is its intimate intergrowth with bornite, the primary mineral leading by its decomposition to idaite. The discovery of nukundamite, closely related to idaite, has once more complicated the problem. The polytypism in the  $\text{Cu}_x\text{FeS}_y$  series has been postulated by Levy as early as 1967.

Idaite has been firstly recognized in Romania by Udubașa (1979) in ores from the copper deposit at Sasca Montana. The recently (1985) identified occurrence of idaite at Cireșu lies in medium grade metamorphics (hornblende-bearing gneisses); idaite occurs as veinlets and small pockets within quartz veins cutting the gneisses. The associated minerals are bornite, chalcopyrite, pyrite, magnetite, chalcocite, covellite as well as malachite, azurite and goethite.

Typically, idaite occurs as a fine network of lamellae within the bornite host. The amount of idaite varies from sample to sample and even from pocket to pocket; the variable ratio idaite to bornite leads to changing of colour of the mineral aggregate, from brown-pale rose of bornite-dominated parts to yellow-orange to dull yellowish-brown, when the material contains prevailingly idaite. An intermediate intergrowth of rose colour may in places be observed too. Electron microprobe analyses gave only Fe, Cu and S as major elements;





quantitative data could not be obtained as the idaite lamellae and the bornite matrix were too small to be adequately measured.

Reflectivity measurements were made on the three colour varieties of bornite-idaite intergrowths. The  $R$  % values at four wavelengths are different and increase from the "orange bornite" to yellow intergrowths in which idaite prevails (table). The general trend of reflectivity curves is similar to that of idaite except the inversion point of  $R_{min}$  and  $R_{max}$  at about 600 nm.

	1		2		3	
	$R_{min}$	$R_{max}$	$R_{min}$	$R_{max}$	$R_{min}$	$R_{max}$
488	12.98	14.07	17.37	19.04	20.02	21.14
553	19.03	20.65	20.70	22.55	23.84	25.03
590	21.55	23.10	20.98	23.04	26.14	28.24
650	24.98	26.66	29.91	27.05	29.76	31.94

1. bornite with lamellae network of idaite
2. orange yellow aggregates of bornite + idaite
3. prevalingly idaite with small amounts of bornite matrix.

Under the microscope two types of idaite lamellae can be seen; (1) a fine network pervasively replacing the bornite and (2) larger lamellae, spindle-shaped, cutting the fine network. A late chalcopyrite generation seems to replace all the bornite "idaitization" steps.

The primary assemblage of Ciresu occurrence consists of magnetite, pyrite and chalcopyrite. It is presumed that the bornite developed at the expense of chalcopyrite under supergene conditions. Bornite itself was further replaced by idaite in a step-by-step transformation which probably ends with the formation of the spindle shaped idaite and finally by its replacement by covellite, malachite, azurite and goethite.

## NEW TELLURIDES FROM SĂCĂRÎMB, METALIFERI MOUNTAINS

Gh. C. Popescu, Gr. Şimon (Bucureşti)

Nagyagite, sylvanite, calaverite, krennerite and petzite are the most common tellurides known at Săcărîmb, the famous gold-silver-telluride ore deposit in the Metaliferi Mts., Romania. A revision of the collection of polished sections of the late prof. D. Giuşcă (Bucharest University), one of the best connoisseurs of the tellurides of Săcărîmb, led to the identification of two new tellurides for this deposit, i.e. coloradoite and tellurantimony.

Reflectance measurements and qualitative microprobe analyses were carried out both on the two new tellurides as well as on other species for which optical diagnosis is quite difficult.

The coloradoite seems to be rather widespread in nearly all the ore veins at Săcărîmb. Nevertheless, it has not been previously reported in any paper published so far. However, the mineral was recognized by Ramdohr in one polished section of his collection at the Heidelberg University (G. Udubaşa, personal comm.).

The reflectance values of coloradoite, i.e. 37.0 % (486 nm), 36.0 % (552 nm), 39.1 % (589 nm) and 37.5 % (656 nm) are quite different from those of similar petzite, for which it has been probably mistaken in the earlier studies. The reflectance curve of coloradoite exhibits a minimum near 550 nm and a maximum at 600 nm. The identification of coloradoite was also proved by means of the electron microprobe analyser. It is the second occurrence of the mineral in Romania, the first one being at Stănija, a further gold-telluride ore deposit in the Metaliferi Mts (Constantinescu, Popescu, 1986, unpubl. data).

The tellurantimony forms prismatic to needle-like crystals or granular aggregates. Under the microscope it is white with a slight pinkish tint, more obvious when tellurantimony is in direct contact with altaite. The bireflectance is barely observed and the anisotropy is weak with grey colours.

The measured reflectivity of tellurantimony of Săcărîmb, i.e. 54.41–64.11 % (488 nm), 50.08–62.95 % (533 nm), 51.29–64.48 % (590 nm) and 54.98–65.93 % (650 nm) is slightly lowered when compared with the specimen





from Quebec (Thorpe, Harris, 1973) and Hokkaido (Feklicev, 1977). However, the general trend of the curve is similar, with a slight minimum at 550 nm. This is the first occurrence of tellurantimony in Romania.

The stuetzite,  $\text{An}_{5-x}\text{Te}_3$ , is more frequent as previously stated. The reflectivity measurements gave the following values: 41.35–41.78 % (488 nm), 40.78–40.29 % (553 nm), 40.52–39.15 % (590 nm) and 41.02–35.48 % (650 nm). The intersection point of  $R_{\min}$  with  $R_{\max}$  lies at 500–540 nm, at a lower wavelength as compared with that presented by Picot and Johan (1982).

