

# Romanian Journal of MINERALOGY

continuation of

DĂRI DE SEAMĂ ALE ȘEDINTELOR INSTITUTULUI DE GEOLOGIE ȘI GEOFIZICĂ  
COMPTES RENDUS DES SÉANCES DE L'INSTITUT DE GÉOLOGIE ET GÉOPHYSIQUE  
(1. Mineralogie-Petrologie)

Founded 1906 by the Geological Institute of Romania

ISSN 1220-5621

Vol. 76  
Supplement Nr. 1

## SECOND SYMPOSIUM ON MINERALOGY

5 – 11 July 1993, Timișoara

## ABSTRACTS VOLUME



Institutul de Geologie și Geofizică  
București – 1993



Institutul Geologic al României



## Romanian Journal of MINERALOGY

Published annually by the Institute of Geology and Geophysics, Bucharest  
Director Ion Rădulescu

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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 and 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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Classification index for libraries 55(058)

Printed by the Institute of Geology and Geophysics



Institutul Geologic al României



## INTRODUCTORY TALK

*G. Udubaşa (IGG Bucharest)*

The decision in favour of Timișoara to be the site of the Second Mineralogy Symposium in Romania has a manifold reason. First of all Timișoara has always been a centre hosting mineralogical or mineralogy-related activities, especially with the Polytechnical Institute (now Technical University). During the World War II Timișoara afforded also shelter to the Faculty of Geology of the Cluj University, the city being for a short time under foreign occupation. Prominent mineralogists such as late Professor Eugen Stoicovici of the Cluj University taught here mineralogy for several years.

The second reason is related to the existence in Timișoara of a well established plant for synthetic rubies and sapphires for industrial purposes. Moreover, the very young Institute of Condensed Matter Research with a crystal growth section will be worth visiting. Last but not least, Timișoara is the nearest city of the celebrated skarn ore deposits at Ocna de Fier (formerly Vaskö or Moravicza), Dognecă and Oravița-Ciclova (which will be also visited during the field trip). As early as 1867 Bernard von Cotta described here and defined for the first time in the world the pyrometamorphic ore deposits and also gave the general name "banatites" (still in use) to the igneous rocks of Upper Cretaceous-Paleogene age.

This was properly not a matter of justifying the Symposium to be here (in fact not necessary) but merely an occasion to highlight the significance of the city of Timișoara in the mineralogical life of Romania.

As compared to the First Mineralogy Symposium held last year in Cluj-Napoca, that had the aim "to estimate the state of the art of the mineralogical research in Romania" (Udubaşa, 1992) and being organized by the Mineralogy Section of the Geological Society of Romania, the Second Symposium marks some differences. This is the Symposium of the recently founded Mineralogical Society of Romania. Further on, the symposia of the MSR will be organized every two years (the next one will be in 1995, probably in Baia Mare). The MSR is now member of EMU and IMA and it is intended both to have corresponding structures and to actively take part in the EMU and IMA activities. Secondly, it seems to me that the mineralogical activity in Romania is now over the limit of the underdevelopment or developing state. Maximal and reasonable use of the existing scientific apparatus and of the software availabilities as well as the more and more intensive international cooperation have contributed much to this and it is hoped to do it better in the near future.

To estimate all the papers to be presented at the symposium is a rather difficult task. However, it is necessary to highlight the significance of some topics of special interest that will seemingly stimulate similar concerns in Romania. For example, the paper of Amisano-Canesi et al. about the IIP micas will surely be followed by such studies in the IIP and HT anisofacial rocks in the South Carpathians (e.g., Iancu, Mărunțiu, 1992), hopefully in a form of cooperation. Such cooperative works are now in progress in the field of Mössbauer spectrometry in an attempt to solve some structural data of the minerals nagyagite (Udubaşa, Wagner, Friedl) or titanian hematite (Udubaşa, Hafner, Bernhardt et al.). SEM images of different minerals prepared by a technique developed by Prof. Hallbauer (Hallbauer, 1983) gave interesting insights into the nature of solid microinclusions (Nedelcu et al.; Udubaşa, Hallbauer).

The skarn mineral assemblages of the famous ore deposits in Banat and Apuseni Mts (Ocna de Fier, Dognecă, Băița Bibor etc) were here only partly presented, e.g., in the papers of ludwigite and "schweizerite" from Ocna de Fier (Marincea, and Ilinca, respectively), ingodite from Valea Seaca, Băița Bihor area (Lupulescu et al.), carrollite from Băița Bihor (Petrescu), hydrotungstite from Oravița-Ciclova and Băița Bihor (Ilinca, Marincea). Nevertheless, many of the celebrated "banatitic" skarn deposits were correspondingly described in several monographic studies derived from doctor's degree theses, such as those on Ocna de Fier (Kissling, 1967), Dognecă (Vlad, 1974), Moldova Nouă (Gheorghită, 1975), Sasca Montană (Constantinescu, 1980). Additional mineralogical data were also later obtained as shown in the review paper of Udubaşa et al. (1992).

Polyminerale aggregates of very fine grained and partly amorphous manganese minerals from the East Carpathians occurrences were matter of long debates; monographic work on Iacobi (Bălan, 1976) is now followed by minute and interesting observations of Perseil (Perseil et al.). Crystallochemical problems of the manganese oxides will kindly be presented in a plenary lecture by Prof. Giovanoli. Many minerals are





also included in the new description of the Delinești Mn-Fe ore deposit, characterizing a highly oxidizing environment of the late (re)crystallization processes (Hârtopanu et al.).

The mineral inventory of Romania became also richer by recent identification of some rare minerals, such as the above mentioned ingodite, carrolite and hydrotungstite; a new occurrence of nukundamite will be presented, too (Lupulescu). Many Co-Ni sulfarsenides were also recently identified within the Mn ores of the East Carpathians (Perseil, Vodă). Special mention deserve the papers concerning the "giant" titanite crystals from the Tismana pegmatites (Tatu et al.) and the almandine found in the Miocene andesites in the Rodna Mts (Nițoi et al.).

A whole session is devoted to gold, a "key" mineral for Romania. Both experimental data concerning solubility and transport of gold (Benning), morphological or compositional features of the native gold (alluvial, Popescu, Ungureanu; hydrothermal, Damian; shear-zone related, Mato, Bebej) will be presented as well as some new data on gold-silver tellurides (Cioflica et al., Ioan et al., Udubașa et al.).

Clay mineralogy has a good tradition in Romania, the Romanian Working Group on clay minerals affiliated to AIPEA being organized as early as 1970. Nevertheless, only few specialized papers will be presented at this symposium, i.e., on rock-salt related clay minerals (Rădan, Vanghelie), on the smectite-illite transition (Boboș, Farkas), on illite and related minerals in coals (Nedelcu), on volcanic glass related montmorillonite (Ghergari et al.), on pervasive nontronitization of some alkaline rocks (Mărza, Ghergari) as well as a paper on clay minerals in sedimentary rocks in Hungary (Viczán). Velho and Gomes (Univ. Aveiro, Portugal) give some aspects of clay mineral use and the related market problems in Europe. Zeolites continue also to offer good matter of studies (Bedelean et al., Damian, Damian; Seghedi et al.).

Not only pure mineralogical topics were here included but also some petrological problems of prime importance both in the field of igneous (Mason et al., Seghedi et al., Russo-Săndulescu, Vaselli et al.) and metamorphic petrology (Balintoni, Costin, Hârtopanu, Iancu & Mărunțiu, Strutinski & Mosonyi). Special items were accepted too, such as magnetic susceptibility of igneous rocks in relation to magma flow (Brotea et al.), opaque mineralogy of volcanic rocks (Ilinca), coexisting albite and oligoclase in alkaline rocks (Bindea), galena and sphalerite deformation under dry conditions (Lupulescu, Watson), distribution of glauconite in iron-bearing sedimentary formations (Bedelean, Pop), chlorites from "metamorphic" ultramafics (Mărunțiu et al.), petrology of low-grade metamagmatites in Banat carrying sometimes beautiful rosettes of stibnomelane (Iancu) and their geochemical features (Mărunțiu et al.), zircon habit significance in granitoids (Robu, Robu). Applied mineralogy is also presented with a paper on tuff-derived synthetic pyroxene masses (Duca, Duca). Last but not least, there are also papers on fluid inclusions (Pintea), siliceous rocks (Seghedi et al.), silicolites (Seclăman et al.).

We warmly acknowledge the presence at our symposium or the contributions of the distinguished colleagues from Austria, France, Hungary, Germany, Italy, Portugal, Slovakia, South Africa, Switzerland, United Kingdom, United States of America. Their attendance surely enhanced the scientific level of the symposium. We are also pleased to say welcome in Timișoara to the first honorary member of the Mineralogical Society of Romania, Prof. Dr. Josef Zemann, Vienna.

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## IN MEMORIAM

## EUGEN STOICOVICI

(1906-1992)

The late Professor Eugen Stoicovici taught mineralogy at the Cluj University between 1930-1975, succeeding at the chair two famous Romania mineralogists, Gheorghe Munteanu Murgoci (1920-1925) and Victor Stanciu (1925-1953). The life of Professor Eugen Stoicovici is closely related to the complex mineralogical research and educational history in the last 70 years at the Cluj University.

Eugen Stoicovici was born in February, 1906 in Bejan-Ilia, Hunedoara district. He attended the primary school in Lugano (Switzerland) and in Brad (Romania) and the secondary school in Brad, Deva and Cluj. Between 1924-1928 he studied at the Cluj University obtaining in 1929 the degree in chemistry and mineralogy; this was followed by a further specializing stage at the Berlin University (1929-1930) and rather soon he obtained his doctor's degree at the Cluj University (1933).

Afterwards it began a very long and successful teaching and scientific activity of Eugen Stoicovici at the Department of Mineralogy, Cluj University, firstly as assistant (1930-1931), reader in mineralogy (1932-1948) and professor of mineralogy and geochemistry (1948-1986) as well as head of the Department of Mineralogy (1953-1975). During the World War II the Department of Mineralogy had to move to Timișoara, where it acted between 1940-1945. Between 1959-1963 Professor Stoicovici was politically expelled from the Department of Mineralogy. Coming back in 1964 he became also (1965) a referent for people working for doctor's degrees. A great number of Romanian geologists benefited by Professor's high competence guidance.

Eugen Stoicovici was member of German Mineralogical Society since 1930, member of the International Association of Crystallography (1965), member of many geological and technical associations, and consulting mineralogist of many ministries, enterprises, Mine Institute of Freiberg (Germany) etc. He led research groups at Romanian Academy (Cluj Branch), Cluj University, Petrochim Institute Ploiești, Porcelain Factory Cluj etc.

In more than 65 years of scientific research Eugen Stoicovici directly wrote more than 145 papers. His interest covered quite large areas in mineralogy, geochemistry, petrology and ore genesis. Over 140 papers dealt with applied mineralogy with outstanding achievements concerning gold-, iron-, base metals ores, clay minerals, sands, building rocks, peat-, teeth- and ceramics mineralogy, mining history, oil and ores technology and many other subjects.

Accuracy of analyses and interpretations based on very strong arguments as well as the ability to find out the most appropriate solutions for theoretical and practical problems characterized the whole scientific work of Eugen Stoicovici.

In addition, he was an excellent teacher. His lectures were always clearly and logically presented, pointing out the chemical and physical supports for each problem of mineralogy, the novelties in the field of mineralogy, the limitations of understanding induced by insufficient knowledge etc. The students were always attracted by his lectures, by his ideas and by the manner he knew to organize the student researches both in the laboratory and in the field.

In the years of communist totalitarianism Eugen Stoicovici supported with dignity and serenity the unjust persecution; he found his refuge in the scientific and educational work. He worked hard till his last days. However, many projects remained as such, representing a lost for the scientific community in Romania.

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## CRYSTAL STRUCTURE OF 3T MUSCOVITE AND PHENGITE CORRELATED WITH GENETIC CONDITIONS

A. Amisano-Canesi, G. Chiari, G. Ferrais, G. Ivaldi, (Univ. Torino)  
S. V. Soboleva (IGEM Moscow)

Occurrences of the six standard polytypes of mica (1M, 2M1, 2M2, 2O, 3T, 6H) are probably connected to genetic conditions. In particular, in high P/T metamorphic rocks 3T muscovite is rare, while 3T phengitic muscovite is quite common (Frey et al., 1983). A structural study of 3T muscovite (mu) and phengitic muscovite (Ph) is here reported.

The muscovite sample is from schists of the Entek-Berlyk suite of the Kokchetav Block (Zerendin Precambrian series, North Kazakhstan) where estimated metamorphic conditions are  $6 < P < 9$  kbar and  $T \approx 600^\circ\text{C}$  (Sobolev et al., 1986).

The phengitic muscovite sample is from the pyrope-bearing whiteschists of the Brossasco-Isasca unit (Dora-Maira Massif, Italy) where occurrence of coesite within the pyrope indicate eclogite-facies conditions ( $P \approx 27$  kbar and  $T \approx 700^\circ\text{C}$ ) (Chopin et al., 1991).

Polytypes were preliminarily identified by X-ray powder patterns (intensity ratios of the 10' reflections) and by electron diffraction (oblique texture method).

The analysis of electron- and X-ray-diffraction (powder and single crystal) data rules out the possibility of polysynthetic twins based on 1M polytype. In fact, no systematic absences are observed for reflections with  $(h-k) = 3n$  and  $(k+l) \neq 3n$  contemporaneously (Güven, Burnham, 1967).

X-ray diffraction intensities were collected on a Siemens single-crystal diffractometer ( $\text{MoK}\alpha$  radiation). The composition and cell parameters of the studied sample are:

Ph:  $(\text{K}_{0.91} \square)(\text{Al}_{1.41}\text{Mg}_{0.60}\text{Ti}_{0.02})(\text{Si}_{3.54}\text{Al}_{0.46})\text{O}_{10}(\text{OH})_2$

$a = 5.215(1)$ ,  $c = 29.755(5)$  Å;

Mu:  $(\text{K}_{0.92}\text{Na}_{0.05}\text{Ca}_{0.03})(\text{Al}_{1.82}\text{Mg}_{0.09}\text{Fe}_{0.09})[\text{Si}_{3.08}\text{Al}_{0.92}]\text{O}_{10}(\text{OH})_2$

$a = 5.212(1)$ ,  $c = 29.804(6)$  Å.

In both cases the structure has been anisotropically refined in the space group  $P3_112$  (88 parameters). The final  $R_w$  value was 0.037 for the two structures (Mu, 1246 reflections; Ph, 1625 reflections). The hydrogen atom has been located in a difference Fourier and occurs in the usual position found in dioctahedral micas, i.e. pointing towards the empty octahedron. The structure is built up by repeating through the  $3_1$  axis a mica layer which shows twofold symmetry.

The differences in the average dimensions of the two independent octahedra (1.952 and 1.943 Å for Mu; 1.971 and 1.957 Å for Ph) and tetrahedra (1.635 and 1.638 Å for Mu; 1.631 and 1.627 Å for Ph) account for the different overall content of Mg and Si in the two samples and show that there is no significant ordering of the cations. The latter result is at variance with that of Güven and Burnham (1967) who reported order both in M and T sites for their 3T muscovite (GBMu). However, these authors collected only 318 independent reflections ( $R = 0.061$  for isotropic refinement).

The trigonal distortion  $\alpha$  of the tetrahedral layer decreases from GBMu ( $11.8^\circ$ ), to Mu ( $7.4^\circ$ ) and, finally, to Ph ( $5.4^\circ$ ). This distortion is correlated with the percentage difference between the average of outer and inner K-O bond length ( $\Delta$ ) and with the distortion index (DI) of the K-coordination polyhedra.  $\Delta$  and DI (in parentheses) are 16.7 % (0.083), 10.7 % (0.054), and 7.8 % (0.039) for GBMu, Mu and Ph, respectively. In other words, the geometrical features of the three 3T samples become more regular with the increase in the genetic pressure: low (pneumatolitic conditions, GBMu), medium (amphibolite facies, Mu) and very high (eclogite facies, Ph).

Since, for a given structure, an increase in pressure tends to produce more regular geometrical features (Hazen, Finger, 1978), it can be concluded that the lower structural distortions showed by 3T phengite favour the occurrence of this phase at high P, as shown by field observations (Frey et al., 1983).

The replacement of Al by Mg requires larger dimension of the two occupied octahedra at the expenses of the empty octahedral site, which reduces his dimension. This effect favours a more regular octahedral layer





and, therefore, again a higher stability at high pressure.

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## PSEUDOMORPHS – A REVISION OF THE TERMINOLOGY AND OF THEIR GENETIC MEANING IN PETROLOGY AND ORE GENESIS

G. C. Amstutz (Univ. Heidelberg)

The geometric and compositional steps in the formation of pseudomorphs are fairly well known understood and pictured in Figure 1. One aspects, however, is still controversial. This is the mimetic replacement of a phase A by a phase B (or C), where the final product is assumed to fill the space of A so perfectly and "crystallographically" that the original presence of A is not any longer recognized. Are such cases of perfect mimicry possible (or are we "mimicking" ourselves, when introducing this hypothesis into genetic theories)? In other words, are such perfect pseudomorphs possible though rare products of replacement, or are they assumptions of the impossible.

The statistical treatment of several thousands of pseudomorphs of all kinds of crystal lattices and compositions resulted in a clear minimum in the grain size distribution between the original phase A and any new (secondary) phase B or (ternary) phase C. The grain size of the new phases is, without known exceptions, between about 10 and 1,000,000 times smaller than that of the original phase A (figure 1, left side). In addition, the orientation of the new phases is different, with very few exceptions of partial orientations, which may represent a form of epitaxial growth. Consequently, the evidence is strong against the formation of optically homogeneous "end-products" of infilling.

A second problem arises from the fact that the existing definition of pseudomorphs does not include cases where the shape of the crystal is merely marked by an outline of remnant material, and where the phase B (or C) has grown beyond the borders of the original mineral grain A. This is shown on the right side of figure 1. These "ghost-crystals" are common and it is proposed here that their geometry corresponds in fact to both parts of the word pseudomorphs. They are "pseudo"-crystals and the shape (greek "morphae") of the original crystal or crystals is visible. In a broad sense, any natural object – also fossil cells, leaves, etc – may be pseudomorphically changed, filled and/or replaced by a phase B or C etc.

The second topic of this abstract is intrinsically related to the first one. If the central column of Figure 1 is a "forbidden area" for pseudomorphs, various genetic theories in petrology and ore genesis must be revised. The rocks and ores in question may belong to the class of processes for which experiments (syntheses) are still missing.

The following conclusion will be drawn: the term "mimetic replacement" is often erroneous and/or premature and should not be used when accurate and systematic observations on pseudomorphism are missing.

## POSSIBLE RELATIONSHIPS BETWEEN CUMPANA MIGMATITE ROCK FABRIC AND STRAIN ELLIPSOID

I. Balintoni (IGG Bucharest)

Balintoni (1975) described the Cumpăna lithogroup striking migmatite rock linear fabric, and the repeated cataclasis/recrystallizations signs, especially of the large microcline eyes, during the medium intensity metamorphic event M2. The linear fabric elements, as amphiboles and microclines eyes, tourmaline crystals, biotite





segregations, paragneiss enclaves, etc., lie almost horizontally and are east-west oriented. There are also different types of folds similarly oriented. The total fabric symmetry is monoclinic. These aspects can be correlated with a noncoaxial general flow, where simple shear played a dominant role, the linear arrangement of the fabric elements being probably rotational. These elements are parallel to the strain ellipsoid Y axis. The strain ellipsoid was almost planar, without important stretching along of Y axis. The migmatite levels can represent shear along which the adjacent lithons have significantly slip. The above mentioned migmatite structures permit good inferences about the shear type and strain ellipsoid pattern during M2 metamorphic event.

## ZEOLITIZATION PROCESSES IN VOLCANIC TUFFS OF THE ȘIMLEU BASIN

*I. Bedeleian, Lucreția Ghergari, II. Bedeleian (Univ. Cluj)  
M. Szekely ("PROCELLA" Brașov)*

The zeolitization processes that affected the Dej Tuff Complex from the Șimleu Basin were investigated in a transverse profile between Ortelec (contact with the crystalline basement) and Mirșid (central-eastern part of the basin) by collecting a great number of samples from the tuff quarry in Mirșid as well as from boreholes drilled by PROCELLA Brașov.

The vitroclasts supported an intensive zeolitization (27–66 %) with increased character from the margins to the center of the basin. At some levels the zeolitization is accompanied by montmorillonitization (6–32 %). The zeolites formed by substitution of the volcanic glass, but also by crystallization in pores or between vitroclasts, being caused by halmirolitic processes. The mineral association includes sodic clinoptilolite, and more rarely mordenite, chabasite, montmorillonite, illite/montmorillonite, muscovite/illite and gypsum.

## MINERALOGIC-PETROGRAPHIC DATA ON THE VOȘLOBENI DOLOMITE, HARGHITA COUNTY

*I. Bedeleian, N. Har, Kinga Kémenes (Univ. Cluj)*

The metamorphosed carbonate formations described as marbles or crystalline dolomites contribute to the knowledge of the geological structures within the mesometamorphic complex of the crystalline-mesozoic area of the Eastern Carpathians.

The mineralogical and geochemical studies (optical, X-ray diffraction, DTA) emphasize the presence in the Voșlobeni dolomitic massif (dolomitic marble) of some calcium, magnesium and iron silicates (tourmaline, actinolite, diopside) resulted from regional metamorphism but also some typical paragenesis of the metasomatic contact metamorphism. The presence of some lamprophyre dykes within the dolomitic bodies may be significant for the identification of the source and stimulators of the metasomatic process. A detailed description of minerals from the dolomite and silicates paragenesis within the Voșlobeni massif is given.

## GLAUCONITE FROM THE TRANSYLVANIAN BASIN

*I. Bedeleian, Dana Pop (Univ. Cluj)*

The presence of the glauconite in the Transylvanian Basin was known long time ago (Hauer, Stache, 1983), but it was considered to have only a lithologic-stratigraphical importance: the glauconite bearing level from the Căpuș-Beds (Upper Lutetian) as a lateral facies variation of the ferruginous oolitic formation; the second,





between the Coruş Beds and Chechiş Beds (Eggenburgian), may be considered a stratigraphical mark for the whole outcropping area of the Miocene deposits from the northwestern part of the Transylvanian Basin.

This typical "autigene" mineral was recently investigated as concerns the structural type of interstratification  $10\text{\AA}/14\text{\AA}$ , the degree of ordering, the polymorph changes (XRD), as well as morphological aspects (SEM) according to distinct granulometric classes. To this some geochemical data are also given. The bathimetric, climatic and geochemical prerequisites implied by the stage of development reached during the glauconitisation process (resulting from the mineralogic analyses) have sedimentological implications, contributing with new data to the characterization of the Eocene and Miocene paleoenvironment of the northwestern part of the Transylvanian Basin.

## TRANSPORT AND DEPOSITION OF GOLD IN HIGH TEMPERATURE HYDROTHERMAL SULPHIDE SOLUTIONS: EXPERIMENTS AND THEIR APPLICATION TO NATURAL SYSTEMS

*Liane Benning (ETH Zürich)*

### Introduction

The nature of the transporting agents in natural systems is largely defined by the composition of the hydrothermal solutions. From the chemical point of view it is likely that gold is transported as chloride-, or hydrosulphide-gold(I)-complex, in which the ligands form compounds of vein minerals (or as fluid inclusions) found in all ore deposits.

The stoichiometry and stability of Au-sulphide complexes were determined in high temperature sulphide solutions by Seward (1973), who concluded that  $\text{Au}(\text{HS})_2^-$  is the dominant gold bearing species stable in the near neutral pH region. The stability of this species was confirmed at temperatures up to  $350^\circ\text{C}$  by Shenberger and Barnes (1989). Seward (1973) proposed the neutral species  $\text{AuHS}^0$  as the complex being stable at low pH. The stability of  $\text{AuHS}^0$ , in the low pH region was firmly demonstrated at  $25^\circ\text{C}$  by Renders and Seward (1989), but Hayashi and Ohmoto (1991) proposed the complex  $\text{HAu}(\text{HS})_2$  as being stable under acid conditions at high temperatures.