The ~~hessite~~  $\text{Ag}_2\text{Te}$ , is widespread, especially in the ores of Longhin and Antelohin vein groups. The reflectance values are: 37.2–40.0 % (486 nm), 37.5–40.0 % (552 nm), 37.0–41.5 % (589 nm), 37.0–42.5 (656 nm). As previously stated by Picot and Johan (1982) no intersection point of  $R_{\min}$  with  $R_{\max}$  was found, a fact in contradiction with the data of Besmertnaya et al. (1971).

The typical telluride-bearing assemblage of Săcărimb consists thus of petzite + stuetzite + tellurantimony ± hessite, coloradoite, stibnite and it is likely that it formed later than the sylvanite + krennerite + calaverite assemblage.

## OPAL-CT LEISPHERES IN HYDROTHERMAL ALTERATION DEPOSITS FROM EAST CARPATHIANS NEOGENE VOLCANIC ZONE

S. Rădan, I. Seghedi, Carmen Bunescu (București)

Silica lepispheres are microspheroidal, botryoidal, or mamillated bodies of bladed crystals consisting of more or less disordered cristobalite and tridymite, randomly intergrown, defined as opal-CT by IMA.

The main lepisphere occurrences were mentioned in marine siliceous, calcareous and clayey deposits, and seldom, in hydrothermal areas (Oehler, 1975).

SEM investigations carried out on samples collected from the alunite occurrences proved for the first time in Romania, that such opal-CT lepispheres are quite common in the hydrothermal deposits, but only in the low-temperature ones. Thus, alunite deposits connected with volcano-sedimentary complexes and andesitic lava-flows from Brada Valley and Răchițele-Cavnic areas in Gutii Mts, Iezer extracaldera zone in Călimani Mts and Sugo-Var extracratereal area in Hărghita Mts show frequent microspherules of lamellate silica, occupying much of the pore or fissure spaces, and ranging in size from 2 to 50  $\mu\text{m}$ . These spherules are isolated or interlocked and aggregated, showing mamillated and botryoidal masses or encrustations.

The X-ray analyses show two particular diffraction patterns: strong and sharp peaks at 4.09 and 4.33 Å, corresponding to cristobalite and tridymite reflection (Brada Valley), or more or less broad diffraction line centred at about 4.09 Å, with a subsidiary broad reflection at about 4.33 Å (Răchițele-Cavnic, Iezer and Sugo-Var). Sometimes the main reflection is located between 4.09 and 4.33 Å diffraction lines. These patterns suggest various pathways by which the opal-CT could have formed. According to Jeans (1978), two interpretations may be considered, either as a single mineral phase, or a mixture of opal A,  $\alpha$ -tridymite and  $\alpha$ -cristobalite. Both explanations seem to be valid in the above described cases.

The opal-CT is associated with alunite and kaolinite and subsidiary or accidentally with siderite, dolomite, halloysite, smectite, quartz, pyrite, sulphur, gypsum, pointing out low-temperature, low-pressure and acidic solutions.

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## ACCESSORY MINERALS IN THE ALKALINE ROCKS OF DITRĂU (EAST CARPATHIANS): PETROGENETIC IMPLICATIONS

*N. I. Robu, Lucia Robu (București)*

The Ditrău alkaline massif is included in the Bucovinian Nappe of the East-Carpathians (Săndulescu, 1975). It consists of a large variety of rock types (hornblendite, syenites, granites, diorites) and numerous dykes cutting across all the above mentioned rocks.

Accessory minerals (zircon, apatite, titanite, rutile, ilmenite, magnetite) separated from different types of rocks of Ditrău alkaline massif have been studied; various mineralogical, chemical and physical properties (colour, crystal fabric, morphology), have been determined in order to depict the relationships between them and the chemical composition of host rocks as well as the geological setting.

Zircon morphological studies were considered according to original typological classification of zircon proposed by J. P. Pupin, G. Turco (1972). Two zircon types have been identified: (1) – long prismatic crystals, with well-developed, but unequal growth,  $\{100\} \gg \{110\}$ , prism and,  $\{211\} < \{101\}$ , pyramidal faces. The colour of the crystals is variable: dark rose, light rose and sometimes dark brown. The crystals are transparent, sometimes translucent; they formed at a temperature ranging between  $900^{\circ}\text{C}$  and  $750^{\circ}\text{C}$ . Particularly, hornblendites contain this type of zircons: (2) – short prismatic crystals, with well-developed  $\{100\}$  prismatic and  $\{101\}$  pyramidal faces, sporadically appearance of the  $\{110\}$  prismatic and  $\{211\}$  pyramidal ones. The colour of crystals is dark and light brown; they are transparent and opaque; they formed at the temperature of about  $900\text{--}750^{\circ}\text{C}$ . This type is characteristic of syenite rocks. Studies on zircon populations point out the mantle origin, the unimportant concentrations of the radioactive substances and  $\text{H}_2\text{O}$  in the first phases of magma evolution and an enrichment in the final ones, the initial alkaline character being preserved during the magma evolution.

Apatite crystals have been observed in some hornblendites and syenites samples. They are colourless, transparent (without inclusions), with long prismatic habits. Two morphological crystal types have been observed: (1) – hexagonal prism,  $\{10\bar{1}0\} \{01\bar{1}0\}$ , and pyramid,  $\{10\bar{1}1\} \{01\bar{1}1\}$ , faces crystals, (2) – hexagonal prism,  $\{10\bar{1}0\} \{01\bar{1}0\}$ , pyramid,  $\{10\bar{1}1\} \{01\bar{1}1\}$ , faces and basal pinacoid,  $\{0001\}$ , ones crystals. The sporadic presence of the apatite crystals points out P and  $\text{H}_2\text{O}$  deficit of the parental magma; the absence of opaque inclusions in apatites is the result of the precocious crystallization of the apatite crystals. Titanite crystals have been observed in different concentrations: considerable amounts in the hornblendite rocks, and less in the syenite rocks. The morphology of titanite crystals is dominated by  $\{001\}$  and  $\{201\}$  faces, which are smooth and glossy; their colour is yellow-brown. The interior of crystals is dominated by the opaque minerals inclusions.

Magnetite is present in all the studied samples. Magnetites can be divided into two groups: the first one comprises crystals with octahedral habit, and the second one contains the granular aggregates, without aggregates of anhedral grains. In reflected light, one can observe that magnetite is substituted by hematite and goethite; the substitutions are partial or total, and they take place at the edge of the crystals or on the numerous fissures cutting them across. Locally, magnetite-ilmenite intergrowths have been observed.

## ZUNYITE AND NATROALUNITE OCCURRENCES IN THE CĂLIMANI CALDERA: COMPARISON WITH OTHER EAST CARPATHIANS OCCURRENCES

*I. Seghedi, S. Rădan (București)*

This is the first mention of zunyite and natroalunite occurring under conditions of high temperature and high hydrogen ion activity (acid) hydrothermal alteration in the central part of the Călimani Caldera. Zunyite





was chiefly determined by X-ray diffraction method; it is closely associated with alunite, quartz, kaolinite and illite. Natroalunite has also been determined by its characteristic X-ray diffraction peaks making possible K/Na ratio evaluation in the Parker diagram (1962). These is a good correlation with chemical analyses. As compared with the Virghiș occurrence (Harghita Mts) where they are more abundant in a similar alunite-quartz assemblage in a central craterial area, zunyite and alunite constitute small amounts of the hydrothermal paragenesis within the Călimani Caldera area.

## COMPARATIVE MINERALOGENETIC STUDY OF ALUNITE OCCURRENCES IN ROMANIA

*I. Seghedi, S. Rădan, I. Vanghelie (București)*

Both high temperature (alunite + quartz) and low temperature (alunite + opal) assemblages have been recognized in the main alunite occurrences related to Neogene magmatism in Romania. It is believed that they were controlled by a high hydrogen ion activity.

The *high temperature* assemblages occur in two geological situation: (1) In the cenral part of evolved volcanic structures with calderas or craters such as in a) – Călimani Caldera (central part) with quartz+alunite+natroalunite±kaolinite±(zunyite, illite, barite, pyrite) and b) – Virghiș craterial area (Harghita Mts) with quartz+natroalunite+kaolinite±(dickite, tridymite, pyrite, zunyite, tourmaline, pyrophyllite); (2) Associated with subvolcanic hydrothermalized and mineralized bodies (porphyry type or vein type) as at Roșia-Poieni (Apuseni Mts) with quartz+alunite+ chlorite±(kaolinite, pyrite, montmorillonite) and Voia (Apuseni Mts) with quartz+alunite+natroalunite+kaolinite±pyrite.

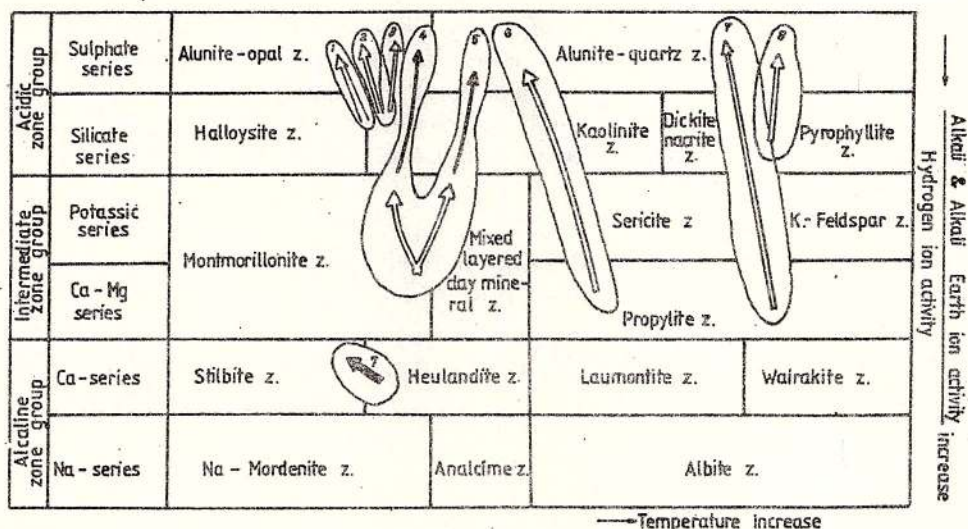
The *low temperature* assemblages also correspond to two situations: (1) To extracraterial areas and/or calderas: Călimani Caldera (out or near the Caldera border) with opal+cristobalite+alunite+kaolinite±(sulphur, tridymite, pyrite, marcasite, anhydrite); (2) Without any connection with central volcanic areas, generally at the periphery of complex volcanic structures, as in a) – Brada Valley (Gutii Mts) with cristobalite+alunite+kaolinite +tridymite±(siderite, pyrite); b) – Răchițele Valley (Văratec Mts) with opal+cristobalite+alunite+tridymite± (kaolinite, siderite, dolomite, halloysite); c) – Sugo-Var Valleys (Harghita Mts) with cristobalite+alunite+kaolinite.