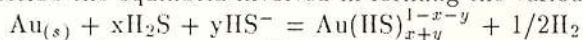
The aim of this study is to determine the stability of hydrosulphido-gold(I) complexes in high temperature sulphide solutions up to  $500^\circ\text{C}$  and 1500 bar.

### Experimental procedure

The experimental were carried out in rocking autoclaves with a flexible gold reaction-cell system. The used cells, made of pure gold have a maximum fluid volume 200 ml. To fix the oxidation potential of the solution,  $\text{H}_2$ - gas was added before heating to run temperature. The solutions were prepared by saturating freshly boiled double distilled water with  $\text{H}_2\text{S}$  gas (acid pH) or from NaOH solutions with known molality, which subsequently were saturated with  $\text{H}_2\text{S}$  gas (near neutral pH). The solutions were analysed by ICP-MS or AAS.

### Results

The experiments shows that gold concentration increases with increasing temperature. The values range from 0.4 to  $1\text{mg/kg}$  ( $2 \times 10^{-6}$  to  $5 \times 10^{-6}$  m) in the experiments with total sulphur and acid pH, and from 50 to  $100\text{mg/kg}$  ( $2.5 \times 10^{-4}$  to  $5 \times 10^{-4}$  m) in the near neutral pH runs. A generalised equation can be written to describe the equilibria involved in forming the various possible thio complexes of gold:



Taking the logarithm and differentiating the equation for the equilibrium constant for above reaction with respect to total sulphur and pH at constant P and T one obtains a general equation for the slope of the solubility curves in this system (see Seward, 1973). The shape of the curve defined by  $\log m_{\text{Au},t}$ , as a function of pH reflects the presence of various Au(I) complexes which have characteristic stability ranges. The experimental data show that in the near neutral slightly acid region the  $\text{Au}(\text{HS})_2^-$  species is predominant. Preliminary data demonstrate that in the acid region the neutral species  $\text{AuHS}^0$  is the important gold species. Preliminary equilibrium constants for the species  $\text{AuHS}^0$  have been calculated.





### Discussion and geological applications

The hydrothermal transport and deposition of gold may be understood only if reliable high temperature thermodynamic data are available. Out of these data one can extract the stoichiometries as well as the stability of gold complexes. One can further deduce the compositions of the fluids that are responsible for the transport of gold concentrations adequate for the formation of economic gold deposits as well as the mechanisms needed to cause the deposition of gold from the transporting solution.

The experimental data show the important role of hydrosulphido-gold complexes in the transport of gold in near neutral to acid sulphide solutions. In hydrothermal solutions with near neutral pH, a considerable quantity of gold can be transported (100 ppm Au at 300°C). There is a large variety of mechanisms responsible for the deposition of gold from hydrothermal solutions. Due to the fact that the maximum stability occurs in solutions with the highest temperature and pH values near neutral, change in pH vs. acid or alkaline and/or a temperature decrease will cause gold precipitation. Due to changes in the oxidation potential of the solution (e.g. by mixing with oxygenated meteoric water) and/or due to decreasing sulphur activity, gold will also precipitate out of the transporting solution.

The better one understands these mechanisms the better one may model the chemistry and individual deposit mechanisms of gold deposits, and this helps also to improve the evaluation of economic gold deposits.

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## COEXISTING ALBITE AND OLIGOCLASE IN SOME ROCKS OF DITRĂU ALCALINE MASSIF

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The rocks of the Ditrău alkaline complex display variations from diorites to granites, all of them having appreciable amounts of plagioclase group minerals. By using the universal stage two plagioclase generations of magmatic origin have been determined showing differences in twin types and composition.

(1) The first generation is an oligoclase (14–25 Anortite) which forms idiomorphic to subidiomorphic crystals (sometimes showing resorption) or may form cores of zoned crystals. The twinning is of albite *ala* type ( $\perp[100] \parallel (010)$ ).

(2) The second generation of feldspar is an albite (0–3% An); the albite is generally xenomorphic surrounding the oligoclase or occurring interstitially. Its twinning is different from the first generation, being mainly of Karlsbad A-type. The albite twin type is rare.

The data obtained show that the two plagioclase generations exhibit structural disorder which may suggest intermediate temperatures of crystallization. There is a correlation between the presence of these feldspars and the presence of reaction zones or of oscillatory extinction. In the feldspar the core is well developed whereas the zones are very thin showing that the difference in temperature of the two systems has not been very great.

The simultaneous presence of oligoclase and albite in the same rock supports the idea of a mixing of the primary dioritic magma and a late alkaline magmatic liquid. A metasomatic albitization of an early magmatic rocks seems improbable because (a) a structural disorder cannot occur unless a later fluid phase is present; (b) the temperature must have been high, a fact which contrasts the intermediate temperature deduced from optical data; (c) the zoned crystals further denies such a hypothesis.

Thus, it seems more appropriate to consider that the primary dioritic magma mixed in an advanced stage of slow crystallization with a low-temperature magmatic liquid of slightly higher degree of alkalinity. Low-temperature conditions implying a low-energy state of the system have not permitted the homogenization to





occur. Instead only a short period of sub-solidus equilibration of the two sub-systems appeared. This resulted in a wide range of rock types, from diorites to alkali syenites through variable proportions of hornblende and oligoclase combined with albite, K-feldspar and nefeline.

The contacts between the different types of rock are graduate with mainly diorites in the western part and syenites in the east. The limits between the different types of rock are purely mineralogical.

I may add that percentage of alkali feldspar is increasing from 0 % in the western part to 100 % in the eastern part of the massif. Moreover, I want to mention that in the eastern part, on Turcu Valley assimilation of quartz from the surrounding metamorphic rocks was frequently observed.

## SMECTITE TO ILLITE TRANSITION IN THE HARGHITA BĂI HYDROTHERMAL AREA AS SEEN BY TEM AND XRD

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The smectite to illite reaction by hydrothermal alteration from Harghita Băi (East Carpathians, Romania) has been studied by transmission electron microscopy (TEM) and X-ray diffraction (XRD). TEM images show that during the transition smectite to illite the morphology changes from the flake habit to the lath habit. The randomly interstratified illite/smectite containing 80–50 percent expandable layers exhibits a flakey habit and ordered interstratified containing 50–60 percent expandable layers exhibits a lath habit. There were distinguished the impure discrete illite and pure illite. The lath habit elongated along "a" are characteristic of the 1M polytype (Güven, 1974). The pure illite composed of hexagonal plates habit probably represents 2 M<sub>1</sub> polytype. XRD analysis confirmed arrangements of mixed layers illite/smectite changing from random to ordered interstratification.

The detailed observations concerning morphology and structure of mixed layer illite/smectite containing 50–60 percent expandable layers suggested a transition mechanism in which illite forms from smectite by dissolution, precipitation and growth.

### Reference:

Güven N. (1974) Lath shaped units in fine grained micas and smectites. *Clays and Clay Minerals*, 22, p. 385.

## ANISOTROPY OF MAGNETIC SUSCEPTIBILITY AND KINEMATIC INTERPRETATION OF SUBVOLCANIC INTRUSIONS

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Anisotropy of magnetic susceptibility (AMS) is used as a petrofabric indicator in magmatic rocks. In this case the general shape of the ferromagnetic grains and the preferred orientations are given by the AMS ellipsoid shape and its main susceptibility K<sub>1</sub>, K<sub>2</sub> and K<sub>3</sub> axis.

In tested cases a distinct kinematic behaviour is observed even for the similar shapes of intrusions but associated to distinct parental magma types. Thus the following cases may be distinguished:

- (1) the cluster of the main K<sub>1</sub> AMS ellipsoidal axes is flow indicator for the andesitic and dioritic bodies.
- (2) the plane given by K<sub>2</sub>K<sub>3</sub> AMS axes shows the transport plane of the magma for the dacitic and rhyodacitic intrusions.
- (3) random distributions of the AMS axes generally characterize the central parts of the intrusions and show a non-Newtonian rheologic behaviour of the magma.





These observation compared with theoretical simulation model help in elucidate the sample position in the intrusive body in order to give the absolute flow direction. Mainly, this "thrust zone" must avoid the marginal area of the intrusions, where disturbing effect may take place as Magnus, Bagnoldt or other effects, as well as the central part where the plug zone may occur if Bingham type fluid is present.

## NEW DATA ON THE TELLURIDES OF THE NEOGENE ORE DEPOSITS IN ROMANIA

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Gh. Damian (Univ. Baia Mare)

Tellurides in the hydrothermal ore deposits related to Neogene volcanic structures on the Romania territory are known as veins and veinlets especially at Săcărîmb, Stănița (Ungurul and Fericele hills), Baia de Arieș, Căraci, Ruda-Barza (Brădișor mine), Bucium (Arama vein, Boteș), Fața Băii, Măgura-Hondol and Techerău, in the South Apuseni Mts.; other occurrences have been described at Băița in Gutâi Mts and at Cobășel and Izvorul Roșu, in Rodna Mts. They constitute either gold-silver telluride ore deposits (i.e. Săcărîmb - a classical mineralization of this type) or telluride bearing gold-silver and base metal ore deposits (i.e. Stănița, Măgura-Hondol, Cobășel, Izvorul Roșu). The tellurides are associated with native gold, sulphosalts and common sulphides.

The following species were studied by optical methods and quantitative electron microprobe analyses: altaite, coloradoite, hessite, krennerite, sylvanite, petzite, nagyagite and an unnamed  $\text{SbTe}_2$ . Main quantitative reflectance and compositional data are listed in the tables 1 and 2.

Table 1  
Reflectance data ( $R$ ;  $R_{\min}$  -  $R_{\max}$ , %) of some  
tellurides from South Apuseni Mts

Nr	Mineral	WL (nm)			
		486	552	589	656
1	Altaite	69.7	66.5	64.5	61.0
2	Altaite	69.7	68.5	66.0	62.5
3	Coloradoite	37.0	36.0	39.1	37.5
4	Hessite	37.2-40.0	37.5-40.0	37.0-41.5	37.0-42.5
5	Hessite	38.0-40.2	37.8-41.0	38.5-43.0	38.7-45.0
6	Krennerite	53.5-62.0	50.8-63.0	56.5-63.3	57.5-64.0
7	Sylvanite	50.6-59.2	51.6-61.0	52.1-61.9	54.5-64.0
8	Sylvanite	45.5-57.0	46.0-58.2	46.8-58.5	49.0-60.5
9	Sylvanite	42.0-57.5	44.0-58.5	45.0-58.0	46.0-59.8
10	Petzite	41.5	38.0	38.0	39.5
11	Petzite	40.8	39.0	39.0	39.0
12	Nagyagite I	42.0-42.5	38.9-40.2	38.4-39.8	37.0-37.8
13	Unnamed $\text{SbTe}_2$	61.3-66.1	61.5-66.5	62.5-67.5	62.0-67.0

1, 3, 4, 6, 7, 10, 12 - Săcărîmb

2, 5, 8, 11, 13 - Stănița

9 - Baia de Arieș





Table 2  
Electron microprobe analyses (in wt %) of some tellurides  
from South Apuseni Mts

No	Minerals	Pb	Hg	Au	Ag	Sb	Mo	Te	S
1	Altaite	61.54	—	0.16	0.17	0.27	—	37.08	0.04
2	Altaite	59.30	—	—	—	—	—	40.20	—
3	Coloradoite	—	56.50	—	0.24	—	2.76	40.50	—
4	Hessite	0.12	—	0.11	63.23	0.14	—	37.77	—
5	Hessite	—	—	—	65.43	—	—	34.57	—
6	Krennerite	—	—	34.75	5.47	—	0.17	60.00	—
7	Sylvanite	—	—	25.21	12.64	0.30	—	61.64	0.05
8	Sylvanite	—	—	22.87	11.69	—	0.10	62.83	—
9	Sylvanite	—	—	25.30	14.30	—	0.13	62.70	—
10	Petzite	—	—	22.25	39.20	—	—	38.45	—
11	Nagyagite I	57.74	—	5.66	0.28	7.97	—	17.31	12.08
12	Nagyagite	57.22	—	3.62	0.03	9.87	—	18.22	12.85
13	Unnamed SbTe <sub>5</sub>	—	—	—	—	34.03	—	67.97	—

Location: 1, 2, 3, 4, 6, 7, 11, 12 – Săcărimb; 2, 5, 8, 10, 13 – Stănița; 9 – Baia de Arieș  
Also: 1 (0.04 % Fe, 0.04 % Cu); 4 (0.02 % Fe); 7 (0.02 % Cu, 0.12 % Bi, 0.02 % Ni);  
11 (0.03 % Ni); 12 (0.01 % Ni).

These data are in agreement with those from mineralogical literature. For nagyagite some contrasting data have been found. Thus in the polished sections examined by us constantly two nagyagite phases have been identified, which have different optical and chemical features. These are: a) nagyagite I is earlier and has a very clear tabular habit, a greyish white colour with a slightly creamy tint, a weak anisotropy in brownish to bluish colours; the chemical analyses show higher values of Au and Ag and lower values of Te and Sb; b) nagyagite II – occurs usually as rims which substitute the nagyagite I; it has a greyish white colour with a slightly greenish tint, a lower polishing hardness than nagyagite I, a distinct anisotropy; the chemical analyses show higher values of Te and Sb and lower values of Au and Ag. The identification of these two phases confirm the Giuscă's (1937) observations as regards the nagyagite "inhomogeneity".

The unnamed SbTe<sub>2</sub> is closely associated with altaite and sylvanite in the ores of the telluride-bearing gold-silver veins at Stănița. The physical and chemical characteristics suggest a new telluride with composition of SbTe<sub>2</sub> near to, but different of tellurantimony.

## Bi-Se MINERALS IN THE ORES OF THE OCNA DE FIER SKARN DEPOSIT

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Samples from an iron body in Paulus mine contain a Bi-association with a seleniferous phase as most abundant mineral, identified as guanajuatite: XRD analysis showed the main diffraction peaks: 3.61(10); 3.16(10); 2.68(10); Se was chemically and spectrographically checked. Guanajuatite appears as nests with steplike bladed aspect, showing white to lead-grey tarnished metallic lustre. The Bi-mineralization consists of three sulphosalts groups i.e., Bi-Se (guanajuatite and junote); Bi-Ag (pavonite and gustavite); Bi-Cu-Pb (bismuthinite, aikinite and intermediate members called "bismuthinite derivatives" (Mumme et al., 1976). Each group show intimate micronic exsolution-like intergrowths. Junote and pavonite display also fine vermicular forms a rhombic net of exsolved phases; furthermore pavonite has also a parquet-like structure consisting probably of cupropavonite as Karup-Moller and Makovicky (1979) showed. Bismuthinite derivatives contain roughly skeletal exsolved phase without clearly boundaries that resemble the gladite exsolution in pekoite (Harris & Chen, 1976); (Large & Mumme, 1975).

The Bi-sulphosalts and more rarely magnetite have sparsely inclusions of lamellar Bi-tellurides and gold-tetradymite blebs. The Bi-tellurides are tellurobismutite, as more abundant phase and tetradymite, the former sometimes as lamellar inclusions in the second, were observed in the richest telluride sample. In the same





case the Bi-tellurides have a bismuthinite like mineral as exsolved fine rods, resembling the Boliden samples (Ramdohr, 1969).

Fissural transformation of magnetite to minor amount of hematite, followed by carbonate veinlets deposition correspond to peculiar altering aspects within the Bi-minerals. The alteration of bismuthinite derivatives and junote begins as a Bi-Cu enrichment on a fissural rhombic network and finishes with Bi-fahlore containing a fine net of covellite-chalcocite with native Bi blebs.

The Bi-Se minerals identified in samples from the Paulus mine at Ocna de Fier were formed from complex fluids containing Bi-Se-Te-Ag-Au in a close relation with iron oxides. The upper limit of the paragenesis is revealed by the association of the Se-phases with magnetite at a quite restricted  $fO_2$  value. The lower limit of the paragenesis is suggested by deposition of the Bi-minerals together with hematite and sulphides near the magnetite-hematite buffer, a fact well correlated with experimental data of Afifi et al. (1989).

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## ECLOGITE BODIES FROM TOPOLOG ZONE, SOUTH CARPATHIANS; RETROGRADE REACTIONS AND GEOLOGICAL IMPLICATION

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This study points out the retrograde transformations of the eclogites from Topolog zone (Clăbucet Peak - Făgăraș Mountains) which is based on a microscopic study correlated with microprobe images and profiles. The host rocks of eclogites consist of biotite bearing quartzofeldspathic gneisses. Eclogites are bordered by a consistent rim of almandine bearing amphibolites with a slight oriented texture.

The primary paragenesis consists of pyrope + omphacite + quartz (coesite?) + rutile; quartz and rutile occur as inclusions in garnet. Pyrope, omphacite and quartz were first eliminated during a fast decreasing pressure (Iancu, Mărunțiu, 1992) and they turned into a simplectitic intergrowth of diopside and plagioclase. A nearly synchronous reaction, i.e., pyrope+omphacite → hornblende+plagioclase resulted in coronitic rims around garnet; it continued also after simplectite completion, affecting it. This reaction was reactivated in each retrograde process which followed. Kyanite was a mineral next appearing in association and it is strongly controlled by a shear stress, which had a recurrent activity. This fact was noticed where the shear microfractures intercepts the kyanite grains, its coronas and the garnet boundaries as well.

The next retrograde event produced the coronas around kyanite, diopside and even hornblende. These coronas show a fine-grained intergrowth (simplectite II) and it represents the recrystallization of the first simplectite, with neoformation of zoisite and spinel (hercynite?). Associated with this simplectite II large zoisite grains were formed in the rock.

The next two moments of transformation were marked by the appearance of a large poikilitic amphiboles (tremolite-actinolite) which included "drops" of plagioclase and also zoisite, kyanite and garnet fragments. These amphiboles show a slight different orientation and argues the successive moments of ductile behaviour of rock within the almandine amphibolites facies.

The simplectite I is interpreted as a fast rock uplift from a deep structural domain. Afterwards kyanite has formed under shear stress conditions with a recurrent activity. The fine-grained simplectite II strongly





argues such an evolution of the rocks from a high pressure towards a lower one. Within this context, the coronitic reactions were thermally controlled. The transformation moments shown were evidently situated before the main metamorphic moments ( $M_1$  and  $M_2$ ) in South Carpathians, which produced the two generation of amphiboles recognized here.

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## HYDROTHERMAL LAUMONTITE FROM BĂIUȚ AREA

Gh. Damian, Floarea Damian (Univ. Baia Mare)

In the mining district Băiuț hydrothermal laumontite was only recently identified. It occurs in the veins Petru and Pavel and in the Pietrele Morii gallery forming a big geode associated with well developed, large-sized calcite and quartz crystals. Laumontite has acicular form, is white-pearly and very friable; the fibres may reach 1-1.5 cm in length. The main X-ray diffraction lines (Phillips diffractometer, Ni filter) of the laumontite are the followings: 9.40; 6.804; 4.71; 4.15; 3.14; 2.94; 2.35; 2.148: 1.56. On the DTA and DTG curves three endothermic effects are present with maxima at 120°C and 440°C, having mass loss correspondents on the TG curve of  $P_1=1.87\%$ ;  $P_2=3.95\%$ ;  $P_3=7.70\%$  respectively and a total loss of 13.72 %. The IR curves show absorption bands at 446  $\text{cm}^{-1}$ ; 570  $\text{cm}^{-1}$ ; 1005  $\text{cm}^{-1}$ ; 1045  $\text{cm}^{-1}$ ; 1665  $\text{cm}^{-1}$ ; 3660  $\text{cm}^{-1}$ . The electron microscope images show the presence of some acicular-fibrous crystals. Chemical analyses of laumontite gave:  $\text{SiO}_2=52.37\%$ ;  $\text{Fe}_2\text{O}_3=0.11\%$ ;  $\text{FeO}=0.03\%$ ;  $\text{Al}_2\text{O}_3=21.24\%$ ;  $\text{CaO}=12.38\%$ ;  $\text{TiO}_2=0.06\%$ ;  $\text{Na}_2\text{O}=0.44\%$ ;  $\text{K}_2\text{O}=0.19\%$ ;  $\text{S}=0.32\%$ ;  $\text{SO}_3=0.51\%$ ;  $\text{H}_2\text{O}^-=13.00\%$ ;  $\text{CO}_2=0.28\%$ . The laumontite-calcite-quartz association from Băiuț represents a late, post ore, hydrothermal mineral formation.

## NATIVE GOLD IN THE HYDROTHERMAL ORES OF TOROIAGA MASIF

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The Neogene intrusion of Toroiaga-Țiganul was emplaced as a result of the multistage magmatic activity generating the following petrographic range: quartz-bearing andesites of Novcior, Toroiaga andesites, quartz-bearing diorites of Secu-Novăț, quartz-bearing andesites of Vertic, Piciorul Caorei andesite. The quartz-bearing diorites are emplaced in the central area and are related to the main vein groups. The mineralizations are predominantly copper bearing and only partly lead-zinc bearing (Piciorul Țiganului). The commonly consist of massive pyrite with subordinately chalcopyrite. Certain zones of Caterina, Iohan, Vîrfuri veins have a polymetallic character. Some of the parts veins contain also sphalerite, galena, pyrrhotite, marcasite, arsenopyrite, bismuthinite, tetrahedrite, bournonite, semseyite, jamesonite, plagionite, meneghinite, boulangerite, matildite, native gold, magnetite, hematite, and as gangue minerals: quartz, calcite, dolomite, siderite, kaolinite, barite, sericite, illite.

Native gold has been detected in the Domnișoara, Orania, Caterina and X veins. It appears included in sulphides and only subordinately in quartz forming isometric, elongated grains with serrated edge. Native gold grains as a rule included in pyrite and partly occur on the contact of pyrite with quartz chalcopyrite, sphalerite or form inclusions in sphalerite and galena. The native gold grain-size varies from several microns up to 148 microns.





Distribution of native gold grains within the host minerals (%)

Crt. No	Vein	Host minerals								
		Py	Py-Q	Py-Cp	Py-Sph	Q	Cp	Sph	Ga	Ttr
1	Domnişoara	92	3	4	1	—	—	—	—	—
2	Caterina sup. NE	79	—	—	—	15	—	3	3	—
3	Caterina inf.	33	11	11	—	45	—	—	—	—
4	Orania	50	—	—	—	13	12	—	—	25
5	Filonul X	—	—	—	—	—	—	—	—	—

Py=pyrite; Q=quartz; Cp=chalcopyrite; Sph=sphalerite; Ga=galenite; Ttr= tetrahedrite.

Electron microprobe analyses gave 4 percent silver (Domnişoara Vein). Reflectivity measurements suggest also low silver contents. The fineness of the gold in the Toroiağa ore veins varies between 910 and 980.

## MINERALOGICAL AND GEOCHEMICAL DATA CONCERNING THE RETEZAT GRANITOID PETROGENESIS

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The Retezat Granitoidic Massif (South Carpathians) appears as a calc-alkaline plutonic suite consisting of quartz-diorites, tonalites, granodiorites and granites that show a low to intermediate  $K_2O$  calc-alkaline differentiation trend (trondhjemitic). The global chemical composition can be approximated as trondhjemitic-tonalitic-granodioritic (TTG). Some mineralogical data have been correlated with trace elements (mainly REE) behaviour, as an attempt to suggest a petrogenetic mechanism by which the TTG series evolved. The REE patterns displaying depleted HREE in contrast with LREE contents and a small negative Eu anomaly (when it exists), suggest a partial melting process followed by slight fractionation of a rather homogenous TTG magma.

## L'UTILISATION DES CENDRES DANS LES AGGREGATES SYNTHETIQUES, PYROXENIQUES

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Cet étude s'occupe d'un domaine de perspective qui vise l'utilisation des cendres provenant des centrales thermo-électrique. Ces déchets industriels, accumulés dans de grandes quantités, sont usinés par des procédées péturgiques, obtenant finalement des masses pyroxéniques.