The deposition of alunite/natroalunite minerals at fairly shallow depth as indicated by morphology is a result of circulating solution systems consisting of hypogene hydrothermal solutions mixed with meteoric waters. In fact, the  $\text{SO}_4^{2-}$  anion is a result of interaction of  $\text{H}_2\text{S}$ -rich hydrothermal solutions with oxidizing exogene waters. The fixation of  $\text{SO}_4^{2-}$  in high hydrogen ion activity system is mainly dependent on the rock support (mostly apdesites and diorites) containing 2.5–3.5 % K and 2–4 % Na, and on temperature, which is higher for alunite-quartz assemblage – (200°–400° C) and lower for alunite-opal assemblage (120°–250° C).

The studied alunite occurrences are either related to fossil geothermal areas e.g. at Răchițele, Brada, Sugo-Var, Virghiș and Călimani Caldera (the most developed area) and forming external envelope of highly hydrothermalized intrusive bodies, e.g. at Voia and Roșia-Poieni.







Zonality of hydrothermal alterations in alunite occurrence areas from Romania: (1) Răchitea; (2) Bradă; (3) Călimani Caldera-central part; (4) Călimani Caldera-out or near the Caldera border; (5) Voia; (6) Roșia-Poieni; (7) Virghiș. (After Utada, 1980).

## MARGARITE IN DYNAMICALLY METAMORPHOSED MICASCHISTS IN THE CIBIN MOUNTAINS, SOUTH CARPATHIANS

I. Stelea, Gabriela Stelea (București)

The main ( $M_1$ ,  $M_2$ ,  $M_3$ ) regional metamorphic events recognized so far within the Sebeș-Lotru Group are accompanied by mostly dynamic mineral associations developed especially on the lithostratigraphic limits. Thus, the micaschists in the Cibin Mountains are dynamically metamorphosed on a thickness of 400-500 m above the limit with the subjacent gneisses. The presence of many thin layers (1-10 cm) of micaceous mylonites and blastomylonites on the  $S_2$ -planes proves a ductile, non-homogeneous deformation synchronous with the  $M_2$  event. The assemblages muscovite + margarite (in quartz-free microscopic domains) and muscovite + margarite + quartz + fibrolitic sillimanite (in quartz-bearing microscopic domains) syntectonically crystallize in these phyllonites.

Margarite is here described for the first time in Romania. This mineral was identified by means of IR analysis of the microblastic white micas from the blastomylonites matrix. The obtained spectra were compared with published data (Langer et al., 1980). They contain characteristic bands both for margarite (i.e. 390, 445, 490, 542, 605, 694, 724, 3636  $\text{cm}^{-1}$ ) and muscovite (i.e. 408, 478, 536, 685, 750, 800, 3660  $\text{cm}^{-1}$ ). X-ray analysis shows that the kaolinite is also present in small amounts.

Margarite-bearing blastomylonites (e.g. sample 7514B) chemically differ from the host muscovitic micaschists (e.g. sample 7514A) by higher  $\text{Al}_2\text{O}_3$  (38.85 % vs. 20.90 %),  $\text{CaO}$  (2.28 % vs. 0.6 %) and  $\text{K}_2\text{O}$  (8.01 % vs. 4.70 %) contents and by smaller  $\text{SiO}_2$  (40.90 % vs. 58.51 %) and  $\text{FeO}$  (0.14 % vs. 5.89 %) contents. The REE contents decrease in blastomylonites.

The physiographic features of margarite and the assemblages in which it occurs are also different in rocks with different deformation degrees. Margarite-rich layers alternate with muscovite-rich ones in blastomylonitized micaschists consisting of oriented micaceous matrix. When quartz occurs, then it includes fibrolitic sillimanite. In adjacent mylonitized micaschists, margarite marginally replaces the kyanite and muscovite porphyroclasts. The margarite ( $\pm$  muscovite) coronas around kyanite were investigated by qualitative microprobe analysis.





Kyanite, coarse muscovite as well as garnet and locally plagioclase are pre-tectonic as against the moment of blastomylonite development. Chloritoid is also present in these rocks but it is related to late retrograde processes. Only fine muscovite, margarite, quartz and fibrolitic sillimanite form the syntectonic paragenesis of blastomylonites. They coexist in equilibrium in a narrow thermodynamic domain (500–520° C and 3.7–4.2 Kbars) confined by the upper thermal stability limits of margarite bearing assemblages intersecting the stability field of sillimanite (Perkins et al., 1980).

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## FIRST OCCURRENCE OF ARTINITE AND COALINGITE IN SERPENTINITES OF ROMANIA

R. O. Strusievicz (Cluj-Napoca)

Artinite –  $\text{Mg}_2[(\text{OH})_2/\text{CO}_3]\cdot 4\text{H}_2\text{O}$ , and coalingite –  $\text{Mg}_{10}\text{Fe}_2(\text{OH})_{24}\text{CO}_3\cdot 2\text{H}_2\text{O}$  are minerals that typically form in the surface weathering zones of serpentinitic rocks. The two minerals have been recently discovered in Romanian serpentinites too, in two separate occurrences. Artinite was found in a brecciated-laminated serpentinitic body of the Latorița Formation (Palaeozoic?) in the Paring Mountains (South Carpathians), on the right side of the Ștefanu Brook. It occurs as very fine needle-like crystals, 1 to 3 mm long, white, translucent, with glassy luster. The crystals form massive or divergent aggregates in the 1 to 2 cm wide crevices of the serpentinite. The X ray powder diffraction pattern showed 14 peaks that are in perfect agreement with those cited in JCPDS card No. 6-0484. The strongest lines are 8.20 (30), 5.36 (65), 3.66 (100), 2.737 (20) and 1.920 (24). An inversion was observed between the intensities of the lines 3.66 and 2.737, the latter being the strongest line in the JCPDS card.