La technologie de fabrication réside dans l'obtention des types de verre caractérisés par une cristallisation volumétrique, individualisent les minerais qui impriment aux produits de remarquables qualités physico-mécaniques et chimiques. De point de vue minéralogique, les principales phases cristallines appartiennent aux pyroxènes. La caractérisation de la structure et de la composition minéralogique a été effectuée à l'aide de microscopie optique, RX, DTA, IR. Les masses des roches synthétiques sont incluses dans la système  $SiO_2$ - $MgO$ - $CaO$ - $Al_2O_3$ .

Parmi les nombreux utilisations que les masses des roches synthétiques peuvent avoir nous mentionnons les placages dans l'industrie chimique, sidérurgique, dans la constructions, etc. Le procédé permet l'élimination d'importants quantités de déchets qui sont inclus dans des produits à grande valeur d'utilisation. L'effet positif du point de vue de la protection de l'environnement tout comme l'aspect utilitaire ont déterminé beaucoup de pays industrialisés de créer une vraie industrie péturgique.





## SUBSTITUTION OF VOLCANIC GLASS BY NA-MONTMORILLONITE AND CRISTOBALITE IN THE IGNIMBRITIC RHYOLITE FROM VALEA CHIOARULUI

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The banatitic ignimbric rhyolite from Valea Chioarului is a result of a phreatic explosion. Late autometamorphic transformations led to replacement of the volcanic glass by Na-montmorillonite and cristobalite. Cristobalite generation was caused by the excess silica resulted from the montmorillonitization process of the volcanic glass. Accompanying hydrothermal minerals are quartz, amethyst, halloysite, zeolites, celestite, barite, etc.

## MANGANESE OXIDE MINERALS

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Manganese oxides and Oxidehydroxides occur generally as finely divided and disordered compounds in a variety of phases.

There is a series of simple binary oxides:

Manganosite  $\text{MnO}$ . Rocksalt structure.

Partridgeite  $\alpha\text{-Mn}_2\text{O}_3$ . Rare Earth C-type structure.

Hattmannite  $\text{Mn}_3\text{O}_4$ . Structure derived from spinel type.

Pyrolusite  $\beta\text{-MnO}_2$ . Rutile type.

Nsutite  $\gamma\text{-MnO}_2$ . Diaspore type with randomly distributed single chains of edge-sharing  $[\text{MnO}_6]$  octahedra.

Another group has a metric similarity to phyllosilicates and is called phylломanganates. 10 Å phylломanganate shows exchange properties and collects transition metal ions like  $\text{Cu}^{2+}$ ,  $\text{Co}^{2+}$ ,  $\text{Ni}^{2+}$ , but also  $\text{Ca}^{2+}$  and  $\text{Zn}^{2+}$ . Its dehydration product is 7 Å phylломanganate (birnessite) also with exchange properties, but less pronounced.

10 Å phylломanganate expands from 10 to 26 Å layer separation by intercalation of dodecylammonium chloride, precisely as some 10 Å phyllosilicates do.

A third group had structural tunnels and maybe called tunnel manganates. This group requires large cations to be stable, e.g.  $\text{Ba}^{2+}$ ,  $\text{K}^+$ ,  $\text{Sr}^{2+}$ ,  $\text{NH}_4^+$ ,  $\text{Pb}^{2+}$ :

Hollandite  $\text{BaMn}_8\text{O}_{16}$

Cryptomelane  $\text{KMn}_8\text{O}_{16}$

Coronadite  $\text{PbMn}_8\text{O}_{16}$

This group has square tunnels along the needle axis. The large cations sit tightly in these tunnels and cannot be exchanged.

Another mineral species of the name psilomelane (romanéchite) has similar tunnels, but with a rectangular cross section such that 1  $\text{Ba}^{2+}$  and 1  $\text{H}_2\text{O}$  molecule can be accommodated.

While the members of the hollandite tunnel manganate group are very stable mineral species, psilomelane (romanéchite) is less stable and its tunnels collapse, when heated, under water loss to hollandite tunnels. Also frequent intergrowth of hollandite microdomains in a psilomelane (romanéchite) matrix has been observed.





## JAPANESE TWINS OF QUARTZ CRYSTALS FROM OCNA DE FIER

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About 90 mineral species are known to occur at Ocna de Fier, some of them showing interesting morphological features, e.g., the Japanese twins of quartz crystals. First description of such twins was made by R. Coechlin in 1904 but the locality given was Dognecea. However, my intensive field search showed that the true provenance of quartz Japanese twins is Ocna de Fier, namely Terezia ("Sorf"), the Reichenstein II adit, and the Iuliana veche quarry, the last occurrence being found in 1992. In all the occurrences the twinned quartz crystals are associated with lamellar hematite, magnetite and andradite.

## NEW DATA ON SOME SKARN MINERALS FROM CACOVA IERII DEPOSIT, GILĂU MOUNTAINS

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At Cacova Ierii, eastern Gilău Mountains, skarns containing hedenbergite, andradite and tremolite-ferroactinolite occurs in 20 lenses (metasomatic columns ?) investigated by mining works. The superposed mineralization consists of magnetite with minor to trace amounts of pyrite, pyrrhotite, galena, sphalerite and chalcopyrite.

All skarn bodies contain similar mineral assemblages.

The main skarn minerals (i.e. hedenbergite, andradite and ferroactinolite) have nearly pure Ca-Fe end-member compositions and have similar compositions throughout the skarns, as can be proved by X-ray powder diffraction and optical data. The skarn has a granular-nematoblastic structure and a massive texture, sometimes consisting of largely developed prisms of pyroxene (crystals up to 8 cm long).

Concerning the garnet it is of note that an obvious "doubling" of the characteristic andradite peaks in the X-ray powder patterns is consistent with the presence of grossular in mechanic mixture.

## EVOLUTION OF ZONING AT THE COSTABONNE TUNGSTEN SKARN DEPOSIT (Pyrenées, France)

*G. Guy (Ecole des Mines, St. Etienne)*

At Costabonne (Pyrenées, France) skarns develop by metasomatic alteration of various metasedimentary rocks of Cambrian age, at the vicinity of the Costabonne Hercynian granitic stock. The transformation took place during a large temperature interval, from about 680° C for the early stages to about 250° C for the late stage. As a consequence the metasomatic minerals and zoning patterns developed at early stage differ from those developed at the end of skarn evolution.

This is particularly conspicuous in the case of the transformation of dolostone. The first zoning pattern shows the development of calcite + forsterite, diopside and andradite, the intermediate patterns show the development of more grossular-rich garnet and more hedenbergitic pyroxene and in the late zoning pattern, manganese-rich garnet and pyroxene, and calcic amphiboles develop.

The various zoning patterns can be portrayed on a diagram where time is figured along the vertical axis and space along the horizontal axis. Chemical potential diagrams at different temperatures explain part of the changes observed in the zoning patterns.

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# THE APPLICATION OF MULTIVARIATE STATISTICS AND PEARCE ELEMENT RATIOS TO THE TESTING OF GEOLOGICAL HYPOTHESES AND GEOCHEMICAL MODELLING OF SEDIMENTARY PROCESSES IN SOME WITWATERSRAND SEDIMENTS

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Variations in whole rock analyses have long been used advantageously to obtain information, not only on rock types and their classification, but on a number of geological processes such as magmatic differentiation and material transfer processes in general. Factor analysis and multivariate discriminant statistical methods have been applied extensively, and more recently the PEARCE element ratio analysis (PERA) (Nicholls, 1988) was added as a statistical evaluation of geological models. However, indiscriminate statistical evaluation of geological data, particularly of mixed, divergent sample sets can easily lead to wrong interpretations. Care must therefore be exercised in the selection and preparation of sample sets for statistical analysis.

In this paper a combination of PERA and R-Mode factor analysis was applied to sets of whole rock data (major and minor elements) of some Witwatersrand reefs to test the hypothesis that sedimentary processes were largely responsible for the formation of reefs and the distribution of gold accompanying in them. A total of 135 sample sets of Ventersdorp Contact Reef (VCR) from the Kloof gold mine and 80 sets of conglomerate bands and grit bands from the Carbon Leader zone at the Libanon gold mine were analyzed.

The VCR samples from Kloof were initially grouped into two large groups, i.e. lower unit and upper unit in relation to sedimentological criteria and their position in the VCR palaeo-placer deposit. Each group had been subdivided into clast supported and matrix supported conglomerates and sandstone. A multivariate discrimination analysis, performed initially of the groupings, showed that only three significant groups exist, namely, upper ( $N=37$ ) and lower ( $N=55$ ) conglomerates and one combined group of sandstones ( $N=43$ ). This grouping was adopted during further analysis. No statistically significant grouping could be identified in the sample set from the Carbon Leader reef, and this set ( $N=80$ ) was subsequently treated as one group.

All data sets were then converted to PEARCE element ratios. Ti was selected as the common denominator element for the Carbon Leader set and Nb for the VCR set of samples. Such a conversion not only allows a modelling of mineral compositions and geologic processes (Nicholls, 1981), it also eliminates the "closure" effect for the major constituents, and meaningful correlations are obtained for Si, Al and others. Using average compositions, the minerals pyrite, chlorite, K-mica and quartz were modelled from PEARCE element ratios, and their respective amounts substituted in the data matrices.

These new data sets were now subjected to R-Mode factor analysis and the results interpreted. In examples given it will be shown that the first three factors for the lower unit of the VCR at Kloof and the Carbon Leader reef at Libanon indicate, in all cases, mineral and/or element associations in the main factors that can be related to sedimentary processes of transport and sorting. Only small portions of the variance in the data sets can be attributed to secondary processes of alteration or remobilization.

Also for both conglomerates, the lower unit of the VCR and the Carbon Leader reef, the dominating factor contains the components gold, uraninite, pyrite, quartz (pebbles) and associated elements. The second factor could be called the "chlorite-pyrite-quartz" factor while the third contains the elements of K-mica. For the VCR sandstones pyrite and gold appear in different factors, and as expected for a well sorted arenite, quartz is not significantly associated with either the heavy mineral or the micaceous components. In the set from the upper VCR unit which is in contact with the Ventersdorp lava, factors point to a remobilization of Pb, Zn, Cu, Ca, Sr and small amounts of gold, the latter probably in the context of carbonate veins.

Only 10 per cent of the variance for Ag can be explained by its correlation to gold in Carbon Leader samples. A relatively large proportion of Ag is apparently contained in pyrite and other sulphides, a case quite well documented for many low grade reefs which persistently show a higher apparent fineness than high grade reefs in their assay results.

It can be stated in conclusion, that the statistical evaluation of VCR and Carbon Leader whole rock samples using PERA and R-Mode analysis confirm the hypothesis that sedimentary processes controlled the distribution of gold and most other minerals in reefs whereas secondary processes of remobilization only attained local importance.

Samples and chemical analyses of the specimens were provided by Gold Fields of S A and COMRO. Their permission to statistically analyze the lithogeochemical data is hereby gratefully acknowledged.





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## THE ESTABLISHING OF A MINERAL REACTION TRACING MICROSCOPICAL SUBSTITUTION TEXTURES IN THE FIELD

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In the Mehedenți Mts (Bahna outlier) a suite of isorelation minerals curves were drawn. The main area in which the most curves are present lies in the middle part of the Bahna outlier. A cross section over the boundary of the two types of metamorphic areas (intermediate low pressure and barrovian) can be imagined. Each member of a mineral relation belongs to a member of the mineral reaction. Totalizing all members of the mineral relations the two members of a mineral reaction can be established. Thus the reaction kyanite + biotite + staurolite = andesite + grnet + muscovite could be depicted.

Other reactions are also possible to be found in other areas of the Bahna outlier but if the intersected curves are rarer established reaction is more uncertain.

The final results of this study is to learn the physical conditions for developing of the mineral reaction inside of each area type of metamorphism and the conditions for appearance of intermediate low pressure metamorphism in the barrovian type area (or volume). In fact this modality to search the metamorphic reactions looks for the realistic reactions by observing them in the field that is the modality by which the Earth solved this problem.

## MINERALOGY AND GENESIS OF THE DELINEȘTI Mn-Fe ORES

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The Mn-Fe ores from Delinești are placed in northern part of the Semenik Mts. The host rocks belong to Sebeș-Lotru Series, metamorphosed in almandine-amphibolite facies. These rocks are intruded by acid intrusions of Buchin and Poiana granites. Alkali pegmatites and hydrothermal quartz veins can be observed too. All these have modified the thermal and baric parameters which have determined mineralogical composition change of the ore. The Mn-Fe ore consists of small lenses interbedded in host rocks. They have a general NE-SW orientation. The former interbedded texture ore become sometimes masive or even porphyroblastic, e.g., the magnetite. The ore is hard and compact and the colour is yellow, yellow-redish or pink, pink-redish.

The Delinești ore consists of three main types: 1) Spessartine type (=gondite) mainly made up by spessartine and quartz  $\pm$  dannemorite; 2) Carbonate type (=quclusite) made up by rhodochrosite, tephroite, rhodonite, pyroxmangite; 3) Kodurite type. It includes spessartine and carbonate ores undergoing thermal, metasomatic and hydrothermal changes giving rise to new minerals. Thus, the thermal metamorphism associated to pressure decreasing induced the appearance of magnetite, bustamite, monazite, antophyllite and tremolite in the ore and grossular, epidote in the nearest carbonate rocks. Both  $\text{Fe}^{3+}$  and Na metasomatism (accompanied by the pressure decrease and an increase of oxygen fugacity, too) gave rise to the following minerals: spessartine-calderite (garnet without FeO and MgO, and high content of MnO and  $\text{Fe}_2\text{O}_3$ ), aegirine-acmite type of natrium alkali pyroxenes (high percent of  $\text{Fe}_2\text{O}_3$  and NaO), yellow alkali amphiboles with  $\text{Na}^+$  in chemical composition. Both boron and fluorine metasomatism determined the appearance of following minerals: dravite (+ natrium metasomatism, + F), Mn-humites, apatite. Potassic metasomatism produced phlogopite. The last minerals - hydrothermal type ones - make up unoriented veins in the ore body. These are: hematite, Mn-calcite, calcite, low temperature albite, low temperature K-feldspar, Ba-feldspar, barite, friedelite, bementite, neotokite. Ore mineralogical evolution developed from manganese rich minerals to iron ( $\text{Fe}^{3+}$ ) rich minerals and from Ca rich minerals to Na rich minerals.





The Delnești ore has a complex genesis: initially it was a sedimentary deposit, consisting of clay-siliceous Mn oxides and hydroxides or Mn-carbonate deposits + Mn oxides and hydroxides-poor  $\text{SiO}_2$ , which were metamorphosed at the level of the almandine amphibolite facies. The products which resulted are spessartine ore and associated tephroite. The both ore types – the spessartine-rich and the carbonate-rich types – the underwent some changes originated in thermal contact metamorphism and from a strong Na, F, B, K-metasomatism resulting a hybrid ore, belonging to kodurite type. The large development of Na-alkali pyroxenes and of the spessartine-calderite garnets can be explained by the adding of  $\text{Fe}^{3+}$  and Na from outside only.

## PETROLOGIC DATA ON THE PALEOZOIC SEQUENCES IN THE SUPRAGETIC UNITS IN THE BANAT AREA

Viorica Iancu (IGG Bucharest)

Mesocretaceous (Austrian) nappe pile in the Banat area (and the southwestern part of the Poiana Ruscă massif) is represented by basement nappes in which discontinuous, thin and gapped. Mesozoic cover is preserved. The Supragetic Alpine nappes (from top to bottom) are: Bocșa, Tilva Drenii, Moniom. The underlying Getic units are: Reșița, Sasca-Gornjak and Getic nappe. The eastern vergence of the nappe complex is compensated by the western vergence of some thrust and retro-thrust contacts of the nappe complex.

The pre-Alpine basement of these units includes: Paleozoic rock-associations, ante-Paleozoic reactivated crustal basement (Tilva Drenii and Bocșița-Drimoxa Fm) and Variscan (Upper Carboniferous – Permian) molasse deposits.

The main lithologic-petrographic and structural Paleozoic entities are: Caraș Group (Lower Paleozoic: Cambrian to Silurian ?) and Moniom Group (Upper Devonian-Lower Carboniferous).

1. Caraș Group contains the following lithologically contrasting formations: volcano-sedimentary Naidaș-Rafnic Fm (in lower geometric position), terrigenous Dognecea-Zlatița Fm and quartzitic Tilva Mare Fm. The major lithologic feature of the Caraș Group is the existence of a bimodal magmatic association (transitional basalts and high-silica alkaline rhyolites) in Naidaș-Rafnic Fm and some metagabbroic and meta-peridotitic rock bodies. These are proofs for the initial, transtensional regime of the older continental lithosphere and the development of an intra-plate rifting (see Mărunțiu et al., this volume). Terrigenous (metapelito-psamitic) or tuffaceous rocks occur in association with magmatic rocks (volcanic or subvolcanic, in Naidaș-Rafnic Fm) or as a dominant member in the Dognecea-Zlatița Fm. A monotonous quartzitic to quartzo-feldspatic ( $\pm$  micaceous) formation (Tilva Mare) may represent a transgressive, discordant, epicontinental sequence. The metamorphic-deformational evolution of these formations has polyphase character. Physical conditions of dynamo-thermal metamorphism ( $M_1$ – $F_1$ ) pointed out by mineral parageneses occur at the green schists facies level, stilpnomelane-chlorite and biotite zones, locally at garnet zone. The age of this metamorphic event is 519 Ma, based on Rb/Sr isochron method. Mineral parageneses contain: epidote-clinozoisite, amphibole, albite (especially as interkinematic porphyroblasts), chlorite, in basic rocks; muscovite, quartz, chlorite (biotite) in pelito-psamitic rocks; albite, stilpnomelane, muscovite, quartz (in metarhyolitic rocks).  $F_2$  regional refolding is connected with a transpressive collisional event and associated with isofacial partial reorganization and overthrust (low angle epimetamorphic shear zones) upon the retrogressed Precambrian basement (Tilva Drenii or Bocșița Drimoxa Fm). Well-preserved pre-metamorphic parageneses and structures are inherited in magmatic protoliths: rhyolitic, doleritic and gabbroic rocks.

2. Moniom Group (Moniom Alpine nappe) contains two lithologic entities: the Valea Săului volcano-sedimentary Fm. (Upper Devonian – Lower Carboniferous, cf. Visarion, Iancu, 1984) and the terrigenous, meta-conglomeratic Cîrșie Fm. (Lower Carboniferous), interconnected by a blastomylonite-shear zone of Variscan age. The main features of the rocks from the Moniom Group are as follows: a) well-preserved sedimentary and volcano-sedimentary minerals and structures (e.g. bedding, pebbles, etc); b) nongeneralized, metamorphic blastesis at anchizone to green schists facies level; c) variate response to metamorphic blastesis during metamorphic ( $M_1$ ) evolution; d) the prevalence of mechanic transposition with respect to metamorphic blastesis. Metamorphic mineral phases are: chlorite, albite, actinolite, carbonates, quartz.

The palynoprotistologic content, the monometamorphic evolution as well as the structural-metamorphic discontinuity in respect with sedimentary-molassic deposits (Upper carboniferous-Lower Permian) points out





a Variscan tectogenetic event – Sudetic phase – of the collisional stage in a Variscan type belt.

## KYANITE BEARING BLASTOMYLONITES IN THE INHERITED DEEP SEATED SHEAR ZONES IN THE SOUTH CARPATHIANS

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Kyanite content of some ante-Mesozoic shear zones may be used as an indicator in the approach of establishing the physical conditions in dynamic metamorphism. Paragenetic associations in which kyanite is implied, in the well delimited simple shear zones, as well as the nature of kinematic indicators are good proofs for the depth level of the shear zones which separate ante-Paleozoic litho-tectonic entities from the basement of the South Carpathians.

Space and time relationships between dynamic and dynamo-thermal affected metamorphic sequences may be deduced having in view  $M_2$  regional event of the supercrustal complexes (Sebeș and Lotru Groups) and  $S_2$  plane as structural marker. On this basis the kyanite-bearing blastomylonitic rocks were described as follows:

1) Kyanite-bearing blastomylonites related to  $M_2$  metamorphic nappes ( $M_2$  synkinematic shear zones). Such kind of  $M_2$  kyanite-bearing parageneses are well represented in the Sebeș Group – Cumpăna Group (including Măgura Ciinenilor – Cumpăna) tectonic discontinuity (in Topolog and Rîul Doamnei valley – Făgăraș massif occurrences) and in the Sebeș Group – Lotru Group low angle shear zone. Kyanite ( $Ky_2$ ) occurs as small neoblasts and aggregates in the blastomylonitic foliation plane which is in agreement with  $S_2$  set of planes of the mentioned rock assemblages. An older kyanite ( $Ky_1$ ) is presented as relict phase, together with biotite, staurolite, garnet ( $Gt_1$ ) from the  $M_1$  regional metamorphism. In some occurrences of blastomylonitic rocks, microblastic kyanite may be associated with sillimanite (e.g. Pășcoia valley); in others places sillimanite appears in connection with biotite as in the Rîmești blastomylonitic zone (Ursu Group – Sebeș Group shear zone).

2) Kyanite-bearing metablastomylonites (subsequently metamorphosed blastomylonites) containing relict kyanite related to ante- $M_2$  deep seated shear zones. This kind of shear zones are preserved in (a) Jidoștița (Porțile de Fier outlier) and (b) Jigureasa (SW of Sebeș massif) areas and are obliterated by subsequent  $M_2$  dynamothermal metamorphism.

In the Jidoștița shear zone, kyanite-bearing microblastic rocks contain fine kyanite crystals (as relict phase together with  $S_1$  oriented garnet, biotite and plagioclase), superposed  $M_2$  dynamothermal low pressure parageneses (sillimanite, cordierite, muscovite) and  $M_3$  static blastesis of andalusite  $\pm$  muscovite.

In the Jigureasa area, a tectonic slab of initially granulitic facies sequence is incorporated at the base of the Sebeș litho-tectonic entity synchronously with  $M_1$  dynamo-thermal event of the Sebeș Group. The associated microblastic kyanite ( $Ky_2 - M_1$ ) from the blastomylonitic rocks succeeds to a relict coronitic kyanite (HP granulitic facies in preserved granoblastic nuclei) and may be followed by sillimanite, biotite, muscovite and garnet  $M_2$  neoblastesis.

3) Kyanite-bearing tectonic rocks at eclogitic and granulitic facies level. Dynamic significance of the kyanite in eclogitic and granulitic rocks may be deduced on the basis of tectonic fabric of the rocks equilibrated in HP-HT eclogitic facies and HP-MT granulitic facies. (a) In exotic eclogitic and granulitic rocks tectonically dispersed in the Sebeș and Cumpăna Groups, relict kyanite (pre- $M_1$ ) may be present as oriented crystals or "schlierens" in flattened pyroxene-bearing matrix. Kyanite from the eclogitic and granulitic stages is affected by decompression reactions (coronitic and symplectitic microstructures) and then by amphibolitic facies polystadial dynamothermal ( $M_1$ ,  $M_2$ ) re-equilibration (muscovite, biotite substitution). (b) Tectonic eclogites from the Bughea shear zone (Leaota massif) contain a paragenetic association of kyanite with omphacitic clinopyroxene and pyrope-bearing garnet in well-foliated rocks, in which dynamic re-equilibration is proved by the presence of oriented amphibole and white micas.

Paragenetic associated phases of kyanite in the deep-seated shear zones can offer a first approximation of physical conditions of the dynamic metamorphism of the older lithosphere from the South Carpathians.





## THE NATURE OF "SCHWEIZERITE" FROM OCNA DE FIER

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It was first observed by Krenner (1877, fide Kissling, 1967) that the serpentine minerals occurring in the thermal-metasomatic contact zone from Ocna de Fier resembled both in aggregate morphology and in color the ones described at Zermatt, Switzerland, so that a connection between the name "schweizerite" and this similarity may reasonably be inferred. Thereafter, the serpentine has been commonly referred to as "schweizerite", but the term pointed rather to a morphological variety than to the mineral itself. The problem of "schweizerite" has been scarcely dealt with in the literature and the few attempts made to reveal its mineralogical nature resulted in a quite contradictory picture. Chemical, thermal and X-ray analyses carried out by Kissling (1967) have shown that "schweizerite" consists mainly of alpha-antigorite, whereas specimens from "Dognoeska" (most probably, an incorrect transcription of Dognesca – a locality near Ocna de Fier) and Zermatt, investigated by van der Marel and Beutelspacher (1976), were found to contain a mixture of chrysotile, calcite and sepiolite.

Therefore, the serpentine occurrence from Ocna de Fier was re-examined with respect to (a) precise determination of mineral phases, and (b) estimation of the thermal conditions of their formation.

Specimens were selected in order to cover most of the morphological and chromatic aspects able to reflect different chemical and/or mineralogical compositions, i.e.:

- pale yellowish-green fibrous-radial textural aggregates with resinous luster;
- yellowish-white, lusterless, compact aggregates;
- bluish-green, lusterless, compact aggregates;

For all samples, the measured interplanar spacing indicated chrysotile and lizardite, sometimes coexisting in various proportions. On a background of very similar X-ray diffraction patterns shared by the two phases, specific diagnosis was based on the reflections at 2.45 (202), 2.27 (203) and 1.827 Å (008) for chrysotile, and 2.505 (201), 2.156 (202) and 1.799 Å (203) for lizardite. As compared to the standard values, some rather low spacings corresponding to (201), (202) and (203) planes in the lizardite-rich samples, may suggest an aluminous variety of this serpentine. No correlation is obvious between the inferred mineralogical compositions and the above mentioned macroscopical appearance of the samples.

The experimental infrared absorption bands are in complete agreement with spectra of chrysotile and lizardite reported by various sources (Moenke, 1962–1966, van der Marel and Beutelspacher, 1976, Luce, 1971), but no definite distinction can be made between the two minerals. Noteworthy are the bands at 692–704 and 556–566  $\text{cm}^{-1}$  occurring quite frequently in the lizardite-rich samples, which are usually assigned to Si-O-Al-type bonds. These bands were interpreted by van der Marel and Beutelspacher (1976) to be induced by sepiolite, but as regards the Ocna de Fier serpentines, no X-ray evidence is yet to confirm such an assumption. Most probably, they are due to the coupled substitution  $2\text{Al}^{3+} = \text{Mg}^{2+} + \text{Si}^{4+}$ , which according to Caruso and Chernosky (1979), is responsible for the stabilization of lizardite.

All the analysed serpentines contain detectable amounts of Al ranging from 0.14 to 1.05 wt %  $\text{Al}_2\text{O}_3$ , with higher percentages corresponding to lizardite-rich samples. This is consistent with the observation that chrysotile incorporates only minor amounts of Al (Chernosky, 1975).

The abundance of chrysotile in the serpentine assemblage from Ocna de Fier suggests formation at temperatures of about 300° C. Lizardite may reflect higher values, but owing to the low Al contents, they did not exceed, however, 400° C. Above this temperature, either antigorite or Al-rich lizardite would have been stable (Caruso and Chernosky, 1979).

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# OXIDE MINERALS IN NEOGENE VOLCANIC ROCKS OF EAST CARPATHIANS AND APUSENI MOUNTAINS: A COMPARATIVE STUDY

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Neogene volcanic rocks from East Carpathians and Apuseni Mountains are undoubtedly the major background of the most important base metal and gold mineralization in Romania. Though many of the volcanic structures and rock assemblages are apparently similar in geochemical or petrological respect, they do not share, however, the same productive potential. Therefore, comparative studies of these rocks have been an early and permanent matter of interest. From this particular angle, the present study is intended to give a well-characterized optical data base of the opaque accessory minerals whereby to compare the various volcanic structures from the above-mentioned areas and to stress upon the relationships between oxide mineralogy and metallogenesis. A detailed chemical characterization of the oxide minerals was neither attempted nor possible. In implication, the interpretations reflect mainly the optical features and mineralogical relationships, thus bearing a rather statistical significance than a genetic one.

The data used in this study are based on extensive suites of volcanic rocks from Harghita (Cucu and Harghita-Ciceu structures), Călimani, Țibleş, Gutâi and Oaş Mountains (East Carpathians), and from Roșia Poieni and Zlatna - Almașu Mare zones (Apuseni Mountains). The elements found to be relevant in terms of comparative analysis are presented further on.

The oxide mineral assemblages are characterized by various states of "exsolution"- and pseudomorphic-oxidation of ulvospinel-magnetite solid solution (Usp-  $Mt_{ss}$ ) and of discrete primary ilmenite (Ilm- $Hem_{ss}$ ). Specific intergrowth textural forms usually point to  $C_3$  -  $C_4$  and  $R_3$  -  $R_4$  medium-grade stages in the oxidation classification (Haggerty, 1976), but some volcanic areas from Harghita tend to display more advanced oxidations of the Usp- $Mt_{ss}$ , i.e. the  $C_7$  (hematite + pseudobrookite) stage. Quite remarkable are the post-"exsolution" structures ( $C_4$ ) of magnetite phenocrysts with sandwich ilmenite lamellae found in the Cucu structure; here, ilmenite is substituted by hematite and rutile while magnetite is affected by pleonaste exsolution blebs oriented along {100} planes. Peculiar sandwich textures of hematite and ilmenite occurring in lava flows from the Ciceu-Harghita zone or in shallow depth subvolcanic bodies from Roșia Poieni, suggest "exsolution"-reduction of an initial Ilm- $Hem_{ss}$  member. Such aspects, more likely to occur in mafic or ultramafic abyssal bodies, may only be interpreted as a result of dry oxidation undergone by a Usp- $Mt_{ss}$  formed during reduction processes. Fine trellis, internal- or external-composite textured magnetite-ilmenite grains were found to occur more frequently in lava flows, while parallel-banded sandwich textures statistically correspond to the shallow depth subvolcanic rocks.

The magnetite *vs.* ilmenite ratio points either to the basic (magnetite > ilmenite) or acid (magnetite < ilmenite) character of the rocks or to local variations of oxygen fugacities when this ratio records marked variations within the same volcanic structure (magnetite reflects higher  $fO_2$ ). Productive volcanic suites from Călimani, Țibleş, Gutâi and Oaş show a tendency towards magnetite-rich assemblages.

Maghemite is an ubiquitous product of magnetite transformation in the lava deposits from all the studied areas. This typomorph feature of lava flows contrasts the prevailingly observed presence of titanite in the subvolcanic bodies (Udubașa, 1984). In addition, it might be stressed that maghemite is more frequent in the intra-craterial zones and that it affects especially the magnetite phenocrysts, whereas magnetite opaque powder is rather unaltered. Hematite pseudomorphs after magnetite are usually subsequent to maghemite, especially in lava flows where rapid loss of water inhibits the maghemitization.

The oxidation and hydroxilation of mafic minerals are sometimes obvious. Oxidized amphiboles, goethite and lepidocrocite substitution of pyroxenes and especially the magnetite-magnesian pyroxenes symplectites are frequent in Călimani Mts. and they typically agree with the basic character of the rocks. Hydroxilation on behalf of magnetite or pseudomorph hematite is regular in various suites from Țibleş, Gutâi and Oaş Mts., and it could signify incipient hydrothermal alteration.

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## HYDROTUNGSTITE FROM ORAVIȚA-CICLOVA AND BĂIȚA BIHOR: THE FIRST OCCURRENCES IN ROMANIA

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Numerous, weak reflections corresponding to planar spacings of hydrotungstite were found to appear quite frequently in the X-ray diffraction patterns of scheelite samples from Oravița-Ciclova and Băița Bihor (table); a situation which might suggest that the wolframic acid is a common alteration product of scheelite from these occurrences. The existence of an admixed hydrous compound was confirmed by infrared spectroscopy analyses of these samples which have constantly produced absorption bands at  $3428-3440\text{ cm}^{-1}$  pointing to a molecular water (*i.e.* "crystallization water") hydrogen bonding.

Table  
X-ray powder data for scheelite-hydrotungstite admixtures from Oravița - Ciclova and Băița Bihor

Standard values for hydrotungstite (Mitchell, 1963)			Measured values						
			sch1 (Oravița-Ciclova)		sch2 (Oravița-Ciclova)		sch3 (Băița Bihor)		mineral
$d_{hkl}$	I	hkl	$d_{hkl}$	I(Cps)	$d_{hkl}$	I(Cps)	$d_{hkl}$	I(Cps)	
3.73	s	200	—	—	—	—	3.7456	50	ht
3.46	ms	020	3.4654	44	3.4173	63	3.4262	51	ht
—	—	—	3.0968	1500	3.0984	1665	3.1033	1358	sch
—	—	—	3.0653	421	3.0675	492	3.0718	407	sch
3.02	w	111	3.0223	83	—	—	—	—	ht
—	—	—	2.8360	272	2.8361	337	2.8404	239	sch
—	—	—	2.6164	354	2.6165	299	2.6195	383	sch
2.54	m	220	2.5366	51	2.5732	58	2.5387	50	ht
2.46	m	211	—	—	2.4493	56	2.4234	44	ht
—	—	—	2.3839	58	—	—	2.3912	50	sch
2.31	m	030	—	—	—	—	2.3482	54	ht
—	—	—	2.2923	235	2.2946	335	2.2956	248	sch
—	—	—	2.6222	84	2.2550	83	2.2575	72	sch
—	—	—	2.0819	126	2.0837	110	2.0869	111	sch
—	—	—	1.9892	153	1.9894	164	1.9914	180	sch
—	—	—	1.9217	459	1.9222	548	1.9239	496	sch
1.88	w	131	1.8883	51	—	—	—	—	ht
1.85	w+	400,002	1.8688	55	—	—	1.8675	52	ht
—	—	—	—	—	1.8474	231	1.8491	162	sch
1.81	w	102,410	1.8156	54	1.8158	52	—	—	ht
1.78	w	321	1.7922	50	—	—	—	—	ht
—	—	—	1.7198	75	1.7197	83	1.7226	76	sch
—	—	—	1.6691	300	1.6796	308	1.6811	275	sch
1.65	w	420,022	1.6417	54	—	—	1.6575	54	ht
—	—	—	1.6263	150	1.6241	432	1.6243	177	sch
1.61	m	411	1.6084	55	1.6029	60	—	—	ht
—	—	—	—	—	—	—	1.5831	355	sch

I(Cps) - absolute intensities in counts per second;

ht - hydrotungstite;

sch - scheelite;

Analyst: A. Ilinca, "PROSPECTIUNI" S.A., Bucharest.





However, no instance of this process is obvious from microscopical examination. Scheelite occurs in rather homogenous and unaltered crystals and no hydrotungstite was yet identified as a microscopically separate phase. Closer inspection by electron microscope and microprobe scanning have revealed minor amounts of a replacive phase localized mainly along (101) cleavage planes and cracks within the scheelite grains, but again, no discrete areas rich in tungsten and lacking calcium could be detected. Similar behavior of tungstites, though in higher amounts, has been described by Sillitoe et al. (1970) at Copiapo, Chile.

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## A NEW OCCURRENCE OF TELLURIDES AT MĂGURA HONDOL, METALIFERI MOUNTAINS, ROMANIA

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Telluride minerals have been recoded in the Măgura vein group, situated on the western side of Măgura Hill and in the Obîrşiei Valley basin. The Măgura vein group consists of: Măgura, Ludovica, Vîna Neagră, Florian, Francisca, Eleonora and Rudolf veins that have NNW-SSE and N-S trends, dipping both to the west and east at 645-90°. These veins are hosted by Hondol type hornblende quartz-andesite. The wallrock alteration consist of propylitic and argillic assemblages. The Măgura vein has a base metal character, consisting of: sphalerite, galena, pyrite, chalcopyrite, arsenopyrite, tetrahedrite, marcasite and minor gold, in quartz as the main gangue mineral. Barite, calcite and gypsum often occur with the quartz.

The main telluride minerals that have been found in the Măgura vein consist of: krennerite, petzite, tellurantimony and sylvanite in the same paragenesis, and these occur with bournonite and tetrahedrite.

Krennerite usually occurs as irregular grains intimately intergrown with petzite. Tellurantimony occurs as needle-like crystals often included in petzite or crossing petzite and krennerite. Sylvanite occurs as blebs included in krennerite. Bournonite and tetrahedrite usually occur as rims around the telluride assemblages.

Quantitative reflectivity and qualitative chemical analysis by electron microprobe have been carried out on these telluride minerals. The reflectivity (Table) and qualitative electron microprobe data suggest the presence of the following minerals at Măgura-Hondol:

Mineral	R/ $\lambda$	486	552	589	656
Krennerite	R <sub>max</sub>	59.00	61.50	62.30	63.50
	R <sub>min</sub>	56.00	59.50	61.00	61.50
Sylvanite	R <sub>max</sub>	57.50	59.50	60.00	60.00
	R <sub>min</sub>	46.00	48.50	50.00	51.00
Tellurantimony	R <sub>max</sub>	66.00	66.00	68.00	70.00
	R <sub>min</sub>	61.30	62.00	61.50	64.00
Petzite	R	41.30	38.00	38.00	38.50





## SINTEZA UNOR SILICAȚI ȘI PARTICULARITĂȚILE LOR ÎN RAPORT CU COMPUȘII NATURALI

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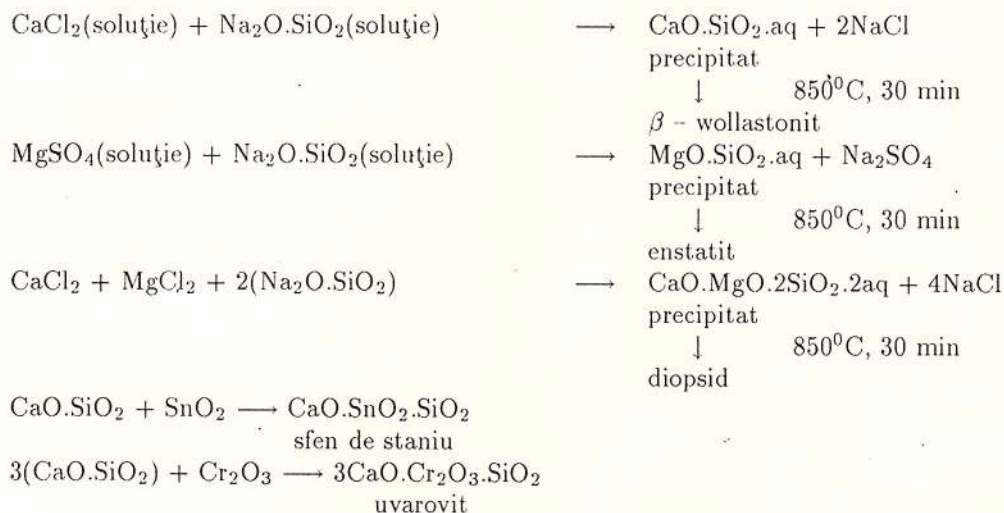
Lucrarea cuprinde o parte din rezultatele noastre privind sinteza unor silicați (wollastonit, diopsid, enstatit, forsterit, uvarovit, sfen de staniu), în condiții de laborator, urmărindu-se stabilirea parametrilor optimi de lucru în vederea reducerii temperaturii de obținere a acestora.

În natură aceste minerale rezultă prin cristalizarea din topituri de compoziție complexă, în decursul unui proces de răcire lentă. Ca urmare deseori rezultă cristale bine dezvoltate, cu o structură cristalină cu puține defecte și o textură compactă.

Obținerea mineralelor similare (în condiții de laborator sau industriale) de puritate avansată presupune utilizarea unor amestecuri de materii prime relativ simple, bi- sau tricomponente, iar reacțiile au loc în fază solidă, necesitând temperaturi ridicate, de obicei peste  $1000^{\circ}\text{C}$ . În aceste condiții se obțin minerale cu o structură și textură mult diferită față de mineralele naturale corespunzătoare; cele sintetice sînt de regulă mai slab cristalizate, prezintă multe defecte de structură și de cele mai multe ori se obțin în stare pulverulentă. Aceste caracteristici reprezintă însă avantaje importante din punct de vedere practic, atunci cînd ele se utilizează în continuare ca reactanți în diverse procese, deoarece le conferă o reactivitate sporită în raport cu mineralele naturale similare.

Metoda clasică de obținere a wollastonitului, diopsidului, forsteritului, etc., constă în calcinarea unor amestecuri de materii prime ( $\text{CaCO}_3$  și/sau  $\text{MgCO}_3$ , împreună cu  $\text{SiO}_2$  reactiv) la temperaturi peste  $100^{\circ}\text{C}$  și în prezența unor mineralizatori.

O metodă nouă, cu multiple avantaje economice, a fost elaborată de noi și constă în esență într-o reacție de precipitare care are loc la aducerea în contact a unei soluții de silicat de sodiu cu soluția unei sări de calciu și/sau magneziu. Precipitatul obținut se separă prin filtrare, se spală, se usucă și apoi se supune calcinării. Pe această cale wollastonitul, diopsidul, enstatitul se obține la temperatura de  $850^{\circ}\text{C}$ , ceea ce înseamnă cu circa  $200 - 300^{\circ}\text{C}$  mai jos decît prin metoda clasică. Metasilicații obținuți în acest mod pot fi utilizați în continuare la obținerea unor silicați mai complecși, care prezintă interes practic. Cîteva din reacțiile care stau la baza acestei metode sînt prezentate în continuare:



Silicații obținuți pe această cale se prezintă sub forma unor pulberi cu grad de dispersie avansat, cristalinitate redusă și reactivitate ridicată, reprezentînd materii prime ceramice de calitate superioară.





## A NUKUNDAMITE-LIKE MINERAL FROM BĂUȚARI AREA, POIANA RUSCĂ MTS

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In the regionally metamorphosed iron ore lenses belonging to the Băuțari occurrence (Poiana Ruscă Mts) we identified a copper iron sulfide with close optical properties and chemical composition to the nukundamite mineral species. It is a mineral component of a hydrothermal sulfide association which overlaps the metamorphosed iron oxide paragenesis.

Nukundamite is associated with chalcopyrite and bornite, being crystallized later than bornite and filling the fissure or spaces in or between magnetite grains. It is fine-grained as very small flakes or very thin needle-like crystals, having a strong pleochroism in orange red tints and a strong anisotropism, with grey to pale-green colors. The electron microprobe analyses (Jeol 733 Superprobe) show the following elements (wt %): Cu-56.34; Fe-11.83; S-31.68; Bi-0.08; Au-0.15; Ag-0.01, which correspond to the  $\text{Cu}_{5.38}\text{Fe}_{1.29}\text{S}_6$  chemical formula. The composition, the Cu/Fe=4.18 and metal/sulfur=1.11 ratios are close to the "hypogene idaite" described by Briggs et al (1977) and to the nukundamite holotype of Rice et al (1979). The microhardness indentation (Leco M-400 Hardness Tester) values are 88.2 kg/mm<sup>2</sup> (10 g load) and 254 kg/mm<sup>2</sup> (25 g load). The imprint shape and the identification values are close to those given for nukundamite from the type locality (Nukundamu-Fidji).

The relations between minerals connected to the experimental data in the Cu-Fe-S and Cu-Fe-S-O systems suggest that nukundamite appeared at temperatures of 250<sup>0</sup>-450<sup>0</sup> C from hydrothermal solutions simultaneously with bornite structural change and the oxidation reaction of magnetite to hematite, which is accompanied by the pyrite and pyrrhotite breakdown, due to their instability in a such association.

The source for the hydrothermal solutions can be some deep intruded magnetites of Upper Cretaceous-Paleocene age, which penetrated the crystalline schists.

## PRELIMINARY DATA ON INGODITE FROM VALEA SEACĂ-BĂIȚA BIHOR AREA; A FIRST OCCURRENCE IN ROMANIA

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Ingodite has been discovered in pyrometasomatic-hydrothermal mineralization related to Paleocene magmatic rocks at Valea Seacă Băița-Bihor area. Mineralization is hosted by calcic skarns and consists of copper- and bismuth-bearing mineral assemblages. Ingodite usually occurs as needle-like crystals, with a perfectly-developed cleavage along the elongation, included in other Bi-minerals, especially galenobismutite, bismuthinite, and sometimes cosalite. In polarized light its colour is bright creamy-white, resembling tetradymite but more creamy. When compared with galenobismutite, ingodite has lower hardness and higher reflectivity. Because it is very soft, it takes a rather difficult polish and scratches are difficult to avoid. In crossed nicols its anisotropy is weak but distinct, with greyish and bluish to slightly yellowish tints. It is usually untwinned but sometimes pressure twins may occur in deformed crystals. No internal reflections have been noticed.

Some quantitative chemical analyses have been carried out using a Jeol 333 Super Probe. The reflectivity values have been obtained using a Reichert Zetopan Reflectivity Microscope (Zeiss WTiC standard, ref. no. 400) and the Vickers microhardness using a LECO M-400 instrument.

The reflectivity values of ingodite from Valea Seacă are shown in Table 1 in comparison with other ingodite data according to Zav'yalov and Begizov (1981).

The reflectivity curves appears normal, having a general increasing trend with wavelength. When compared with other minerals, these curves seem to resemble those for grunlingite and tetradymite (Picot and Johan, 1982).

The Vickers microhardness values for ingodite from Valea Seacă are as follows:  $\text{VHN}_{10} = 20.6$  and  $\text{VHN}_{25} = 36.8$





The stoichiometric chemical formula for ingodite is  $\text{Bi}_2\text{TeS}$ , but usually a limited amount of Pb substitution for Bi has been recorded by Zav'yalov and Begizov (1981). According to Zav'yalov and Begizov (1981) the chemical formula for ingodite is nonstoichiometric, varying from  $(\text{Pb}_{0.02}\text{Bi}_2)\text{Te}_{0.86}\text{S}_{1.12}$  to  $(\text{Pb}_{0.24}\text{Bi}_{1.38})\text{Te}_{1.42}\text{S}_{0.95}$ . The chemical analysis of ingodite from Valea Seacă is recorded in Table 2 and exhibits a slightly higher content of lead than other published analyses from the literature. The chemical formula for ingodite from Valea Seacă (calculated for 4 atoms) is as follows:  $(\text{Pb}_{0.33}\text{Bi}_{1.36})\text{Te}_{1.26}\text{S}_{1.04}$ .

Table 1

R/ $\lambda$	400	420	440	460	480	
A	51.1-47.5	51.5-47.8	51.7-48.0	52.0-48.2	52.96-48.6	
B				55.5-51.4		
	500	520	540	560	580	600
	53.2-49.4	54.0-50.0	54.3-51.0	55.5-52.0	55.8-52.3	56.8-52.5
			57.7-52.2		57.8-52.4	
	620	640	660	680	700	
	57.0-52.2	58.1-52.1	58.3-52.0	52.2-52.0	58.1-52.0	
			56.9-51.6			

Note: A=ingodite from Valea Seacă (Băița Bihor); B=ingodite according to Zav'yalov and Begizov (1981).

Table 2  
Chemical composition of ingodite (wt. %)

	Bi	Pb	Ag	Fe	Sb	Te	S
A	51.7-73.3	0.6-10.6				19.3-32.1	5.2-6.3
B	51.41	12.40	0.01	0.02	0.16	29.94	6.10

Note: A=ingodite according to Zav'yalov and Begizov; B=ingodite from Valea Seacă (Băița Bihor)

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## THE SPHALERITE AND GALENA BEHAVIOUR, IN DRY CONDITIONS, AT 0.5GP AND 400<sup>0</sup>-700<sup>0</sup> C

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The experimental study of the sulfides behaviour was achieved in a piston-cylinder apparatus. The runs were made in the following conditions:  $P = 0.5 \text{ GP}$  (5 k**b**),  $T = 400^{\circ}\text{C}$ ,  $500^{\circ}\text{C}$ ,  $600^{\circ}\text{C}$ ,  $700^{\circ}\text{C}$ . The time was 72 h for each experiment.