Coalingite was found in Mesozoic serpentinites of the Transylvanian Nappe in the northern part of the East Carpathians, at Breaza. It occurs as pseudomorphoses after 4 to 5 mm long chrysotile slip fibers. The very fine lamellar aggregates that substitute the chrysotile are pale brown, with resinous luster. Only under microscope one can see the  $0.02 \times 0.005$  mm coalingite platelets, with weak pleochroism, from reddish-brown to pale brown, very weak birefringence and  $\omega=1.596$  and  $\epsilon=1.580$ . Coalingite was identified diffractometrically by finding 8 lines similar with those of the type specimen and those of the JCPDS card No. 22-708. The strongest lines are 7.75 (12), 6.00 (35), 4.29 (100) and 2.345 (3). The peak cited in the literature at d values of 13.2 – 13.4 in our case occurs at greater values, i.e. 14.40 – 14.45. Both artinite and coalingite powder diffraction patterns appear mixed with lines characteristic for lizardite, with which they are intimately intergrown. This is the first mention of coalingite in Romania, while artinite was already identified by means of IR spectra and thermal analysis in carbonate (mainly calcitic) concretions of the loesses from Dobrogea.





## THE "GREEN CRUSTS" IN CHROMITES FROM BANAT

*R. O. Strusievicz (Cluj-Napoca)*

The ultramafic (i.e. harzburgitic and dunitic) serpentinized rocks that build up the caledonian Tisovița-Iuți ophiolitic complex in the southern Banat contain several chromite bodies, the largest ones being known at Golețu Mare, Golețu Mic, Lomuri, Rudina. A striking characteristic of these chromites is the great frequency of submillimetric cracks filled with a green material. Previous (controversial) works of Savul (1932) and Moțiu (1971) stated that these green crusts are constituted of garnierite (Ni-serpentine) and zaraitite (Ni-carbonate) respectively. X-ray powder diffraction patterns of two samples collected from "green crusts" found in chromites from Golețu Mare allowed us to conclude that these are constituted mainly of theophrastrite -  $\text{Ni}(\text{OH})_2$ , with minor participation of nimite -  $(\text{Ni}, \text{Mg})_6[(\text{OH})_8/(\text{Si}, \text{Al})_4\text{O}_{10}]$  and hydrotalcite -  $\text{Mg}_6\text{Al}_2[(\text{OH})_{16}\text{CO}_3] \cdot 4\text{H}_2\text{O}$ . Theophrastrite, the natural nickel hydroxide was identified diffractometrically. The strongest lines in the pattern are 4.59 (100), 2.704 (42), 2.336 (90) and 1.757 (35), all in good agreement with those of the synthetic  $\text{Ni}(\text{OH})_2$  - JCPDS card No. 14-117, as well with those of the theophrastrite from Vermion-Greece, the type locality of this mineral discovered in 1981. Calculation of cell parameters from 7 reflections gave  $a=3.1281 \text{ \AA}$  and  $c=6.6294 \text{ \AA}$ .  $D_{\text{calc}}=3.925 \text{ g/cm}^3$ . Theophrastrite is emerald green, translucent, with vitreous luster and conchoidal fracture. Crystals are very small (0.1-0.2 mm) and visible only under microscope. They are lamellar, with a weak pleochroism from pale-green to yellowish-green. Refractive indices  $\omega$  and  $\epsilon=1.616-1.620$  are a little lower than those cited for the type specimen. Nimite, a Ni-chlorite, appears as thin films on the walls of the cracks filled with theophrastrite. It was a pale green colour and was identified also diffractometrically. Its strongest lines are 14.20 (50), 7.13 (100), 4.71 (80), 3.55 (55) and 2.83 (40). They are very close to those of the original material from Barberton (South Africa), the type locality. Hydrotalcite was identified only by X-ray diffraction, as a minor constituent of the Ni-rich mineral assemblage. Main diffraction lines are 7.85 (100), 3.92 (16), 3.347 (5) and 1.991 (4). All three minerals cited here are supergenous and formed from Ni and Mg rich colloidal solutions in the cracks of the chromites. This is the first mention of theophrastrite, nimite and hydrotalcite in Romania.

## HARKER'S STRESS AND ANTISTRESS MINERALS - MISFITTING CONCEPTS FOR A CORRECT OBSERVATION

*C. Strutinski (Cluj-Napoca)*

According to Harker, introduction of shearing stress as an additional condition beside P and T in regional metamorphism causes an extension or, conversely, a contraction of the stability fields of a great number of minerals. Those which are thought to extend their stability fields according to stress are termed "stress minerals", whereas the others reacting in an opposite way - "antistress minerals".

In the last decades the idea of classifying minerals according to their behaviour to stress has been increasingly rejected. It was rightly been asserted that the stability field of a mineral in regard to pressure depends only on the magnitude of the latter and not on its nature. It has only been admitted that stress has a catalytic effect, enhancing the reactivity during formation of the most stable mineral assemblages under given PT conditions. Thus, it is denied that stress or deformation induced by it might qualitatively influence the reaction paths, as compared to a hydrostatic regime. Anyhow, the observational data cast some doubt on this point of view, justifying at least a reconsideration of the problem.

Our data point to the fact that, beyond P and T, the strain rate may be - under certain circumstances - quite an independent factor in regional metamorphism. Harker soon realized that in dynamo-thermal regional metamorphism three-dimensional diagrams are required in order to outline the stability fields of minerals. Accordingly, he considered T, P and shearing stress as the relevant factors. We diverge from this view by replacing shearing stress with strain rate. Our standpoint is supported by the fact that operation of shearing stress does not implicitly involve remanent deformation, or if so, the deformation may take place at a rate low enough not to influence the stability of the mineral phases. Only under certain conditions and beyond





a threshold that varies for different mineral assemblages the strain rate can affect the stability field of a mineral. Such conditions are met where minerals of contrasting elasto-plastic behaviour coexist in well-defined proportions, as for example quartz and feldspar in a variety of acid and intermediate rocks. As compared to feldspar, quartz may be considered as a "ductile" mineral. Under the same applied stress it will therefore deform with greater facility, i.e. it will flow by means of dislocation gliding, imposing upon the adjacent "hard" feldspars a rotational movement that will successively inactivate their own gliding planes, creating dislocation tangles that increase the internal energy of the crystals. From the equation:  $A = U - TS$ , where  $A$  is the free energy,  $U$  the internal energy and  $TS$  the bound energy of a crystal, it follows that, leaving  $P$  and  $T$  constant, the free energy of the crystals with a high density of dislocations will rise significantly, as will their chemical potentials. It means chemical instability and dissolution. We consider feldspars of quartzo-feldspathic rocks, as well as Harker's "antistress minerals" to be preferentially affected by such a process. Consequently, their leaving of the stability field must be ascribed to strain rate variation and not to variation of  $P$  or  $T$ . Thus, whereas at a low strain rate albite may be replaced during progressive metamorphism by a lime-rich plagioclase, under strain rates this alternative vanishes, as not the chemistry but the crystal lattice as a whole becomes unstable. In this case, instead of replacing the instable mineral species by a new product structurally and/or chemically related to it, mineral species will appear with crystal lattices more resistant to imposed high strain rates. These mineral species Harker improperly termed "stress minerals".

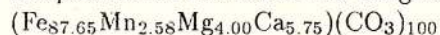
## THE SIDERITE OF THE NEOGENE VOLCANISM-RELATED IRON ORES IN THE EAST CARPATHIANS (ROMANIA). MINERALOGICAL AND CHEMICAL FEATURES

*Al. Szakács (București)*

Neogene volcanism-related siderite deposits occur in Oaș (Huta-Certeze), Gutii (Tăuții de Sus), Călimani (Toplița) and Harghita (Mădăraș, Lueta, Vlăhița, Chirui, etc) Mountains. Major ore bodies form accumulations of economic interest at Lueta and Mădăraș. Both conformable and unconformable ore body geometries – lenses, lenticular layers, veins, irregular-shaped bodies and concretions – are known. The sideritic ore is largely represented by sideritized rocks of various initial composition, origin and age. An extremely simple mineral assemblage is characteristic of these deposits. Two main varieties can be distinguished: (1) monomineral siderite ore and (2) siliceous siderite ore. The latter is prevailing in Huta-Certeze, Tăuții de Sus and Chirui areas. The mineral paragenesis may include: siderite; siderite + marcasite; siderite + opal; siderite + chalcedony and siderite + chalcedony + marcasite.

Siderite displays various crystallographic aspects ranging from euhedral to anhedral – sparitic and microsparitic siderite, micritic siderite, fibrous siderite, spherulitic fibrous siderite and pseudomorphotic siderite – pointing to the diversity of depositional processes and conditions as open-space and pore-filling precipitation from dilute or superconcentrated solutions, metasomatic replacement, etc.

Siderite displays a remarkable chemical homogeneity in the Gutii, Călimani and Harghita Mountains irrespective of the occurrence areas, mineral paragenesis and crystallographic features: their low-Mg character is obvious. The mean composition of siderite in the Harghita occurrences is:



Siderites in the Oaș Mountains are slightly more magnesian. Electron microprobe analyses of Harghita siderites show a larger dispersion of the chemical composition of siderite grains but their mean values are in the range of chemically analysed samples. Trace element depletion of sideritized rocks with respect to their unsideritized counterparts indicates metal-poor hydrothermal solutions as parent for the studied siderites.





## CASSITERITE-BEARING GREISENS IN THE HIGHIȘ GRANITOIDS

M. Tatu (București).

The petrogenetic assemblage of the Variscan granitoids in the Highiș Mts consists of a series of granodiorites, plagiogranites, monzogranites, granites, alkali-granites to syenites and the youngest differentiated phases (rhyolites, albitites and granophyres) as dykes. The relationships between the major phases are diffuse, like in situ differentiates. On the other hand the dykes of the youngest magmatic phases cut across older granitoids bodies and the basic complex of the Biharia Series. Geochemical data point out the calc-alkaline character of the magma with minor alkalic and tholeiitic tendencies. The leucocratic evolution trend (Tischendorf, 1988) is proper to the whole assemblage. In a strong connection with the last aspect, we described in this area greisens and greisenized granitoids (Radna V., Soimoș V., Jernova V., Milova V., Odvoș V., Conop V.). The most interesting occurrences are in the Radna Valley. In the Highiș Mountains the main shapes of greisen deposits are veins and disseminations. They occur in all the petrographic types, especially in monzogranites and rhyolites, rare to absent in granophyres and albitites. The mineralogical composition of the veins and disseminations is characterized by the presence of: quartz<sub>2</sub>, albite<sub>2</sub>, microcline<sub>2</sub>, cassiterite, tourmaline, fluorine, topaz, Li-micas, magnetite, epidote, apatite, carbonates and very small amounts of Fe and Cu sulfides.

Cassiterite appears as granular, tetragonal (rarely ditragonal dipyramidal) crystals (<1 mm); usually it is short prismatic. In transmitted light the mineral is colourless, yellowish to brownish, locally with irregular zoning; it is uniaxial positive. In polished section the crystals present a strong anisotropism and very weak pleochroism, abundant internal reflexions and zonal growth banding. As a rule, cassiterite is closely associated with magnetite. Cassiterite is partially coated by magnetite.

Topaz occurs very rarely as long prismatic crystals (1÷3mm). They are less pleocroic in yellowish shades, biaxial positive ( $2V=50^{\circ}-60^{\circ}$ ),  $\gamma/c = 0^{\circ}$ , with refringence around 1.610 and birefringence = 0.010.