Before the experiments, the sphalerite and galena were size reduced by grinding, without to be passed into powder. We used a graphite cylinder, 6 or 8 mm in diameter and 8 mm long, which was predrilled with two holes of 2 mm diameter. The predrilled holes were filled with ground sphalerite and galena, and the face of the graphite cylinder was covered with a pyrophyllite gasket. The cylinder was placed in a 3/4" NaCl-pyrex-crushable alumina piston-cylinder assembly. After completion, the samples were recovered from the piston-cylinder assembly and polished.





The sulfides separated in round and layered aggregates perpendicular to the action of pressure, as a pile of sheets, due to quenching and decompression. The study in polished sections of the sulfides, after each run shows the following features and textures:

- the change (decreasing) of the polishing hardness for both sulfides, when the temperature increases;
- the accretion of galena grains, in a compact aggregate between 400<sup>0</sup>-600<sup>0</sup> C;
- generation of sphalerite grains, which become more and more evident from 400<sup>0</sup>-600<sup>0</sup> C; at 600<sup>0</sup> C the subgrains are oriented on the cleavage planes of sphalerite;
- the very strong deformation and the dissemination in very small grains of sphalerite at 700<sup>0</sup> C associated with the lack of subgrains.

The galena and especially sphalerite textures in the temperature range between 400<sup>0</sup>-600<sup>0</sup> C are similar with the known textures of the sphalerite from Zn-Pb mineralizations related to the Făgăraș Mts shear zone, and we can use them as a criterion to establish the P-T conditions of this type of occurrences.

## MINERALOGY OF SOME EPIGENETIC ORE OCCURRENCES: CÎRLIBABA - FLUTURICA AND CANAL, EAST CARPATHIANS

V. Macaleț, M. I. Petrescu (*Polyt. Inst. Bucharest*)

The studied ore samples were found on old waste dumps dating back in the XVII century. The ores consists of pyrite, arsenopyrite and sphalerite and are hosted by micaschists and gneisses, frequently showing retrograde changes and cataclasis.

Under the microscope chalcopyrite, galena, cubanite, tetrahedrite, bournonite and pyrargirite have been also recognized. The ore minerals are accompanied by quartz and siderite, to which locally albite, calcite and chlorite add. Several mineral assemblages could be separated, i.e., (1) quartz±albite±pyrite; (2) pyrite+arsenopyrite±quartz±calcite±chlorite; (3) sphalerite+chalcopyrite±siderite±quartz±calcite±chlorite; (4) galena±tetrahedrite±bournonite±pyrargirite±quartz±calcite±chlorite.

Positive correlations among some major ore elements have been depicted, i.e., Cd-Zn, Ag-Pb, Ag-Sb, Cu-Pb.

The epigenetic features of the studied mineralized samples resemble the late Jurassic ore occurrences at Ostra-Gemenea-Slătioara and Delnița-Botoșel, previously studied by the senior author; they contrast the syn-genetic features of the large ore belt hosted by the Lower Cambrian Tulgheș Group in East Carpathians.

## ONCE AGAIN ON THE LUDWIGITE FROM THE TYPE LOCALITY OCNA DE FIER

Șt. Marincea (*IGG Bucharest*)

Samples of ludwigite from Ocna de Fier, type locality for this mineral, were investigated in order to establish some chemical, physical and genetical peculiarities not studied before. It was shown that ludwigite from Ocna de Fier can be always considered magnesioludwigite sensu Aleksandrov (1982), having lower ferruginities than some of those previously reported. A source of error in estimating the real ferruginity is the presence of fine magnetite grains irregularly distributed throughout ludwigite, a fact which induce an obvious increase of ludwigite magnetic susceptibility; consequently, 9060.392 to 12511.76 S.I. units were recorded for an unpurified ludwigite sample.

There are many characteristics which indicate, for ludwigites from Ocna de Fier, low contents of vonsenite (therefore low ferruginities):

- 1 - mean reflectances varying between 9.58 and 11.82 %;
- 2 - mean (calculated) refractive indices between 1.82 and 1.95;
- 3 - cell-parameters  $a = 9.20$  to  $9.26$  Å;  $b = 12.27$  to  $12.32$  Å and  $c = 3.04$  to  $3.06$  Å;
- 4 - calculated densities between 3.72 and 3.78 gms:cm<sup>-3</sup>;





5 – frequencies of the  $\nu_3$  antisymmetric stretching of the  $\text{BO}_3$  group recorded on the infrared spectra at 1264 to 1268  $\text{cm}^{-1}$ ;

6 – frequencies of the  $\nu_2$  symmetric bending of the  $\text{BO}_3$  group recorded on the infrared spectra at 704 to 706  $\text{cm}^{-1}$ .

Wet-chemical and microprobe analyses show that the ludwigite from Ocna de Fier is remarkably homogeneous and confirm the low content of vonsenite; between 4.37 and 10.39 mole percent. It displays limited quantitative variations of the isomorphic substitutions in the M (4) sites of the structurally "disturbed" octahedrons ( $\text{Fe}^{3+}$ ,  $\text{Al}^{3+}$ ,  $\text{Ti}^{4+}$ ): the content aluminoludwigite varies between 1.31 and 2.40 mole percent and the content of azoproteite varies between 0.10 and 0.30 mole percent.

The chemical and paragenetical data obtained so far for the analysed ludwigites and some experimental topologies suggest the following physico-chemical conditions governing the mineral crystallization: temperature of about 600 to 650 $^{\circ}$  C; a weak alkalinity; an oxidizing Eh; a high potential of  $\text{B}_2\text{O}_3$ .

## GEOCHEMISTRY OF CALC-ALKALINE ROCKS OF THE EASTERN CARPATHIAN ARC

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Geochemical investigations have been carried out on a preliminary suite of rocks from the Călimani, Gurghiu and Harghita Mountains. Basaltic andesites, andesites and dacites have been collected and analysed for bulk element, trace element and isotopic composition. Lavas are typically medium K to high K calc-alkaline with an additional shoshonitic rock series in the Southern Harghita Mountains.

Calc-alkaline rocks contain plagioclase, clinopyroxene and hornblende phenocrysts with sparse orthopyroxene and olivine. Silica contents (51–68 %), magnesium numbers (0.35–0.65) and Sr contents (300–600 ppm) are typical of subduction related magmas. Shoshonitic series rocks additionally contain biotite phenocrysts and rare titanite.

A group of dacites from the Călimani mountains has low  $\text{K}_2\text{O}$  (0.5–1 %) and low  $^{87}\text{Sr}/^{86}\text{Sr}$ . These may represent evolved products of an earlier phase of volcanism. Ages from potassium-argon dating (8.5 Ma) suggest that these rocks predate activity in the main chain.

The youngest volcanism consists of a group of small volume, highly potassic (2–4 wt %), high Sr content (800–2200 ppm) rocks, including the shoshonites, at the chain terminus. Small degree partial melting or direct slab melting related to the final stages of subduction may be possible petrogenetic causes. plagioclase accumulation as a cause for Sr enrichment may be ruled out due to sparse phenocryst populations. Trace element ratios (e.g. Sr/Y, Ti/Nb) pick out this group as one of significantly different evolution.

Preliminary  $^{87}\text{Sr}/^{86}\text{Sr}$  isotope ratios vary over a wide range (0.7041–0.7099) suggesting widespread crustal, contamination processes. Lowest values overlap those of the alkali basalt behind the arc.  $^{143}\text{Nd}/^{144}\text{Nd}$  ratios vary between 0.5124 and 0.5128. Assimilation and Fractional Crystallisation processes are important and are supported by mixing trajectories on isotopic and trace element variation diagram (e.g. Sr against  $^{87}\text{Sr}/^{86}\text{Sr}$ ).

## AURIFEROUS SHEAR ZONE OF THE UDERINA DISTRICT, CENTRAL SLOVAKIA

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The southwestern part of the Veporicum crystalline complex in the Western Carpathians, Slovakia, represents a fairly large tectono-stratigraphic region that host several small gold occurrences. They are scattered throughout the region and some of these were actively mined since the 13th century up to the end of the 18th century.

Since 1986, in the Lovinobana district, especially in the Uderina prospect, a general prospecting program for Au-Hg mineralization has started. During the current mineralogical study of the ores, abundant grains





of a Au-Ag-Hg alloy were found in the upper horizon of the auriferous shear zones. The most important mineralized shear zones have northeast-southwest trend; the narrow parallel to subparallel shear zones transect the amphibolite and paragneisses and are related to regional tectonic lines. These shear zones record evidences of both ductile and brittle behaviours; the quartz matrix exhibits an intense microfracturing giving evidence of a strong brittle deformation later than the ductile movements.

The gold mineralization with minor sulfides is hosted by quartz lenses. These gold-bearing quartz lenses formed during extension phases, after cataclasis of initially barren quartz postdating mylonites. The economic mineralization is hosted by microaccharoidal quartz. A later paragenesis associated with hyaline quartz comprises Ag-rich gold, Hg-bearing tetrahedrite and sphalerite. Subsequent partial remobilization of the gold-bearing lenses during phases of extension caused coarsening of the gold, with the appearance of mercuriferous nuggets - Au-Ag-Hg alloy. Mineralized shear zones extending to the surface are also weathered and contain gold nuggets rich in mercury. The hydrothermal alterations synchronous with ore deposition resulted in a chlorite-sericite-carbonate-illite assemblage. Data from fluid inclusions suggest that the general evolution of the ore fluids is: (1) circulation under higher pressure (1.5 kbars ?) at  $400^{\circ}\pm 20^{\circ}\text{C}$  of a low-salinity solution with minor volatile contents, (2) mixing of this solution with  $\text{CO}_2$ -rich vapor induced by pressure drop down to 0.5 kbars producing a heterogeneous fluid at  $300^{\circ}\text{C}$ , and (3) circulation of volatile-free aqueous solution at decreasing temperature ( $250\text{--}110^{\circ}\text{C}$ ) and salinity. Most of the economic ore probably formed at the transition from (1) to (2).

## GEOCHEMISTRY OF THE MAGMATIC ROCKS FROM THE PALEOZOIC ASSEMBLAGES IN THE SUPRAGETIC UNITS IN BANAT - CARAŞ GROUP

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The Caraş Group is a Lower Paleozoic polymetamorphic greenschist facies volcanic-sedimentary association belonging to the Supragetic Unit in Banat area. It is composed mainly of graywacke metasedimentary rocks and mafic-felsic metavolcanic rocks. Three formations are lithostratigraphically separated from the base to the top: Naidaş-Rafnic volcanic-sedimentary Fm., dominantly terrigenous Dognecea-Zlatna Fm., and Tilva Mare quartzitic Fm. The bimodal volcanogenic association is made up of metabasalts (actually looking like actinolitic greenschists), metagabbros, metaultramafics (plagioclase-bearing wehrlites) and metarhyolites. Geochemical data provide some evidence that no alteration occurred both during and after eruption.

The behaviour of major, minor and rare earth elements strongly suggests that metabasalts are transitional ones with tholeiitic differentiation trend, dominated by plagioclase and clinopyroxene fractionation; they are more differentiated than MORB. Geochemical characters of metagabbros, metaultramafics and metabasalts are consistent with a comagmatic origin and those of the high-Si, low-Al alkaline metarhyolites are typical for rhyolites belonging to anorogene bimodal associations derived from a mantle or low crust silicic magma. Distribution of Zr, Y, Ti, V, P and LIL-elements in metabasalts showed their affinity to within-plate, intracontinental magmatism. The intracontinental protorift tectonic-setting of bimodal volcanites are also consistent with types of metasedimentary terrigenous rocks of volcanic-sedimentary Caraş Group.

## CHLORITES FROM ULTRAMAFIC ROCKS OF SOUTH CARPATHIANS: MINERALOGICAL DATA

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Two Alpine-type chlorite-bearing ultramafic rocks assemblages have been investigated. The Lower Paleozoic Tisovița-Iuți ophiolitic complex (TIOC) and some ultramafic bodies associated with the amphibolite facies polymetamorphic Precambrian areas (Sebeş Group of Getic Realm-SGG and Ielova Serie of Danubian Realm - ISD):





Dunites and harzburgites of harzburgite tectonites and olivine cumulates units of TIOC contain chlorites which surround or penetrate primary Al-Cr spinel (podiform bodies or minor phase) and intergrown along the reticular directions with secondary Cr-Fe spinel. Chemical compositions emphasize obvious Al-Cr, Mg-Al substitutions in the octahedral sheets and small Mg-Fe<sub>T</sub> ones, chlorites showing a magnesian-aluminous character. Continuous decreasing of Cr and Al<sub>IV</sub> and increasing of Mg have been observed from chlorites intergrown with secondary Cr-Fe spinel to corona and matrix-chlorites. They belong to clinocllore and tri-trioctahedral structural type.

Chlorites of the SGG and ISD ultramafics are observed in metaperidotites (ol + opx + tremolite ± anthophyllite ± Cr spinel + chlorite ± talc ± antigorite), metadunites (ol ± opx + chlorite ± Cr spinel ± talc) and magnesian schists (chlorite ± anthophyllite ± tremolite ± talc) with superposed M<sub>1</sub> and M<sub>2</sub> parageneses. A special rock-type is the chlorite developed like: (a) black-wall with rodingites (chlorite ± magnetite ± tremolite ± diopside ± ilmenite); (b) chlorite-metasomatised clinopyroxenite (chlorite + tremolite + cpx relics); (c) zoned vein-like metasomatic association (chlorite ± magnetite ± tremolite ± apatite); (d) irregular metasomatic bodies (chlorite + tremolite ± apatite ± magnetite). No different chemical compositions exist between all paragenetic and morphological types of chlorites. Mg-Fe<sup>++</sup>, Mg-Al and Al-Cr substitutions define the clinocllore and tri-trioctahedral structural types. IR data point out to restricted Si-Al, Al-Mg substitutions and low total iron content. X-ray diffraction patterns show a similar iron distribution in octahedral sheets and the cell dimensions calculated for some chlorites indicated I<sub>ba</sub>, II<sub>a</sub>, II<sub>b</sub> structural types, but Fe/(Fe+Mg) and Al<sub>IV</sub> values are restricted to II<sub>b</sub> type.

## NONTRONITE FROM LECHINȚA, MARAMUREȘ

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In the subvolcanic alkaline volcanites from Lechința (Oaș area, Maramureș) nontronite occurs in brecciated rocks and as fissure-fillings, leading to a pervasive nontronitization of the magmatic rocks.

Nontronite is canary-yellowish-green; TEM images show characteristic features for this mineral. The DTA curve has endothermic effects at 162°, 210°, 505° and 770°, and an exothermic one at 860° C. X-ray diffraction data reveal the most important peaks at 14.10 (100), 4.49 (25) and 1.52 Å (12).

## BIOTITE VARIABILITY AND GARNET-BIOTITE GEOTHERMOMETRY: MEDIUM GRADE REBRA SERIES, RODNA MTS

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This paper represents part of a study on the evolution of metamorphic rocks from the southern part of the Rodna massif. Data about biotites and garnets from gneisses and micaschists of the Rebra Series, cropping out in the Rebra, Cormaia and Anieș valleys, are presented.

Microscopic observations prove the polymetamorphic evolution of the rocks belonging to the Rebra Series: a barrovian-type metamorphism under amphibolite-facies conditions is followed by a local low pressure retromorphism giving greenschist assemblages, and finally by a dynamic metamorphism.

Biotites from gneisses and micaschists give evidence of at least three stages of blastesis. In a first stage, biotite I, transversal, related to penetrative foliation, grew beside muscovite and chlorite. In the second stage, biotite II generated synkinematically in association with muscovite II, garnet ± chlorite II(?) ± staurolite ± hornblende and bands of quartz segregates. Stage three is represented by postkinematically recrystallized biotite III (beside muscovite III and chlorite III).

The microprobe analyses on different biotites and associated garnets enabled us to characterize the minerals by variables: f, F, Mg/Fe, Mg/(Mg+Fe<sub>T</sub>) and to apply the garnet-biotite geothermometer. Using Ferry & Spear and Perchuk calibrations, temperatures of 400–600° were calculated. These temperatures and the K<sub>D</sub> are in accordance with amphibolite-facies conditions (ranging from the medium garnet zone to the lower staurolite





zone). Transversal biotites have, in some cases, clearly different parameters and optical properties, as compared to those concordant to foliation. They belong to the first stage of blastesis. Anyhow, transversal biotites (at angles of about  $96^{\circ}$  to foliation) may sometimes show parameters approaching those of concordant biotites, seemingly belonging to the second stage of blastesis.

## CONSIDÉRATIONS GÉOHIMIQUES SUR LES GRENATS DES ROCHES DU CHAMP PEGMATITIQUE DE CONTU (MONTES DE CIBIN)

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Le champ pegmatitique Contu se trouve dans les montes de Cibin (la subprovince pegmatitique Gétique). Le fond petrographique du ce champ pegmatitique est constitué par des paragneiss, micaschistes et amphibolites, caractéristiques pour la série de Sebeş-Lotru de la nappe gétique. Ces roches sont spécifiques au faciès métamorphique des amphibolites à almandin, la zone à staurotide et disthène. Les pegmatites granitiques connues sous forme des lentilles et des filons, sont disposées en concordance avec les paragneiss et les micaschistes. D'après la composition minéralogique, les pegmatites du champ de Contu sont de deux types feldspatique ( $\pm$  muscovite) et albite-spoduménique. Dans les pegmatites et dans les paragneiss encaissantes, les grenats représentent des minéraux accessoires. Des importants teneurs en Mn, Mg, Fe, Ca et Ti caractérisent les grenats analysés. La teneur en Mn est plus élevée dans le grenat des pegmatites albite-spoduméniques: 15,28 % MnO comparatif à 9,77 % MnO dans le grenat des pegmatites feldspatiques et à 0,93 % MnO dans le grenat des paragneiss. Le comportement du Mg est différent par rapport à celui du Mn: la valeur plus élevée est présente dans le grenat de paragneiss (3,86 % MgO) tandis que des contenus réduits ont été remarqués dans les grenats des pegmatites: 0,1 – 0,68 % MgO. Le contenu en Ti des grenats des pegmatites (0,08–0,9 %  $\text{TiO}_2$ ) est caractéristique pour les grenats des pegmatites métamorphiques. Le grenat des paragneiss montre une valeur plus élevée: 0,57 %  $\text{TiO}_2$ . Une valeur élevée du CaO a été remarquée dans le grenat des pegmatites feldspatiques: 3,11 % CaO.

Les formules cristallographiques ainsi que la composition normative montrent que les grenats se rangent dans la série isomorphe des pyrospites. L'almandine et la spessartine sont les composants principaux. La teneur plus élevée en spessartine et plus réduite en pyrope est caractéristique pour le grenat des pegmatites albite-spoduméniques. Dans le grenat des paragneiss, l'almandine est le composant principal tandis que la spessartine est présente en teneurs réduites.

Les composants normatifs, la ferricité(F), la magnésialité(M)  
des grenats des roches du champ pegmatitique de Contu

Les composants normatifs (%)	Les grenats des pegmatites		Le grenat des paragneiss
	albite-spoduménique	feldspatique	
Pyrope	0,4	2,8	18,3
Almandine	61,6	65,3	73,0
Spessartine	30,1	22,8	2,5
Grossular	–	2,6	–
Andradite	1,0	6,5	6,1
Calderite	6,8	–	–
F	99,0	96,1	81,0
M	0,6	3,9	20,0





## CONTRIBUȚII LA CERCETAREA WULFENITULUI DE LA BĂIȚA BIHOR

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Wulfenitul de la Băița Bihor este citat pentru prima dată de C. A. Zipser (1817), apoi de V. R. von Zepharovich (1859, 1873, 1893), K. F. Peters (1861), R. Dimitrescu și D. Rădulescu (1966) etc.

Wulfenitul analizat de noi apare în cristale tabulare subțiri dezvoltate după {001}, de maximum 2 mm și cu grosimea sub 0,5 mm. Sînt prezente formele {001}, {010}, {110} și {021}. Are culoare galbenă, galben-oranj pînă la alb-gălbuie. Proprietățile optice, compoziția chimică, rezultatele analizei prin difracție de raze X și asociațiile de minerale în care apare wulfenitul, permit unele precizări privind condițiile de formare a acestui mineral.

## CONCREȚIUNILE DE SULFURI DIN NISIPURILE CUARȚOASE-CAOLINOASE DIN STRATELE DE VAR ȘI INFLUENȚA LOR ASUPRA PROPRIETĂȚILOR CAOLINULUI

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Formațiunile oligocene din Bazinul Transilvaniei, dispuse pe bordura de nord a Munților Gilău, cantonează în ele nisipuri cuarțoase-caolinoase. Nisipurile sînt localizate în Stratele de Var ce au grosimea de 30–50 m și se dezvoltă continuu de la Popești pînă la Jibou. Nisipurile se exploatează la Popești, Sînpaul, Cornești, Stoguri și Var.

În zăcămintul de nisipuri cuarțoase-caolinoase de la Popești, concrețiunile și nodulii de sulfuri formează intercalați discontinui, cu grosimi centimetrice. În stratele de nisip nr. 1, 2 și 3 sînt una pînă la 2 intercalații, cu grosimea de la 5 pînă la 15 cm, iar în stratele 4 și 5 concrețiunile de sulfuri se întîlnesc sporadic.

Concrețiunile au formă sferică pînă la elipsoidală, diametrul de 10 cm iar nodulii sînt columnari sau aplatizați, cu grosimea de 1–8 cm și lungime de 3 la 15 cm. Suprafața le este acoperită cu proeminente. Analiza microscopică arată că în concrețiuni și noduli conținutul de sulfuri este de 75 pînă la 100 %. Analiza chimică a concrețiunilor indică:  $\text{SiO}_2$  23,07 %,  $\text{Fe}^{2+}$  35,10 %,  $\text{Mn}^{2+}$  urme,  $\text{Na}_2\text{O}$  0,17 %,  $\text{K}_2\text{O}$  0,10 %, S 40,29 %, C 0,05 %, Co 0,05 %, Ni 0,17 %. Alături de sulfuri, în concrețiuni și noduli mai sînt prezente cuarț, caolinit, illit, sericit și materie organică. Sulfurile sînt reprezentate prin marcasită și pirită. Raportul Co:Ni este 0,29.

În bazinul de sedimentare fierul a fost adus de pe continent în suspensie, soluții coloidale sau compuși organo-metalici. Substanța organică prezentă în bazinul de sedimentare a fost utilizată de bacterii în procesele metabolice, rezultînd  $\text{H}_2\text{S}$ . Prin reacțiile dintre  $\text{H}_2\text{S}$  și fier s-au format, probabil în prima fază, sulfuri negre de fier: monosulfură de fier amorfă, mackinawit  $\text{Fe}_{1+x}\text{S}$  și greigit  $\text{Fe}_3\text{S}_4$ , care fiind instabile s-au transformat în pirită și marcasită.

În cadrul proceselor diagenetice și apoi după deschiderea de către eroziune a zăcămintului, sau prin lucrări miniere, sulfurile s-au oxidat și au hidrolizat transformîndu-se în limonit coloidal, alături de care s-au format melanterit și gips. Limonitul avînd mare putere de dispersie acoperă pereții lucrărilor miniere și în parte este adsorbit de caolinit. Melanteritul și gipsul formează cruste milimetrice pe concrețiunile de sulfuri; ele formează cristale aciculare, fibroase sau mase pulverulente colorate în nuanțe de verde (melanteritul) sau în alb și transparent (gips). Melanteritul se formează în prima etapă de oxidare a sulfurilor, poate chiar în cadrul diagenezei; în prezența oxigenului melanteritul devine instabil și se transformă în sulfat feric. Acesta, în prezența apei, hidrolizează formîndu-se limonit și acid sulfuric. Acidul sulfuric reacționează cu carbonații, silicații etc formîndu-se sulfăți.