In all of the occurrences the Li-micas are quite abundant. During the processes of greisenization the brown iron-rich micas are progressively replaced by olive-green micas and finally by pale green, grey, pink or almost colourless Li-micas. Thus is related to the decrease of Fe, Ti, Mg and Na from iron-rich micas to Li-micas.

The greisenized granitoids are enriched in SiO<sub>2</sub>, alkalis, F, Li, B, Sn, Nb, Rb, Y, LREE and depleted in Sr, Ba, Eu. The Sr/Sr and Rb/Ba ratios are high. The contents of Sn, Li, F, Nb, in the Highiș greisenized granitoids are: Sn(30-850 ppm), Li (10-1850 ppm), F (1500-7000 ppm), Nb (60-850 ppm).

The presence of allanite closely associated with magnetite in the Highiș granitoids points out high temperature conditions, oxidation regime and high water activity (Broska, Gregor 1992). On the other hand, the high contents of F suggest that tin was transported in chloride and fluoride solutions. According to Tischendorf (1988) the precipitation of cassiterite was caused by the decrease in temperature and oxidations and the increase in pH.

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## A HOMOGENOUS INTERMEDIATE MEMBER OF THE HEMATITE-ILMENITE SOLID SOLUTION SERIES

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Homogeneous grains of a "titanian hematite" were found in a series of heavy mineral concentrates in the South Carpathians. Microscopically, they have a colour intermediate between hematite and ilmenite, show no or slight bireflection and, depending on optical orientation, slight or moderate anisotropy. No internal





reflexions are present. The mineral polishes well and in most cases the grains are homogeneous; very rarely minute exsolution of a hematite-like phase may occur, too.

X-ray diffraction analysis shows an intermediate pattern between hematite and ilmenite, with some lines identical to those of geikielite. However, no magnesium has been detected by analysing the grains with the electron microprobe. The cell parameters and the unit cell volume (i.e.  $a=5.059 \text{ \AA}$ ;  $c=13.872 \text{ \AA}$ ;  $V=307.467 \text{ \AA}^3$ ) suggest an intermediate member with nearly exact 1:1 ratios of hematite to ilmenite; this fact is obvious, when such data are plotted on the diagram of Lindsley (1965). Reflectance data measured at four wavelengths, 488, 553, 590 and 650 nm show values intermediate between hematite and ilmenite, i.e. 22.95–26.54, 21.84–24.42, 20.79–22.97, and 22.58–24.92 %, respectively.

As such members are highly uncommon, especially when taking into account their optical homogeneity, microprobe analyses were carried out on several grains. The distribution of Ti and Fe is homogeneous. In addition, evidences concerning the existence of small amounts of Mn, Ta and V were obtained (such elements not being present in the associated magnetite, hematite or intermediate members of the ilmenite-hematite solid solution series showing reciprocal exsolution lamellae). It is thus presumed that the homogeneous intermediate member with the 1:1 ratio of hematite: ilmenite is stabilized by the presence of Ta and V.

According to the phase diagram of the  $\text{Fe}_2\text{O}_3$ – $\text{FeTiO}_3$  system (see Lindsley, 1976) such intermediate members may appear only at temperatures exceeding 600–650<sup>0</sup> C. Thus, the mineral must have derived from high-grade metamorphic rocks such as eclogites, scarcely found in the metamorphites of the South Carpathians (Iancu et al., 1988).

A secondary "effect" of such a discovery is the possibility given to localize the position of tantalum element, sometimes found in the magnetic concentrates with contents of up to 20 ppm. The positive correlations Ti–Ta and Ti–V also support the preference of Ta and V for the homogeneous titanian hematite grains in the area.

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## CONTRIBUTION TO THE STUDY OF "PLUMOSITE" OF HERJA

S. S. Udubaşa (Bucureşti)

The Herja lead-zinc ore deposits, Baia Mare mining district, is known as type locality of fizelyite and parajamesonite. The Herja veins furnished also beautiful stibnite, pyrrhotite, sphalerite and galena samples. More than 25 minerals were so far identified in the ores. However, the microscopic-examination of ore from the northern part of the deposit revealed the presence of further minerals, i.e. mackinawite, magnetite and the "intermediate product" (secondary, formed by decomposition of pyrrhotite), pre-graphite and rutile. In addition, some interesting data were obtained as concerns the fibrous, felt-like "plumosite". It occurs in geodes, with galena, chalcopyrite, pyrite and marcasite, as well as inclusions in calcite, giving it a blackish colour.

XRD analysis of Herja plumosite gave a powder pattern very similar to that of jamesonite, the main diffraction peaks are: 3.43(100), 2.82(60), 3.09(40), 3.86(33), 8.18(10).

Quantitative spectrographic analysis carried out on pure jamesonite needles revealed interesting contents of Ag (6000 ppm), Mn (400 ppm) and Tl (250 ppm). While to Ag and Mn are already known as minor elements in jamesonite, the presence of thallium seems to be a novelty.

The unit cell edges calculated from X-ray data show values slightly modified as compared to the data presented by Kostov and Mincheva (1981) for jamesonite.





By comparison of the unit cell data of Herja jamesonite, standard-jamesonite and benavidesite (the Mn-jamesonite, Oudin et al., 1982) (Table) it can be concluded that the Herja jamesonite may represent an intermediate member of the jamesonite-benavidesite series. In addition, the Herja jamesonite shows a significant thallium content, which supplementary explain the deparature from the theoretical unit cell edges. Thus, the jamesonite of Herja seems to be a thallium variety of the mineral, intimately related to the jamesonite-benavidesite series.

Table

Unit cell edges (Å)	Jamesonite (Kostov and Mincheva, 1981)	Jamesonite Herja	Benavidesite (Oudin et al., 1982)
a	15.71	15.7291	15.74
b	19.05	19.0941	19.14
c	4.04	4.0284	4.06

## ADULARIA-SERICITE AND ACID-SULPHATE TYPES ALTERATION OF TERTIARY VOLCANIC ROCKS OF MADJAROVO EPITHERMAL SYSTEM, BULGARIA

I. A. Velinov, S. L. Nokov (Sofia)

Madjarovo ore field is a suitable geological object for studies of adularia-sericite and acid-sulphate (kaolinite-alunite) types of wall-rocks alterations and related ore mineralizations.

The Madjarovo precious base metal epithermal ore field is one of the most intensively studied in Bulgaria. It is located in a paleovolcanic structure, situated at the northern periphery of the Eastern Rhodope Paleogene depression. The volcanic rocks characterized by increased alkalinity belong to the shoshonite-latite association. In the central part of the volcanic structure there are intrusive bodies of monzonites and syenites. Morphologically, the Madjarovo paleovolcano is a well-expressed recent caldera caused by a collapse and or by a strong erosion. The process of mineralization is a multy-stage one. The ores, mostly lead-zinc with some gold-silver mineralizations, are mainly medium to low temperature products.

The hydrothermal alteration of the volcanic rocks are multistage in character; accordingly, their bearing on the metallogenic development of the area is quite different.

Host rocks	Type of alteration	Characteristic non-metalliferous minerals	Accompanying elements	K <sub>2</sub> O:Na <sub>2</sub> O ratio
Shoshonites, Latites	Propylitic	albite, chlorite, calcite, epidote, actinolite(±uralite)	Mn, Fe, Si, W, Cu, ± Pb	1:1
Quartz-latites	Advanced argillic	quartz, alunite, diaspore, zunyte, sericite, kaolinite	Al, Cu	2:1
Monzonite, Syenites	Adularia sericite	quartz, adularia, sericite (illite), barite	Pb, Zn, Cu, Ag, Au, ± Mo, Hg	up to 75:1

With respect to theory and practice as well, the following conclusions may be drawn:

– the hydrothermal alterations of adularia-sericite and kaolinite-alunite types are mainly developed over shoshonite-latite Tertiary volcanic rocks. Their areal manifestation is mainly determined by subvertical faults;





- both types of alteration are considered to be induced by diffuse-infiltration; its characteristic features are the metasomatism and the filling up of open cracks, amigdules and pores with hydrothermal minerals.
- the age of the adularia-sericite type is about 32 mil. years and has been determined by the K/Ar method. Similar data about kaolinite-alunite type are not available;
- the zones with adularia-sericite alteration type represents suitable exploration targets for gold-silver mineralization, which are very well expressed at depth;
- the kaolinite-alunite type, developed in the central part of Madjarovo paleovolcano (without any direct genetic relationship to the adularia-sericite type) is not of economic value.

## THE STATUS OF SOME MINERAL SPECIES RELATED TO THE CARPATHIAN BASIN (WEHRLITE-PILSENITE, KITAIBELITE, SZTRÓKAYITE, FELSÖBANYITE ETC)

T. Weiszbürg (Budapest)

## NON-SILICATE ZEOLITES

J. Zemmann (Vienna)

Normal zeolites are aluminium-bearing framework silicates with wide channels. For their dehydration-rehydration behaviour, ion exchange capacities and catalytic properties they have found much interest in pure and applied research. This is not so much the case for other classes of framework structures with wide channels (microporous structures), see e. g. (1,2). They can be built from polyhedra of only geometrical shape (isopolyhedral microporous structures) or from polyhedra of different shapes (heteropolyhedral microporous structures). In the majority of cases the wall of the channels is formed of only one kind of atoms (isoatomic walls): mostly of oxygen. But there exist also microporous structures with heteroatomic walls; they are candidates for research and possibly also for application. Examples will be given mainly from the mineral kingdom: pharmacosiderite, cacoxerite, mixite, zemannite, etc.

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## WHAT IS MONSMEDITE ?

J. Zemann (Vienna)

Monsmedite was described some two decades ago from Baia Sprie, Romania (1,2). It was said to form cubic, very dark green crystals ( $N_{av} = 1.608$ , but with low zonal birefringence); density 3.00 g/ccm. The chemical composition was given to be close to  $K_2O.Tl_2O_3.8SO_3.15H_2O$ , with additional 1.2 weight-%  $Fe_2O_3$  and traces of  $MnO$ , etc.

With this chemical composition monsmedite would be the first dark green thallium salt of an oxo-acid:  $Tl^{1+}$  as well as  $Tl^{1+}$  salts of oxo-acids are otherwise colourless. Therefore, monsmedite was re-examined. Samples from several collections that corresponded macroscopically well to the original description were shown by X-ray investigation to be voltaite ( $a = 27.24 \text{ \AA}$ ); the analytical water content was 15.3 %, close to that voltaite. In this context it seems worth mentioning that the X-ray powder data, the density and the optical properties given in (2) for monsmedite correspond well with those of voltaite. As a consequence monsmedite is, according to the present state of knowledge, to be considered to be (possibly Tl-bearing) voltaite.

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–, Pavelescu L. (1954) Contribuţii la studiul cristalografic al mineralelor din zăcămintul de la Muşca. *Comm. Acad. Rom.*, IV, 11–12, p. 685–991, Bucureşti.

b) books

Bălan M. (1976) Zăcămintele manganifere de la Iacobeni. *Ed. Acad. R. S. R.*, 123 p., Bucureşti.

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