Sulfurile și produsele lor de oxidare și hidroliză dispersate în mineralele argiloase le impurifică, modificîndu-le în sens negativ culoarea, gradul de alb, tixotropia, pH-ul. Se restrînge astfel domeniul de utilizare a caolinului și procesele de preparare devin mai costisitoare.





## PYRITE MORPHOLOGY AND FLUID PHASE EVOLUTION AT THE ROȘIA POIENI PORPHYRY-TYPE SYSTEM

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A relationship between the crystal morphology of pyrite and its paragenetic and geochemical environment has been reported from ore deposits elsewhere for various degrees of correlation. We report here a very well developed relationship for the Roșia Poieni pyrite that is also useful as an exploration tool.

The Roșia Poieni pyrite exhibits seven crystallographic forms: cube (C) (100), octahedron (O) (111), pentagonal dodecahedron (P) (210), (110), (321), (421), (211) and also (hkl) forms. Their combination resulted in eight habits which can be grouped in three morphologic trends. These trends present a zonal distribution corresponding to structural and hypogene alteration zonality as follows:

Zone I : C-O-P (hkl) trend = to the inner, potassic zone,

Zone II : C-O (hkl) trend = to the intermediate, breccia zone,

Zone III : C-P trend = to the external, argillic zone.

Taking the fluid phase evolution into account, this zonality is also characterized by three supersaturation (S) – temperature (T) domains, namely:

morphologic zone I :  $S_H - T_H$  domain,

morphologic zone II :  $S_h - T_H/S_M - T_L$  transition domain,

morphologic zone III :  $S_M - T_L$  domain,

The quartz veinlets associated with porphyry-copper-type mineralization contain two main fluid inclusion types:

a) Polyphase inclusions, consisting of vapour, solids and liquid trapped under high thermic conditions. The original fluids would correspond to hydrosaline melt series. The minimum trapping temperature (i.e. the homogenization temperature) frequently exceeds 750<sup>0</sup> and total apparent salinity, expressed in NaCl + KCl wt % equivalent, varies between 60 and 90 %. The minimum trapping pressure of this fluid inclusions type does not exceed 200 to 250 bars. The polyphase inclusions are considered to be of primary origin and probably formed directly from the magma by unmixing processes.

b) Fluid inclusions rich in vapour composed of a gas bubble (vapour + CO<sub>2</sub>) and a thin liquid film. They appear to be contemporaneous with the polyphase inclusions and also suggest an evolution under conditions of immiscibility but of a less dense fluid of magmatic origin.

## LE DEGRE DE CRISTALLINITÉ DE L'ILLITE DANS DES DÉPÔTS AUX CHARBONS DE ROUMANIE

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Les transformations des minéraux des roches des complexes charbonneux augmentent en intensité en même temps que le degré d'houillification des charbons associés.

Dans les roches grès-argileuses, associés aux charbons bruns xilitiques, privés d'éclat, faiblement gélifiés (le pouvoir moyen de réflexion de l'huminite est  $R_h=0,08 - 0,28 \%$ ) par exemple dans les gisements de Sinersig, Rovinari, Motru, Berbești, etc. la muscovite et la biotite sont peu transformées en hydromicas et/ou en chlorite (Tisu, Nedelcu, 1990). Ces transformations sont déjà héritages des phases d'érosion et de transport dans les tourbières des micas préexistantes. L'illite n'est pas présent.

Dans la matrice des grès et des argiles associées aux charbons bruns mats ( $R_h=0,30 - 0,39 \%$ ) par exemple dans les gisements de Bozovici et de Borozel, les analyses par diffraction en rayons X, mettent en évidence l'apparition des interstratifications montmorillonite-illite (Tisu, Nedelcu, 1990). Il y a aussi des hydromicas décolorées, aux clivages faiblement exprimés.

Les interstratifications montmorillonite-illite, de même que les transformations partielles des micas en hydromicas, sont présents dans les roches grès-argileuses associées aux charbons de Comănești (Nedelcu et al., 1990) ou aux houilles cokefiables des gisements de Petroșani ( $R_{\text{vitrinite}} = 0,60 - 0,79 \%$  : Panaitescu, 1991),





de Cozla (R vitrinite = 0,80 – 0,90 %), de Anina (R vitrinite = 0,90 – 1,15 % : Panaitescu, 1991; Nedelcu et al., 1993).

Dans les roches grès-argileuses, associée aux houilles faibles et aux anthracites de la zone de sédimentation Sirinia et ici on parle des gisements de Baia Nouă (R vitrinite = 1,76 – 3,70 %; Bițoianu, 1987 ou R vitrinite = 1,61 – 2,10 %) et de Pregheda-Chiacovat-Ostresu, (R vitrinite = 1,60 – 2,70 %), les hydromicas néoformées suite à la dégradation diagénétique des micas préexistantes, la kaolinite, l'illite, la chlorite sont les composants de base de la kaolinite, l'illite, la chlorite sont les composants de base de la matrice. On y trouve aussi, des interstratifications montmorillonite-illite, mais surtout des très rares de l'illite faiblement cristallisée (9–5 mm à mi distance relative à l'hauteur du peak de 10 Å).

Dans les anchimétamorphites au pyrophyllite (mais aussi au kaolinite), d'Armeniş (la zone de sédimentation Presacina, l'aréal Riul Lung, Riul Alb), associées aux méta-anthracites (formés de sémifusinite, fusinite, pyrocarbone, coke naturel, sémigraphite et vitrinites intense pléochroïques, anisotropiques, réfléchissantes: R<sub>vi</sub> = 5,20 – 7,62 % et biréfléchissantes: R = 1,75 %, Nedelcu 1990) les micas sont complètement transformées en hydromicas et/ou en quartz, chlorite et minéraux opaques, et l'illite néoformée de la fine matrice argilleuse est bien cristallisée (6–3 mm, à mi distance relative à l'hauteur du peak de 10 Å).

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## LOWER TRIASSIC BASIC DYKE SWARM IN NORTH DOBROGEA

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In the Alpine chain of North Dobrogea, Triassic basic magmatic rocks occur within the main tectonic units. A suite of basic dykes is emplaced in the Variscan folded basement of the Măcin unit. In the Niculițel and Tulcea units, a thick pile of basaltic rocks (mainly pillow-lavas, accompanied by anamesites, dolerites, microgabbros) occur, interbedded in places with Triassic limestones (Spathian to Ladinian).

The basic dyke swarm, emplaced into various formations from Upper Precambrian metamorphic rocks to Paleozoic deposits and granitoid bodies shows a consistent NW-SE direction, parallel to the main structural trend of the Alpine belt. Most of the dyke rocks are dolerites, subordinately basalts and anamesites. Basic dykes are accompanied by a suite of similar trending rhyolitic dykes, suggesting a bimodal volcanism. Both basic and acid dyke rocks are usually mylonitic. Basic dykes and Niculițel ophiolites show a great resemblance in geochemical features. Ti-Cr, Ti/Cr-Ni, V-Ti/100 plots and Ba/Y ratios suggest ocean floor settings both for the dyke swarm and the Niculițel ophiolites.

Based on geochemical features and tectonic setting, the following model for the geotectonic evolution of the basic rocks of North Dobrogea is proposed: a period of crustal distension at the beginning of the Triassic favoured the initiation of longitudinal, deep fractures, accompanied by basic dyke emplacement meanwhile, acid magma was produced in the sialic crust and injected as rhyolitic dykes; one of the deep fractures evolved into a rift, being the site for generation of the Niculițel ophiolites; in adjacent areas, acid and basic dykes continued to be emplaced, along secondary fractures; Jurassic or Lower Cretaceous compressional movements created the thrust-fold belt of North Dobrogea; strong mylonitization of dyke rocks is related to these compressional movements.





## ALMANDINE PHENOCRYSTS IN ANDESITES FROM RODNA MOUNTAINS

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Not previously described, the garnet-bearing andesites from the subvolcanic zone of the East Carpathians (Rodna Mountains) represents an intrusive manifestation of the second cycle of the Neogene volcanism in this area (Sarmatian in age). They occur as dykes intruded in some metamorphites belonging to the Bretila Series (group) or in sedimentary deposits of Paleogene age.

Petrographically they are quartziferous hornblende and biotite andesites, always containing normative (CIPW) corundum.

Garnet occur as subhedral to euhedral phenocrysts of 1.5 to 2.5 mm in size, free of inclusions and optically homogenous. Generally they are surrounded by clusters of plagioclase crystals (andesine 42-52 %) or are enclosed in plagioclase phenocrysts up 0,5 to 1 cm in size. This plagioclase is identical in form and composition with that one found elsewhere in the host rock. Usually the garnets do not show any sign of breakdown or resorption and are rarely surrounded by chlorite-magnetite reaction rims. All the physical parameters recorded for these garnets (i.e. the refraction index  $n=1,794$  and the cell edge  $a=11.552 \pm 0.007 \text{ \AA}$ ) and some peculiarities of the infrared spectra indicate that they are almandine rich in composition. Wet-chemical and microprobe analyses have confirmed the high content of almandine mole in the solid solution. No significant differences in composition were found between various phenocrysts and between core and rim in the same phenocryst. A wet-chemical analysis, regarded as expressions of the mean composition containing about 79 mole percent almandine in the solid solution, point out that the garnet are of almandine-pyrope composition with minor amounts of spessartine and grandites moles.

Having in mind mutual relations with the feldspar and some chemical and morphological features we have established for the analysed garnet the following genetical conditions: (1) an igneous crystallization in a calc-alkaline magma, at early evolutional stage, rather than their accidental inclusion as xenocrysts; (2) origin at depth, corresponding to the storage of the parental magma at the crust/mantle interface or in lower crust. Thus, we can estimate a pressure of crystallization between 9 and 18 kbar.

## PRESENCE DE SULFOARSENIURES DE COBALT ET DE NICKEL ASSOCIES AUX CONCENTRATIONS MANGANESIFERES DE OIȚA (CARPATHES ORIENTALES-MONTS DE BISTRITA)

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C'est la première fois que l'on signale à Oița des sulfoarséniures; dispersés dans un niveau de carbonates recristallisés, ils sont présents sous forme de plages automorphes et de groupements globulaires. Le niveau de carbonates, à prédominance de rhodochrosite, est traversé de nombreuses veinules de rhodonite-pyroxmangite. On observe souvent au voisinage de ces veinules des îlots de téphroïte largement cristallisée. Les sulfoarséniures se manifestent en inclusions dans les carbonates; leur dimensions varie entre quelques microns et quelques centaines de microns. Grâce à l'observation microscopique en lumière réfléchie, ainsi qu'à l'analyse ponctuelle à la microsonde électronique de plus de 300 plages dépassant 5 microns, nous avons pu mettre en évidence des termes se rattachant à la cobaltite, des termes intermédiaires entre ce sulfoarséniure et la gersdorffite (possédant des macles complexes) et enfin des termes assez proches de la gersdorffite. Ces sulfoarséniures sont toujours associés à la pyrite et à la chalcopryrite. Le tableau, qui regroupe les résultats les plus significatifs, révèle d'une part des teneurs importants en manganèse, et d'autre part des traces d'Ag, Au, Bi, et de Sb.

Au delà de la mise en évidence d'une espèce rare ainsi que des termes intermédiaires entre les deux pôles, la découverte des sulfoarséniures de cobalt et de nickel une importance telle qu'il sera désormais impossible d'envisager sans en tenir compte, l'évolution des concentrations manganésifères de Oița et les hypothèses génétiques qui s'y rapportent.





Composition ponctuelle des sulfoarséniures de Oița, en atome %

As	S	Co	Ni	Fe	Zn	Ag	Au	Bi	Sb	Mn
30.88	33.69	30.42	1.40	0.94					0.19	2.48
32.25	33.00	27.15	5.69	0.69		0.08		0.06		1.09
31.07	33.73	24.79	6.17	1.22	0.23	0.04			0.07	2.51
31.90	33.86	22.84	8.16	1.41	0.05				0.01	1.76
33.21	31.78	22.63	8.33	2.78					0.04	1.22
33.15	31.94	11.10	16.55	5.57	0.08	0.03			0.08	1.50
33.75	31.76	9.84	17.29	5.61	0.15				0.12	1.45
31.66	32.92	7.72	18.56	6.45	0.08		0.01		0.07	2.37
34.85	30.25	7.05	20.83	4.30			0.03		0.10	2.49
36.29	28.83	8.08	21.16	4.19		0.10	0.06		0.11	1.16

## L'ENRICHISSEMENT EN MANGANESE L'EVOLUTION DES OXYDES DANS LES CONCENTRATIONS DE OIȚA (MONTES DE BISTRITA, CARPATES ORIENTALES-ROUMANIE)

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C'est l'altération météorique des quartzites à grenat (spessartite), sous des climats tropicaux humides, qui, dans les grands gisements manganésifères d'Afrique de l'Ouest, du Brésil et de l'Inde est responsable de la constitution du minerai oxydé secondaire. Dans ces célèbres gisements, l'épigénie des gangues par des phases  $MnO_2$  généralement assez stables, succède à l'hydrolyse et au lessivage des grenats. Les échantillons trop rares que nous avons eu l'occasion d'analyser, et qui appartiennent au groupe de gisements manganésifères du Noed-Ouest de la Moldavie-Iacobeni-Șarul Dornei (Ivanovici, 1956), nous permettent de constater des particularités notables qui les différencient nettement de ces grandes concentrations connues dans le monde. Ces échantillons, qui se situent dans une coupe de la carrière Oița; ont été soumis à l'analyse microscopique sur lames minces polies (en lumière transmise et réfléchie), l'analyse ponctuelle à la microsonde électronique sur les mêmes préparations, complétées aux rayons X, l'analyse au microscope électronique à balayage et en transmission. Toutes ces observations nous autorisent à confirmer que l'oxydation des carbonates et de silicates représente le processus prépondérant d'enrichissement en manganèse du minerai secondaire (Bălan, 1976) tout au moins dans cette carrière. La présence du fer à côté du manganèse a valeur d'un caractère hérité des formations originelles et préservé à travers tous les processus de transformations qui ont affectés ces concentrations. L'importance des sulfures ( $MnS$ ,  $FeS_2$ ,  $FeS$ ,  $CuFeS_2$ ) et de sulfoarséniures ( $CoAsS$ ;  $NiAsS$ ) est à souligner et il convient de tenir compte de cette caractéristique lors de l'interprétation des analyses globales du minerai. La pyrrhotite monoclinique (ferrimagnétique), pratiquement transformée en magnétite, évolue dans certains échantillons en hématite; il s'agit là, selon les travaux récents de Bina et Daly (1993), d'une indication de conditions particulièrement favorables à l'oxydation.

Dans la masse de carbonates largement cristallisés, la pyrite automorphe – visible même à l'œil nu – s'oxyde graduellement en goethite ( $\alpha-FeOOH$ ), légèrement manganésifère, alors que la rhodochrosite (à traces significatives de strontium) s'oxyde en todorokite et birnessite. La plupart des plages de birnessite évoluent en  $\gamma-MnO_2$  (nsutite). Quelques clichés aux rayons X de nsutite indiquent une  $\gamma-MnO_2$  particulièrement désordonnée, de sorte que le diagramme peut être indexé comme hexagonal, alors que la maille habituelle est orthorhombique; il s'agit là d'un produit d'oxydation tout à fait comparable à la phase  $\epsilon-MnO_2$ . Il semble important de souligner que ce type d'évolution caractérise le minerai riche en sulfures en voie de distribution. L'oxydation des silicates aboutit le plus souvent à la formation de birnessite-nsutite. Nous avons constaté l'enrichissement des microfissures en termes de la série cryptomélane-hollandite, ainsi que des enrichissements tardifs en potasse et baryum.

Sans extrapoler d'une synthèse qui concerne exclusivement les échantillons de la carrière de Oița, à l'ensemble du groupe de concentrations, il est cependant permis d'estimer que la signification des données exposées dépasse le cadre strictement local.





## CARROLLITE AT BĂIȚA BIHOR: THE FIRST OCCURRENCE IN ROMANIA

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The series of the linnaeite  $(\text{Co}, \text{Ni}, \text{Fe}, \text{Cu})\text{S}(\text{Co}, \text{Ni})_{24}$  comprises several terms – linnaeite, siegenite, carrollite, violarite and polydymite – that result from the isomorphous substitutions between Co and Ni on one side and Co, Ni, Fe, Cu on the other side.

The carrollite found out at Băița Bihor is present in the samples taken from horizon 580 m belonging to Baia Roșie zone as part of the cupriferous massive mineralization. It appears in a simple paragenesis beside other minerals such as chalcopryrite, ferro-zincian tetrahedrite and bornite. The carrollite has been observed microscopically as submillimetric hypidiomorphous aggregates located in compact chalcopryrite together with tetrahedrite.

In a semiquantitative way the carrollite chemistry has been determined by direct emission X ray microprobe analysis (wavelength dispersion method). X ray maps show some cobalt and subordinately nickel.

The quantitative chemical composition has been determined by the energy dispersive microprobe analysis, including the characteristic energy spectra for all chemical elements present in the carrollite grains. The following chemical composition has been established (in weight per cent): Cu=15.32 %, Fe=1.63 %, Co=31.11 %, Ni=9.68 %, S=42.26 %. This chemical composition is in very good agreement with the analyses quoted in literature and it corresponds to the following chemical formula:  $(\text{Cu}, \text{Ni}, \text{Fe})(\text{Co}, \text{Ni})_2\text{S}_4$

It is the first occurrence of carrollite in Romania; at Băița it is the sole mineral containing Co and Ni as major elements.

## FLUID INCLUSION IN ANHYDRITE CRYSTALS OF SOME TERTIARY PORPHYRY – COPPER SYSTEMS FROM APUSENI MOUNTAINS, ROMANIA

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The tertiary porphyry-copper mineralizations from Apuseni Mts display a characteristic network of veinlets and/or are disseminated in the host rocks. The ore minerals are represented by pyrite, chalcopryrite, magnetite, hematite, bornite, sphalerite, frequently associated with quartz and anhydrite. The last one may be present as daughter phase in multiphase fluid inclusions (i.e. hydrosaline melt) from the K-core of the porphyry-type structures; it obviously is associated with pyrite and/or chalcopryrite and magnetite in the phyllic, cloritic or argillic zones in the marginal part, respectively.

Depending upon the nature and the number of phases at ambient conditions the crystals of anhydrite contain one or more type of fluid inclusions, as follows:

- i) monophasic fluid inclusions filled entirely by liquid or vapor phase;
- ii) biphasic fluid inclusions in which liquid and vapour or liquid and solid(s) phases occur in various proportions;
- iii) multiphase fluid inclusions formed by liquid, vapour and solid(s), phases (halite, hematite).

The liquid homogenization temperature ranged between 450–240°C;

$T_{m\text{NaCl}}=395\text{--}240^\circ\text{C}$ , salinity=46–34 wt% NaCl for multiphase fluid inclusion type and  $T_e=-52$  to  $-21.5^\circ\text{C}$ ;  $T_{mi}=-6$  to  $-14^\circ\text{C}$ , salinity=9.2–18.5 wt% NaCl for the biphasic type.

The various grade of filling and the scattered microthermometric data allow the conclusion that the fluid phases trapped as fluid inclusions in anhydrite crystals from porphyry copper system suggest a typical heterogeneous equilibria at the trapping conditions when anhydrite precipitated as stable solid phase.





## ALLUVIAL GOLD FROM NERA RIVER; OPTICAL AND ELECTRON MICROPROBE INVESTIGATION

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The Nera River basin covers a large area with a great variety of geological formations, i.e., medium grade metamorphic rocks belonging to the Sebeş-Lotru Group, lower grade metamorphic rocks of Buceava and Miniş Units, old granitoids of Ponişca and Sicheviţa, Upper Cretaceous magmatic rocks with associated iron-and base metal ore deposits, sedimentary Mesozoic rocks of Reşiţa-Moldova Nouă sinclinary and Neogene sedimentary rocks of the Bozovici Basin.

Gold is known for a long time in the Nera stream sediments. The very important occurrences here are at Bozovici and Naideş. Investigations of free gold from these places have pointed out the following main characteristics:

(1) - there are four morphological types of gold: paillettes 0.5-1 mm<sup>2</sup> in size, small grains (0.1 mm) associated with quartz, tabular and discoidal grains with irregular shape and rounded isometric grains (0.05-0.1 mm). The last three morphologic types were observed only in the Naideş occurrence.

(2) - qualitative and quantitative optical characteristics suggest also the existence of four types of gold: reddish-yellow with R=39 % (486 nm), 70 % (551 nm), 78 % (589 nm), 85 % (656nm); yellow with R=56 % (486 nm), 75.5 % (551 nm), 82 % (589 nm), 85.5 % (656 nm); light yellow with R=46 % (486 nm), 72 % (551 nm), 75.5 % (589 nm), 81.5 % (656 nm); white yellow R=67 % (486 nm), 81.5 % (551 nm), 84 % (589 nm), 88 % (656 nm).

In conclusion the lower part of the spectrum (486-551 nm), is characterized by a high dispersion of R values. There is a gold correlation silver percentage as against the color of the gold grains: the content of silver increases from reddish yellow gold to white yellow where silver is of about 50 %.

The alluvial gold from Nera has many sources. The greatest quantities derived from the shear zone (southern part of Văliug ore district) and have an important content of silver. The other parts derived from banatitic sources, for example Sasca copper ore deposits where native gold has been found. This gold has similar properties with some detrial grains from Naideş occurrence.

## CLAY MINERALS FROM THE SALT DEPOSITS OF ROMANIA

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An earlier general study concerning clay mineralogy of the East Carpathians Miocene deposits pointed out two distribution patterns for clay mineral assemblages, controlled by the fluctuating activity of two source areas (Rădan, 1978). In this respect, clay mineralogy of sedimentary material derived from the emerged areas of the Carpathians is characterized by a rather complex mineral assemblage: degraded illite (dominant), smectite, chlorite ( $\pm$ kaolinite), and random mixed-layer clay minerals of the illite-smectite (I-S) type. On the other hand, the clayey fractions provided by the Foreland source area is devoid of smectite, consisting mostly of a binary assemblage: well crystallized illite (dominant) and chlorite ( $\pm$ kaolinite). As a rule, the random mixed-layers show a wider variety (I-S, I-V, C-S), but frequently they may be missing.

Pelitic material contained by evaporitic sequences is represented by clayey interbeds, breccia fragments, or finely disseminated clay particles. Clay mineral composition of evaporite deposits generally follows the distribution pattern of the detrial sequences encompassing them.

During Lower Miocene salt deposition the Foreland was the main source area for the Moldavian segment of the Foredeep and, consequently, the clays associated with, or included within salt and potassium salt deposits are characterized by a binary assemblage (55-95 % illite + 10-45 % chlorite), or even a monomineral one (100 % illite), accompanied by various random mixed-layer structures. Middle Miocene sedimentation was controlled by sedimentary supplies from the Carpathian area, which determined a specific clay mineral assemblage consisting besides illite (40-80 %) and chlorite (10-35 %), of smectite (5-45 %) as well. The I-S random mixed-layers are practically ubiquitous.





The distribution of clay minerals within salt deposits of Romania suggests that clay fractions are mainly inherited from the land, and the diagenetic changes are generally not very important. However, some transformation and/or neoformation processes are to be admitted in order to explain the random mixed-layer clay minerals approaching regular I-S interlayering, well developed within Lower Miocene salt deposits of Târgu Ocna, or some smectite-rich samples from the Middle Miocene salt deposits.

The peculiar evolution of the clay mineral assemblages within Lower and Middle Miocene salt formations may become a valuable index for stratigraphic correlation of evaporite sequences, and suggests also the possibility to determine the age of the salt deposits involved in the complex nappe and/or diapir fold tectonics of the Carpathians.

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## ZIRCONS PETROGENETIC SIGNIFICANCE IN GRANITOID ROCKS OF THE RETEZAT MOUNTAINS, SOUTH CARPATHIANS

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The Retezat Massif is intruded in crystalline formations belonging to the Drăgășan Group, which forms the basal part or Lainici-Păiuș nappe representing a very important Alpine tectonic unit of the Danubian Realm.

Petrographically, there is a remarkable reduced variability of petrotypes (diorites, granodiorites, tonalites and granites), showing a specific chemical evolution for silicic rocks, arising from a low differentiated calc-alkaline magma.

No evident difference exist between the major, minor and REE elements concentrations in certain zone or petrotypes of the massif. Optical and morphological zircon characteristics are very similar for all studied samples. All zircon populations contain different coloured crystals (colourless, light and dark pink or brown), sometime zoned or translucent. Two inclusions types are observed in zircon crystals: (1) – elongated or ovoid gaseous inclusions and (2) – very small zircon crystals. The main morphological types (according to Pupin, 1980) are Q, S, P, L, G, D, presenting an obvious subtypes variability, induced by the alkalinity and temperature variation during zircon growth. Typological Evolutionary Trend (T.E.T.) point out a calc-alkaline tendency and a mixed origin (crust + mantle).

## PETROLOGY OF THE BANATITIC MAGMATITES OF THE BULZA-COSTEIU AREA, TIMIS DISTRICT

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The banatitic magmatites in the Bulza-Costeiu de Sus area penetrate and/or lie over the Poiana Ruscă crystalline schists, and the Mesozoic ophiolitic and sedimentary formations, which belong to the southern part of the Apuseni Mountains. In the Mures couloir, which includes the area under discussion, the banatitic volcanics are mainly represented by andesitic rocks (pyroclastites, lavas and small-sized non-erupted bodies), as well as by rhyolites, which represent the late phase of the volcanic activity. From the point of view of their mineralogical composition, the pyroclastic elements and the matrix are identical with their lava intercalations and the andesite and rhyolite bodies. Pyroxene andesites  $\pm$  olivine, hornblende and pyroxene andesites, hornblende andesites and rhyolites were separated; the last ones displaying textural and structural characters similar to those of the ignimbritic rocks and presenting eutaxitic and breccious facies.





The intrusive magmatites subsequent to volcanics are represented by pyroxene and biotite andesites, porphyritic monzodiorites, monzodiorites and quartz-monzodiorites. Monzodiorite rocks are associated with thermal metamorphism products (diopside and biotite hornfels and orthopyroxene hornfels). The monzodioritic rocks are followed by hornblende + biotite quartz-andesites, dacites and porphyritic microgranodiorites; the late ones yield intrusive breccias and significant hydrothermal alteration phenomena locally accompanied by mineralization (porphyry copper and base metal sulphides).

The pyroxene and olivine bearing basaltic andesites are the latest magmatic products in the area and show a slight alkaline character.

The geochemical characterization of the banatitic magmatites is performed on the basis of twenty wet-chemical analyses and minor elements determination using various diagrams. In these diagrams the distributions fields of similar magmatites from the Poiana Ruscă and the Mureş couloir are also represented. Most of tested magmatic rocks plot into the calc-alkaline field and only few of them in the alkaline field, which differentiates them from the banatitic rocks in the Poiana Ruscă which show a more pronounced alkaline tendency.

The REE patterns show a slight differentiation processes with the range of andesite volcanics and a more pronounced one – within the range of rhyolite rocks (i.e. an Eu negative anomaly). The quartz-monzodiorite rocks and hornblende + biotite quartz-andesites display also a slight differentiation of REE as well as the absence of the Eu anomaly. On the other hand, the porphyritic microgranodiorite rocks emphasize a significant Eu negative anomaly, suggesting a differentiation process by fractional crystallization or the plagioclase conservation in restite.

It is difficult to state now whether the magma corresponding to the banatitic rocks originates in the mantle or in melting processes of the ophiolitic crust eventually mixed with sedimentary deposits. The zircon crystals morphology seems to demonstrate that at least the monzodioritic rocks originate in the mantle, whereas the other magmatite types seem to be resulted by melting of the mixed material (mantle + crust).

Tourmalinizations, propylitizations, sericitizations and argillizations are genetically associated with the granodiorite rocks. The hydrothermal alteration products and the mineralization from the west side of the Ionesca valley – Bulza valley display a well expressed spatial zoning which could be traced as follows (towards the subvolcanic body): Sb – Pb, Zn, Cu – Cu, Mo  $\pm$  Au.

## LATE CRETACEOUS-PALEOGENE MAGMATITES IN BANAT: A MODEL OF MAGMATIC EVOLUTION

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The term "banatites" firstly used by Cotta (1865), actually designate a magmatic province of the Late Cretaceous-Paleogene age. With regard to the major tectonic units in Romanian Carpathians there are two big zones with banatites: (1) The Apuseni Mts. North of the Mureş ophiolitic zone, where the "banatites" are genetically related to the oceanic crust consumption in the Transylvanides, and (2) the South Carpathians (Banat) where they are related to the oceanic crust consumption in front of, and below the Getic Domain. South of Danube the banatitic igneous rocks are known in Eastern Serbia and in Srednogie in Bulgaria.

The model proposed here (for the area between Timiş and Danube Rivers) is based on all the available petrochemical, geophysical data and radiometric age measurements, including also the relationships of "banatites" with their host as well as the structural framework (they penetrated the Getic-Supragetic nappes system). No volcanic formations are known in this area contrasting the abundant occurrences to the North – Poiana Ruscă Mts. and to the South – Timoc area in Serbia. The intrusive igneous rocks are consolidated at different levels in the Earth crust: (a) the plutonites dominated in western part, mainly within the Supragetic Nappes and (b) the hypabissal bodies swarm in the eastern part, covering large areas in the Almăj and Semenik Mts.

Two main stages of magmatic activity with different petrogenetic features could be thus separated:

– Coniacian-Maastrichtian stage (K/Ar 87–68 Ma). This stage is subsequent to the Mesocretaceous tectogenesis (the first important compressive tectogenesis recorded in the South Carpathians) accompanied by crustal shortening and subductions. In the Timoc area, calc-alkaline volcanics are connected to the same processes. In western Banat large polyphasic plutons were intruded during the Early Senonian. Within them a first intrusive phases, i.e. gabbro-anortosites with cumulate textures occur, indicating a fractional crystallization of a basic





magma generated in the mantle ( $\text{Sr}^{87}/\text{Sr}^{86} = 0.704$ ) in a distensive tectonic regime (behind the paleoplane of subduction). The new magma batches includes and mix with parts of primitive cumulate crystals evolving to a K-alkaline differentiate, monzosyenite.

– Maastrichtian-Eocene stage (K/Ar ages = 65–55 Ma). It follows the Endcretaceous tectogenesis (intra-Maastrichtian?). Their magmatic products are known both in the Western – "banatitic plutonic zone" and in the Eastern – "banatitic hypabissal zone". The magmas generating the rocks of this stage may be connected to the subduction of Severin trough with oceanic-type crust, but also to that of intermediate-type crust corresponding to the Arjana intracontinental rift. However, if contemporary, the plutons of this stage, situated far away from the presumably paleoplane of subduction, are different from the hipabissal bodies ( $\text{Sr}^{87}/\text{Sr}^{86} = 0.7033\text{--}0.7054$  in plutonites and  $0.7049\text{--}0.7069$  in hipabissal bodies).

## THE BRĂNIȘCA HILL CALC-ALKALINE AND THE MĂGURA SÂRBI ALKALINE PALEOGENE VOLCANIC ROCKS, MUREȘ COULOIR

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Within the Mureș Couloir there are Paleogene (56–39 Ma) volcanics that were formed under distension conditions. The volcanic activity was favoured by an E-W system of crustal fractures. The most representative are the basalt-andesitic neck and lava flows of Brănișca Hill and the trachyandesitic elongated neck of Măgura Sârbi. The component rocks have a very uniform composition in each volcanic structure which shows a rapid evolution, without any important differentiation or contamination processes. This suggests also that the parental magmas of each volcanic structure could have been primary magmas, formed in the mantle at a great depth. the calc-alkaline or alkaline characteristic of these magmas was determined by the partial melting of the metasomatized peridotitic substratum in a small or very small amount (0–5 percent). The rocks have ambiguous characteristics as regards their tectonic setting – they being transitional volcanics between the arc (banatitic) and the intraplate (basanitic) rocks. These characteristics have resulted by the partial melting of the metasomatized substratum in the distension conditions of the Paleogene period.

## PETROLOGY OF PALAEOZOIC SILICEOUS ROCKS FROM NORTH DOBROGEA

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Thick sequences of biogenic siliceous deposits cropping out in Palaeozoic Rădău and Beștepe Formations (North Dobrogea) were recently investigated by deep borehole drillings. Detailed studies using optical and scanning electron microscopy, X-ray diffraction and geochemical data of samples from exposures and boreholes yielded important information concerning the mineralogy and lithofacies of siliceous rocks.

The dominant facies is bedded chert, interbedded with siliceous slates and with thin beds of ferrous chert, cherty iron carbonates and banded ironstones. Cherts contain radiolarian remains, best preserved in ferrous cherts, where they show details of both internal and external skeletons. In bedded cherts only quartz replaced radiolarians and seldom calcite replaced ghosts occur. Various aspects related to silica, phyllosilicate and carbonate diagenesis are investigated, as well as mineralogical changes produced during Hercynian deformation and very low grade metamorphism of rocks.





## GEOCHEMICAL APPROACH TO THE ORIGIN OF THE EASTERNMOST NEOGENE-QUATERNARY ALKALI-BASALTIC VOLCANISM IN EASTERN EUROPE (BANAT REGION AND PERȘANI MOUNTAINS - TRANSYLVANIA)

I. Seghedi (IGG Bucharest), Hilary Downes (Univ. London), Al. Szakács (IGG Bucharest)

The easternmost occurrences of Neogene-Quaternary (2.64–0.7 Ma) alkali-basalts in Europe are found in the eastern part of the Pannonian Basin (Banat) and in the south-eastern part of Transylvania (Perșani Mts.). Two occurrences are known in Banat: a minor one at Sumeg Hill, south of Gătaia, and another one exposed in an area over 40 km<sup>2</sup> between Lucareț and Sanovița. Both are monogenetic volcanoes. Volcanic activity in the Perșani Mts. is more complex; it has developed in two stages divided by a period of quiescence. Each stage started with violent explosive eruptions (phreatomagmatic and phreatic activity) followed by less energetic eruptive events (lava outpourings or cone-building strombolian activity). At least five important monogenetic and complex volcanic edifices have been recognized (Seghedi, Szakács, in press). Peridotite mantle xenoliths can be found in several lava flows and pyroclastic deposits.

New geochemical and isotope data (Downes et al., in press) gave us the opportunity to undertake some comparative remarks on these two alkali-basaltic occurrences. The Perșani Mts. and Banat alkali-basalts are similar in many chemical parameters but there are also some differences. With the exception of one sample (from Racos) which fall in the transitional basalt field, all the other lavas are trachybasalts according to the classification scheme of Le Bas et al. (1986). The basalts from the Banat region are slightly richer in SiO<sub>2</sub> (48.3–48.9 wt %) but have variable total alkali contents. They are more enriched in K<sub>2</sub>, TiO<sub>2</sub> and P<sub>2</sub>O<sub>5</sub> than Perșani Mts. basalts but have lower concentrations of Al<sub>2</sub>O<sub>3</sub> and CaO. Ni and Cr contents in both areas are high (119–213 ppm Ni, 210–488 ppm Cr), a little higher Cr content in Perșani Mts. Mantle-normalized trace element diagrams show similar patterns to other continental basalts, with enrichment of Nb and all the other incompatible elements. The Racos sample from Perșani Mts. has the lowest Nb, K and P. REE patterns are very similar displaying LREE enrichment ( $La_N = 100$ ,  $Yb_N = 10$ ). Eu anomalies are extremely small and are mostly slightly positive ( $Eu/Eu^* = 0.99–1.04$ ).

Ocean island basalts (OIB) are derivatives of convecting asthenospheric mantle with high  $^{87}Sr/^{86}Sr$  and low  $^{143}Nd/^{144}Nd$ . In comparison with OIB, the Banat samples are slightly enriched in Rb, Ba, Th, Nb, K, Pb and slightly depleted in the remaining incompatible trace elements. The Perșani Mts. alkali-basalts show elevated Rb, Ba and Pb concentrations and particularly, in the case of Racos, a depletion in trace elements including Nb. The deviations from OIB average are much greater in the Perșani Mts. than in Banat basalts. The Perșani Mts. basalts have a greater degree of enrichment in Rb, K and Pb relative to other incompatible elements such as Nb and REE. The Perșani basalts have generally a higher  $^{87}Sr/^{86}Sr$  ratio and lower  $^{143}Nd/^{144}Nd$  than the Banat basalts.

All the data suggest that these alkali-basalts are formed by the partial melting of a deeper asthenospheric mantle similar to that of OIB but it is enriched in K, Rb, Ba, Pb in Perșani Mts. (the extreme case being Racos). This is consistent with idea of a lithospheric mantle source modified by subduction components. One argument sustaining this interpretation is the presence of mantle xenoliths in Perșani basalts which indicates that high-level processes such as fractional crystallization and crustal contamination did not influence significantly the composition of the magmas. The subduction enrichment was most likely in connection with the generation of large volumes of calc-alkaline magmas erupted along the inner part of Carpathians (Călimani-Gurghiu-Harghita volcanic chain) where the last volcanic events are almost coeval with the alkali-basaltic volcanism in Perșani Mts.

## REMARKS ON ZEOLITIC DIAGENESIS IN THE MIOCENE (BADENIAN) TUFFS, NORTH-WEST TRANSYLVANIA, ROMANIA

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Zeolites are common diagenetic products of silicic, mostly vitric Badenian tuffs from the north-western part of the Transylvanian Basin. Throughout most of the main outcrops the tuffs are strongly altered.





The study was done on 20 samples from all the studied profiles (Tărbu, Vale, Bobâlna, Aluniș, Soimeni) from different intervals. Diagenetic processes affected both fallout tuffs and ignimbritic rocks.

The relative abundance of zeolites and other diagenetic minerals was determined by X-ray powder diffraction. Selected samples were also studied by SEM and thin section optical mineralogy to ascertain the genesis and paragenetic relationships of the minerals. Zeolitic tuffs consist of prevailing clinoptilolite and opal-CT. Mostly the tuffs contain 40–90 percent clinoptilolite. Trace amounts of fibrous to filiform mordenite can be recognised only by SEM. In the same way phillipsite at Tărbu (first occurrence in these deposits) was recognized. The common paragenetic sequence is glass – clinoptilolite – mordenite. Opal-CT crystallized at the same time with clinoptilolite or later.

The genesis of zeolites and other autigenic minerals corresponds to diagenesis; they have formed by hydrolysis and dissolution of the silicic glass by pore-water trapped during marine sedimentation of the pyroclastic material. The hydration and solubilization of volcanic glass by saline alkaline cognate fluids was followed by zeolite precipitation.

## THE PRESENCE OF ELBAITE IN NEOGENE ACIDIC VOLCANICS IN METALIFERI MOUNTAINS

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Elbaite, a variety of alkali tourmaline, was found in Neogene acidic volcanics at Fața Băii-Larga, Metaliferi Mountains, being crystallized from high-temperature hydrothermal solutions.

The mineral is colourless, with ivory luster, needle-like, radially disposed, forming "sun-like" aggregates. It fills cracks, the small cavities in, or partially substitutes, the rhyodacitic rocks; it is sometimes associated with quartz and chlorite.

The mineral has optically studied and by means of X-ray diffraction analysis checked.

## MINERALOGICAL OF SOME NEW ALPINE VEINS FROM THE SOUTH CARPATHIANS AND THE APUSENI MOUNTAINS, ROMANIA

*R. O. Strusievicz, Dana Pop (Univ. Cluj)*

Although not as well developed as in the Alps, alpine-type veins occur in the Romanian Carpathians too. A number of four distinct mineral assemblages found in alpine veins from the South Carpathians were already presented by Constantinescu & Săbău (1984), this being the first explicit mention of this kind of veins in Romania.

We describe here the mineralogy of some alpine veins found in the Danubian Realm of the South Carpathians (Retezat and Vilcan Mountains), as well as in the NW part of the Apuseni Mountains, i.e. in the Plopiș (Rez) Mountains.

The investigated veins, ranging in width from 1–20 cm are mostly completely filled up, and are always transversally cutting the schistosity of the host rocks. Lense-shaped geodes in the veins exhibit perfectly developed crystals and interesting aggregates of crystals. The following mineral assemblages were identified:

(1) – quartz+albite and (1a) – quartz+albite+calcite in laminated granitoids of the Lainici-Păiuș Group (Sterminos Valley, Retezat Mts);

(2) – quartz+actinolite+chlorite and (2a) – quartz+chlorite in amphibolites of the Drăgășan Group (Boului Valley, Vilcan Mts);

(3) – quartz+albite and (3a) – quartz+albite+calcite+chlorite in anchimetamorphic sandstones of the Poiana Mărului Unit (Branu valley, left tributary of the Lăpușnicul Mare River, south of the Retezat Mts);





- (4) - quartz+adularia+muscovite;
- (5) - quartz+limonite (pseudomorph after ankerite)+hematite;
- (6) - quartz+oligoclase+feroan clinocllore(ripidolite)+rutile in migmatized gneisses of the Someş Group (Marghita, Bistra and Văjitorului valley, Plopiş Mts).

## ATOLLS AND DENDRITES: UNSPECIFIC GARNET HABITS OF STILL EQUIVOCAL SIGNIFICANCE

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In dynamo-thermal metamorphic rocks garnets usually occur as equant grains of variable size. It should be emphasized that under moderate strain rates, only low diffusion rates are active, preventing extensive grain growth and permitting survival of premetamorphic textural features. Under the same PT conditions, but at a higher strain rate, diffusion rates will likewise be high. Consequently, garnets are growing faster, develop millimetric to centrimetric dimensions and embay or poikiloblastically include adjoining mineral grains. Yet, even under these circumstances the garnet keeps its identity as a mineral grain, as well as its equant shape.

The more is it astonishing to meet sometimes very unspecific garnet shapes, like "nutshells", better known as atoll or ring structures, and dendrites. Selective replacement of the garnet core has been generally considered to be the most likely mechanism of formation of atoll garnets. As to dendritic garnets, many students consider that they grow by extending in the form of very thin branches along quartz/quartz interfaces. In effect, according to these views, atoll structures derive by selective leaching of garnet substance, whereas dendritic garnets should signify the opposite process, of garnet deposition, particularly at the expense of quartz. We shall see, however, that contrary assumptions may likewise be tenable.

Anyhow, there should be general agreement that, irrespective of garnet being leached or fixed, atoll and dendritic structures strongly suggest significantly grater diffusion rates as compared to the 'normal' case previously discussed. The question is what are the real circumstances under which high diffusion rates may induce either garnet dissolution or, contrarily, precipitation? Like other workers, we noticed dendritic garnets exclusively in association with quartz. If the dendrites protrude their neighbourhood as marginal extensions of a garnet grain, delimiting and ultimately enclosing more or less angular quartz grains (and, sometimes, also mica or chlorite flakes), we may admit poikiloblastesis to be at work. Not the same is to be expected if a garnet grain appears disintegrated into a swarm of garnet 'islands', or if there is only a dendritic structure left, without any 'mother'-grain. Such occurrences are embedded in a quartz mass that extends perhaps as an 'aureole' beyond the actual perimeter of the garnet. These aspects suggest garnet substitution by quartz, and not vice versa. Garnet seems to be an advanced stage of corrosion and it is not incidental that occurrences of this kind are widespread in quartz-rich rocks, maybe secondary quartzites. These are frequently characterized by mylonitic textures and may be considered as a residue of the initial rock assemblage.

On the other hand, atoll garnets observed by us occur in gneissic rocks and are obviously link to albite or acid oligoclase poikiloblasts. These are studded with inclusions of quartz, micas (biotite, muscovite), garnet, a.o. Not all garnets are atoll-shaped, but the latter almost exclusively surround quartz grains, forming some kind of a frame between the quartz inclusion and the feldspathic host. There is evidence that the porphyroblastic gneiss with atoll garnets derived from microgranular plagiogneisses due to a percolating alkaline metamorphic fluid that reacted with the latter under low-strain conditions. The fluid obviously caused the development of large albite porphyroblasts at the expense of the more or less randomly oriented initial plagioclase grains. It seems reasonable to suppose that the alumina resulted during albitization reacted with the captured quartz grains and with some iron supplied by adjoining biotite or magnetite to produce garnet, including atoll garnet, that may thus represent nothing but a reaction rim between the involved reactants (plagioclase and quartz).

These aspects all suggest that the complexity of phenomena generating such unspecific garnet structures atolls and dendrites is still far from being fully comprehended and needs further research.





## THE SIGNIFICANCE OF THE FABRIC OF THE SILICOLITES FORMED ON VEGETAL RELICS

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It is a well known fact that some vegetal remains may be substituted by quartz by silica metasomatism resulting specific metasomatic silicolites. The silicolites generally preserve the shape of the vegetal bodies and their cellular structure; that means: (a) the metasomatism developed under isochore conditions, and (b) the quartz blastesis evolved under static conditions, i.e. during the blastic growth the remanent deformation of quartz crystals as well as their translations and rotations were practical non-existent.

The microscopic study of such silicolites offered some informations about the mechanism of static blastesis of quartz and its consequences on the size and shape of the quartz crystals.

Thus, it can be seen that: (1) the average size of the quartz crystals can be very well correlated with the quartz nucleation velocity on the vegetal cell walls; (2) the crystals shape is mainly controlled by their relative growth velocity; (3) neither the relative sizes of the quartz crystals nor their shapes were influenced by the growth pressure.

Although the volume of quartz in some silicolites is greater than 95 %, the initial configuration of the cells and the position of woody vessels were well enough preserved due to the fact that a part of the organic matter has remained on the initial position as tinty opaque inclusions within the quartz grains. In some of these silicolites the quartz grains show a wavy extinction which proves that they have undergone a slight remanent deformation. In such particular situations the initial cell and vessel shapes were slightly disturbed, therefore an attempt was made to estimate the minimum strain required for obtaining the wavy extinction of the quartz grains.

## TITANITE – BEARING PEGMATITES IN THE TISMANA MASSIF

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In the western part of the Vilcan Mts and the eastern one of the Mehedinţi Plateau, the Tismana granitoid massif forms a "concordant" body within the structural directions of the Lainici Păiuş Group (Precambrian). The petrogenetic assemblage of the Tismana massif consists of porphyroid granites (about 80 per cent of the massif) and of equigranular granitoids such as diorites, quartz diorites, tonalites, granodiorites, leucogranites, aplites. According to the geochemical and mineralogical data the Tismana granitoids, the porphyroid granites especially, have a calc-alkaline character with pronounced K-alkaline tendency.

In the Tismana Valley some in situ differentiated small pegmatite bodies occur within the granites. The mineralogical composition of the pegmatites is characterized by the presence of quartz, alkali-feldspar, micas and titanite.

Titanite appears as long prismatic crystals, with dimensions comprised between 1–7 cm, of a typical brown color. In the transmitted light the titanite grains are pleochroic showing yellow-brown to orange-brown colors. They present extrem refringence and the birefringence around 0.100;  $\gamma \wedge C \cong 50^\circ$  and  $2V(+) = 35^\circ - 40^\circ$ . The cell dimensions are:  $a = 6.5455 \text{ \AA}$ ,  $b = 8.6953 \text{ \AA}$ ,  $c = 7.4335 \text{ \AA}$ . In some crystals there have been observed light-colored patches and ilmenite inclusions arranged along the mechanical defects and or structural directions.

These aspects and especially the dimensions of crystals are typical for pegmatites related to alkaline massifs.





## MICRO INCLUSIONS IN ORE MINERALS OF THE BOLCANA-TROIȚA PORPHYRY COPPER DEPOSIT, ROMANIA AND THEIR PARAGENETIC SIGNIFICANCE

G. Udubașă (IGG Bucharest), D. K. Hallbauer (Univ. Stellenbosch)

The Bolcana Troița porphyry copper deposit is associated with Miocene, subduction related volcanics of intermediate composition and can be described by the diorite model. Both the alteration zones and the copper contents display a concentric distribution which are partly disturbed by alterations accompanying the later veins.

Ore samples were prepared by method proposed and described by Hallbauer (1983) and studied by the means of a Topcon SEM, model ABT-60, at Stellenbosch University, South Africa. The samples included:

- (1) magnetite-hematite intergrowth found as round-shaped nests, 20–30 cm across, within the breccias formed along boundaries of the porphyry copper body,
- (2) magnetite and chalcopyrite disseminations in rocks of the inner alteration zone,
- (3) sphalerite and galena from veins cutting the porphyry copper body, and
- (4) quartz-pyrite auriferous ores from veins situated outside the disseminated copper mineralization.

The most interesting specimens were from the type-1 samples, in which iron-rich gold was found as inclusions in magnetite. The gold flakes were always associated with phyllosilicates (illite), hematite and KCl-bearing fluid, singly or all together. In the type-2 samples a close association of magnetite and anhydrite has been found, associated with euhedral quartz grains. Partly recrystallized sphalerite grains in the type-3 samples contain quartz or calcite micro-inclusions as well as NaCl euhedral crystals situated within minute fluid cavities. Other sphalerite and galena grains contain inclusions of a manganese-bearing calcite, anhydrite and small KCl blebs distributed around the fluid voids or "negative crystals". In type-4 samples micro inclusions abound; the pyrite shows numerous fluid voids shaped like "negative crystals", containing NaCl, anhydrite or even pyrite microcrystals displaying {100} and {210}, and more rarely, {111} forms.

The general evolution of the ore-bearing solution seems to be characterized by an early deposition of gold in magnetite-rich aggregates under conditions of KCl- and  $\text{CaSO}_4$ - rich fluids. The later vein minerals typically contained only remnants of NaCl fluids, a feature which suggests both a certain evolution in the ore fluids composition and a change in the NaCl-KCl ratio due to late tectonic movements along the veins. Such movements as observed along the veins were locally very strong, leading to significant changes of the sulfide textural relationships and of their isotopic composition.

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## NEW DATA ON THE HOMOGENEOUS TITANIAN HEMATITE

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H. Klein (Univ. Marburg), Corina Cristea (IGG Bucharest)

A naturally occurring homogeneous member of the hematite-ilmenite solid solution series was recently reported by Udubașă et al. (1992). The mineral forms euhedral grains up to 1mm in size, that were recovered from heavy mineral fractions of alluvial samples from the Topolog Valley in Romania. Microscopic examination showed the mineral to be homogeneous even at the highest magnification of the optical microscope. X-ray diffraction analyses and the reflectance measurements gave values intermediate between hematite and ilmenite, with a quite constant ratio of about 1:1.

New microprobe analyses confirmed the homogeneity of the mineral down to the micrometer level. About 255 point measurements on six different grains have been carried out and the results show that (1) the correlation Fe/Ti is negative; (2) there exist two populations of titanium and iron contents that have, however, a very





narrow variation intervals; (3) Al, Mn and Mg occur in small amounts with average values of about 0.3, 0.2 and 0.6 wt %, respectively. The calculated formula is of  $\text{Me}_{0.10}^{3+}\text{Me}_{1.10}^{2+}\text{O}_3$  suggesting a constant excess of bivalent elements.

Mössbauer spectra of the "titanian hematite" are different as compared to those of pure endmembers. At 295 K the spectra show the existence of micro-domains with different magnetic properties, i.e. the material is superparamagnetic and paramagnetic. However, at 7 K the magnetic properties change becoming typically antiferromagnetic with small paramagnetic domains.

The new data resulted in further characterizing a naturally occurring member of the hematite-ilmenite solid solution series with an uncommon 1:1 ratio of the end members and with magnetic properties different of hematite and ilmenite. This seems to be a new variety or even a new mineral species.

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## SOLID MICRO INCLUSIONS IN DETRITAL GRAINS OF TITANIAN HEMATITE FROM THE TOPOLOG VALLEY, ROMANIA – A STUDY OF PROVENANCE

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An intermediate member of the hematite-ilmenite solid solution series was recently identified in alluvial deposits of the Topolog Valley, Romania (Udubaşa et al., 1992). According to the measured values of the cell parameters and the spectral reflectance, the mineral was found to have an unusual 1:1 ratio of the two end members. The grains have an average diameter of about 300 to 500 micrometers. Micro inclusions were first detected in polished sections during ore microscopy but could not be identified.

The grain were split (Hallbauer, 1983), mounted and systematically searched for inclusions in a scanning electron microscope (SEM). Rounded, ellipsoidal or even euhedral micro inclusions were observed in nearly all the grains of the titanian hematite. The micro inclusions were identified by their crystal morphology and the composition obtained by means of the EDAX system attached to the SEM.

The inclusions consist mainly of euhedral micrograins of apatite, sometimes associated with fine grained quartz. Locally xenotime was also identified as well as euhedral grains of pyrrhotite which is commonly associated with an unidentified needle-like mineral.

The data obtained is expected to help elucidating the problem of source rocks, although at the time being no direct proof exists as to the presence of the mineral in known bed rocks. Earlier analyses showing the systematic presence of tantalum (thought as being the main stabilizing element for such an unusual composition) and the recently identified "daughter" minerals (apatite, xenotime) suggest, however, that the source rocks may be represented by high P-T metamorphic rocks of primary, pegmatitic origin.

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## NAGYAGITE: SOME FEATURES OF ITS COMPOSITION AND MOSSBAUER SPECTRA

G. Udubaşa (IGG Bucureşti), F. Wagner, J. Friedl (Univ. München)

Nagyagite is one of the gold-bearing telluride minerals whose crystal structure has been not solved yet, although the mineral was discovered some 100 years ago. In ores of the type locality, Săcărimb (formerly Nagyag), Romania, the nagyagite occurs in veins hosted by Miocene andesites. It frequently associates with quartz and rhodochrosite and shows widely developed transformation rims consisting of altaite, krennerite, galena etc.

In spite of numerous wet chemical and microprobe analyses the nagyagite lacks a confirmed unequivocal formula. The major element contents exhibit rather wide variation as shown in the table giving a nearly continuous series of formulas from  $\text{AuPb}_5\text{Te}_3\text{SbS}_5$  to  $\text{AuPb}_9\text{Te}_3\text{SbS}_{11}$ . However, most of the existing analyses match with the formulas of  $\text{AuPb}_7\text{Te}_3\text{Sb}_{1.5}\text{S}_8$  or  $\text{AuPb}_7\text{Te}_{3.5}\text{Sb}_2\text{S}_9$ .

Variation of major element contents  
in nagyagite (wt. %)

	Lowest	Highest	Average (n=26)
Au	3.62	10.16	7.78
Pb	52.55	63.10	56.77
Te	13.00	18.99	16.77
Sb	3.69	9.87	7.25
S	3.69	12.85	10.54

Early works by Helke (1934) and Giuscă (1937) showed that the nagyagite sometimes consists of two or even three phases with slightly different optical properties. Two nagyagite phases have been also identified by one of the authors (G. Udubaşa) in the Ramdohr's collection of polished sections of the Heidelberg University (Udubaşa et al., 1992, p. 33). Thus it is likely that the variations in the chemical composition are related to analyses involving different nagyagite phases. The nearly continuous variation in the nagyagite composition resulting sometimes in the apparition of two or three phases suggests a spinodal-like decomposition of a complex compound reminiscent of intermetallic or alloy-like compounds.

Mössbauer spectra of several nagyagite absorbers were measured at 4.2 K with the 77 keV gamma rays of  $^{197}\text{Au}$ . The spectra are single, unbroadened quadrupole doublets with virtually the same splitting and isomer shifts for all samples studied so far, even though the chemical formula of the mineral indicates wide compositional variations and non-stoichiometric compositions. Some of the studied absorbers consisted of thin crystal plates broken from the mineral aggregate. The symmetry of the quadrupole doublets found in such single crystal absorbers shows that the electric field gradient at the gold site is axially symmetric with its symmetry axis perpendicular to the plane of the plates. This implies that gold occupies a unique site in the tetragonal unit cell, and that the crystallographic c-axis is perpendicular to the plane of the plates. The values found for the isomer shift and the electric quadrupole interaction show that gold in nagyagite is trivalent. The same oxidation state shows the gold in sylvanite, krennerite and calaverite (Wagner et al., in press). The antimony in nagyagite is also trivalent.

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## GEOCHEMISTRY AND PETROLOGY OF UTRAMAFIC XENOLITHS IN PLIO-PLEISTOCENE ALKALI BASALTS FROM THE TRANSYLVANIAN BASIN (ROMANIA)

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Ultramafic xenoliths from the alkali basalts of the Perşani Mts Eastern Transylvanian Basin (ETB), are mainly spinel lherzolites, but harzburgites, anhydrous pyroxenites and amphibole pyroxenites are also present. The range of textural variations in the xenoliths is restricted to protogranular to porphyroclastic types, compared to the mantle xenoliths from the neighbouring Western Pannonian Basin (WPB). Moreover, the ETB xenoliths are richer in amphibole than those from the WPB. Thus, the ETB mantle is less deformed but more strongly metasomatised than the WPB mantle. Mineralogical and bulk-rock geochemical variations resemble spinel lherzolites from other sub-continental shallow mantle xenolith suites. There is no particular correlation between deformation and geochemistry, and much of the geochemical variations is due to variable depletion (i.e. extraction of basaltic melts). The REE patterns of separated clinopyroxenes from the xenoliths are mostly LREE-depleted except for those which contain amphibole. The amphibole is strongly LREE-enriched and is considered metasomatic in origin. The  $^{87}\text{Sr}/^{86}\text{Sr}$  and  $^{143}\text{Nd}/^{144}\text{Nd}$  isotopic ratios of the separated cpx-es vary between 0.7019 and 0.7044 and 0.51276 and 0.51353, respectively. These values are more depleted than those obtained from the WPB:

Thus, despite its position close to the calc-alkaline volcanic arc the Eastern Carpathians, the upper-mantle beneath the ETB did not interact to any great extent with the subduction-related magmas, but was metasomatised by passage of alkaline magmas similar to host alkali basalts.

## THE BOLCANA-TROIȚA PORPHYRY COPPER DEPOSIT: SOME MINERALOGICAL FEATURES

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Typically developed porphyry ores contain pyrite, chalcopyrite gold and magnetite as main minerals. Subordinately there occur bornite, enargite, ilmenite, hematite and molybdenite. Secondary minerals such as covellite, chalcocite, malachite and azurite were also observed in some places. Sphalerite and galena are contained by late veins cutting the porphyry body. The non-metallic minerals are represented by quartz, biotite, chlorite, anhydrite, gypsum, barite as well as some zeolites and clay minerals.

Three alteration facies have been recognized, i.e. propylitic, potassic and phyllic.

Pyrite is by far the most widespread ore minerals being abundant especially within the phyllic zones forming both impregnation and fissure fillings. It contains inclusions of chalcopyrite, magnetite, rutile and locally also of hematite and pyrrhotite.

Chalcopyrite is the next abundant mineral with an obvious enrichment in the anhydrite dominated ore parts. It forms various intergrowths with pyrite, bornite, magnetite as well as with chalcocite and digenite.

Gold has been microscopically identified as microinclusions in chalcopyrite, quartz and in the altered rocks as well.

Progressively transformed titanium-rich magnetite shows different intergrowths types with ilmenite, hematite and titanite being locally completely substituted by leucoxene.

Anhydrite is the leading non-metallic mineral forming sometimes monomineralic masses of tens and hundreds of meters, a feature rarely encountered in the porphyry coppers known in the Metaliferi Mountains.





## WHITE MINERALS MARKET AND THE EUROPEAN PAPER INDUSTRY

*J. A. L. Velho, C. S. F. Gomes (Univ. Aveiro)*

White minerals, such as: kaolin, calcium carbonate and talc, particularly the first two, are essential raw materials for paper applications, both as fillers and pigments. The white minerals market related with the paper industry is very requiring and competitive. For 1994 white minerals consumption in Europe is estimated to attain about  $8 \times 10^6$  tons. Other economical previsions and statistical data will be considered. Important developments have characterized last decade in what concerns the production of new commercial grades of kaolin and calcium carbonate. For instance, in the case of kaolin about twenty quality grades are presently commerciable, each of them with its particular specifications, uses and prices.

Due to the acid to neutral-alkaline conversion taking place progressively in the paper producing process, kaolin is being replaced favourably for some purpose by calcium carbonate. Therefore kaolin producers are responding to the situation making available new kaolin grades, particularly of delaminated, calcined and chemically structured kaolins, which are being used in very special papers.

Information on the research actually being developed on kaolin beneficiation through delamination and calcination and their influence on paper properties will be presented.

## TYPICAL CLAY MINERAL ASSOCIATIONS IN HUNGARIAN SEDIMENTARY ROCKS

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Five types of clay mineral associations will be discussed:

1. Evaporitic facies of the Triassic. Special Mg-rich clay minerals such as corrensite are products of neoformation in a restricted basin environment (Mecsek Mts).
2. Upper Triassic to Lower Cretaceous carbonate rocks. The variation of the kaoline content is in relation to the paleogeographic situation in the Tethys Basin during deposition. The main clay mineral is illite (Transdanubian Central Mts, Mecsek Mts).
3. Enrichment of kaolinite Upper Cretaceous and Paleogene continental sediments ("siderolitic facies", fire clays in the Transdanubian Central Mts).
4. Tuffaceous and volcanoclastic deposits of the Carpathian neovolcanic region (Miocene to Quaternary). Typical minerals are varieties of smectite due to devitrification of acid to intermediate pyroclastics, zeolites such as clinoptilolite and mordenite (e.g. Mátra, Tokaj Mts, Great Hungarian Plain etc).
5. Sediments of the Tertiary basins (North Hungarian Paleogene Basin, Neogene Pannonian Basin). The detrial clay mineral assemblage is due to high rate of denudation, redeposition and sediment accumulation. High geothermal gradients and thick sequences result in transformation of illite/smectites.





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ROMANIAN JOURNAL OF MINERALOGY publică contribuții științifice originale în domeniile mineralogiei, cristalografiei, geochimiei mineralelor etc.

Vor fi acceptate numai lucrările care prezintă concis și clar informații noi. Manuscrisul va fi supus lecturii critice a unuia sau mai multor specialiști; după a doua revizie nesatisfăcătoare din partea autorilor va fi respins definitiv și nu va fi înapoiat.

Manuscrisele trebuie prezentate, de regulă, în engleză sau franceză; cele prezentate în limba română trebuie să fie însoțite de un rezumat, în engleză sau franceză, de maximum 10 % din volumul manuscrisului.

Lucrările trebuie depuse, în două exemplare, la secretariatul Comitetului de redacție, inclusiv ilustrațiile în original. Manuscrisul trebuie să cuprindă: textul (cu o pagină de titlu, care este și prima pagină a lucrării), bibliografie, cuvinte cheie, abstract, ilustrații, explicații ale figurilor și planșelor, și un sumar cu scop tehnic.

Se va adăuga o filă separată cu un sumar, în care se va indica ierarhia titlurilor din text în clasificarea zecimală (1; 1.1; 1.1.1), care nu trebuie să depășească patru categorii.

Textul va fi dactilografiat la două rânduri (31 rânduri/pagină și 64 spații/rînd), pe o singură parte a colii, cu un spațiu liber de 3-4 cm în partea stîngă a paginii și nu trebuie să depășească 20 pagini dactilografiate (inclusiv bibliografia și figurile).

Prima pagină a textului va cuprinde: a) titlul lucrării (concis, dar informativ), cu un spațiu de 8 cm deasupra; b) numele întreg al autorului (autorilor); c) instituția (instituțiile) și adresa (adresele) pentru fiecare autor sau grup de autori; d) colontitul de maximum 60 semne. Notele de subsol se vor numerota consecutiv.

Citările din text trebuie să includă numele autorului și anul publicării. Exemplu: Ionescu (1970) sau (Ionescu, 1970). Pentru doi autori: Ionescu, Popescu (1969) sau (Ionescu, Popescu, 1969). Pentru mai mult de doi autori: Ionescu et al. (1980) sau (Ionescu et al., 1980). Pentru lucrările care se află sub tipar, anul publicării va fi înlocuit cu "in press". Lucrările nepublicate și rapoartele vor fi citate în text ca și cele publicate.

Abstractul, maximum 20 rânduri, trebuie să fie în limba engleză și să prezinte pe scurt principalele rezultate și concluzii (nu o simplă listă cu subiecte abordate).

Cuvintele cheie (maximum 10) trebuie să fie în limba engleză sau franceză, corespunzător limbii în care este lucrarea (sau abstractul, dacă textul este în română), prezentate în succesiune de la general la specific și dactilografiate pe pagina cu abstractul.

Bibliografia se va dactilografia la două rânduri, în ordine alfabetică și cronologică pentru autorii cu mai mult de o lucrare. Abrevierile titlului jurnalului sau ale editurii trebuie să fie conforme cu recomandările respectivelor publicații sau cu standardele internaționale.

Exemple:

a) jurnale:

Giușcă, D. (1952) Contributions à l'étude cristallographique des niobates. *An. Com. Geol.*, XXIII, p. 259-268, București.

- , Pavelescu, L. (1954) Contribuții la studiul mineralogic al zăcămintului de la Mușca. *Comm. Acad. Rom.*, IV, 11-12, p. 658-991, București.

b) publicații speciale:

Strand, T. (1972) The Norwegian Caledonides. In: Kulling, O., Strand, T. (eds.) *Scandinavian Caledonides*, 560 p., Interscience Publishers.

c) cărți:

Bălan, M. (1976) Zăcămintele manganifere de la Iacobeni. Ed. Acad. Rom., 132 p., București.

d) hărți:

Ionescu, I., Popescu, P., Georgescu, G. (1990) Geological Map of Romania, scale 1:50,000, sheet Cîmpulung. Inst. Geol. Geofiz., București.

e) lucrări nepublicate sau rapoarte:

Dumitrescu, D., Ionescu, I., Moldoveanu, M. (1987) Report. Arch. Inst. Geol. Geofiz., București.

Lucrările sau cărțile publicate în rusă, bulgară, sîrbă etc. trebuie menționate în bibliografie transliterînd numele și titlurile. Exemplu:

Krasheninnikov, V. A., Basov, I. A. (1968) Stratigrafiya kainozoi. Trudy GIN, 410, 208 p., Nauka, Moscow.

Ilustrațiile (figuri și planșe) trebuie numerotate și prezentate în original, pe coli separate (hîrtie de calc), bune pentru reproduc. Dimensiunea liniilor, a literelor și simbolurilor pe figuri trebuie să fie suficient de mare pentru a putea fi citite cu ușurință după ce au fost reduse. Dimensiunea originalului nu trebuie să depășească suprafața tipografică a paginii: lățimea coloanei 8 cm, lățimea paginii 16,5 cm, lungimea paginii 23 cm, pentru figuri, iar pentru planșele liniare nu trebuie să depășească dimensiunile unei pagini simple (16,5/23 cm) sau duble (23/33 cm) și trebuie să fie autocopiativă (să includă titlul, autori, explicație etc.). Scară grafică obligatorie.

Ilustrațiile fotografice (numai alb-negru) trebuie să fie clare, cu contrast bun și grupate pe planșe de 16/23 cm. În cadrul fiecărei planșe număratoarea fotografiilor se repetă (de. ex. Pl. I, fig. 1, Pl. II, fig. 1).

Tabelele vor fi numerotate și vor avea un titlu. Dimensiunea originală a tabelelor trebuie să corespundă dimensiunilor tipografice menționate mai sus (8/16,5 sau 16,5/23).

Autorii vor primi un singur set de corectură, pe care trebuie să-l înapoieze, cu corecturile corespunzătoare, după 10 zile de la primire. Numai greșelile de tipar trebuie corectate; nu sînt acceptate modificări.

Autorii vor primi gratuit 30 de extrase pentru fiecare lucrare.

Comitetul de redacție



Institutul Geologic al României











## INSTRUCTIONS TO AUTHORS

ROMANIAN JOURNAL OF MINERALOGY publishes original scientific contributions dealing with any subject in the field of mineralogy, crystallography, mineral geochemistry etc.

Only papers presenting concisely and clearly new information will be accepted. The manuscript will be submitted for critical lecture to one or several advisers. Papers will be definitely rejected after a second unsatisfactory revision by the authors. The manuscripts will not be returned to the authors even if rejected.

Manuscripts are preferred in English or French. Manuscripts submitted in Romanian will be accompanied by an abstract in English or French (maximum 10 per cent of the manuscript volume).

Papers should be submitted in duplicate to the secretary of the Editorial Board, including the reproduction ready original figures. The manuscript should comprise: text (with a title page which is the first page of it), references, key words, abstract, illustrations, captions and a summary for technical purposes.

The author(s) should add a separate sheet with a summary indicating the hierarchy of headings from the text listed in decimal classification (1; 1.1; 1.1.1) but not exceeding four categories.

The text should be double-spaced typed (31 lines/page with 64 strokes each line) on one side of the paper only, holding an empty place of 3–4 cm on the left side of the page. The text cannot exceed 20 typewritten pages (including references and figures).

The front page (first page of the text) should comprise: a) title of the paper (concise but informative) with an empty space of 8 cm above it; b) full name(s) of the author(s); c) institution(s) and address(es) for each author or group of authors; d) short title (colontitle) of maximum 60 strokes. Footnotes should be numbered consecutively.

Citations in the text should include the name of the author and the publication year. Example: Ionescu (1970) or (Ionescu, 1970). For two authors: Ionescu, Popescu (1969) or (Ionescu, Popescu, 1969). For more than two authors: Ionescu et al. (1980) or (Ionescu et al., 1980). For papers which are in course of print the publication year will be replaced by "in press". Unpublished papers or reports will be cited in the text like the published ones.

Abstract, of maximum 20 lines, must be in English, summarizing the main results and conclusions (not a simple listing of topics).

Key words (max. 10 items), in English or French, following the language used in the text (or the *Resumé* if the text is in Romanian), given in succession from general to specific, should be typed on the abstract page.

References should be typed in double-line spacing, listed in alphabetical order and chronological order for authors with more than one reference. Abbreviations

of journals or publishing houses should be in accordance with the recommendations of the respective publications or with the international practice.

Examples:

a) journals:

Giuşcă, D. (1952) Contributions à l'étude cristallographique des niobates. *An. Com. Geol.*, XXIII, p. 259–268, Bucureşti.

– , Pavelescu, L. (1954) Contribuţii la studiul mineralogic al zăcămintului de la Muşca. *Comm. Acad. Rom.*, IV, 11–12, p. 658–991, Bucureşti.

b) special issues:

Strand, T. (1972) The Norwegian Caledonides. p. 1–20. In: Kulling, O., Strand, T. (eds.) *Scandinavian Caledonides*, 560 p., Interscience Publishers.

c) books:

Bălan, M. (1976) Zăcămintele manganifere de la Iacobeni. Ed. Acad. Rom., 132 p., Bucureşti.

d) maps:

Ionescu, I., Popescu, P., Georgescu, G. (1990) Geological Map of Romania, scale 1:50,000, sheet Cimpulung. Inst. Geol. Geofiz., Bucureşti.

e) unpublished papers or reports:

Dumitrescu, D., Ionescu, I., Moldoveanu, M. (1987) Report. Arch. Inst. Geol. Geofiz., Bucureşti.

Papers or books published in Russian, Bulgarian or Serbian etc. should be mentioned in the references transliterating the name and titles. Example:

Krashennnikov, V. A., Basov, I. A. (1968) *Stratigrafiya kainozoa*. Trudy GIN, 410, 208 p., Nauka, Moscow.

Illustrations (figures and plates) must be numbered and submitted as originals on separate sheets (tracing papers), ready for reproduction. The thickness of the lines, lettering and symbols on figures should be large enough to be easily read after size-reduction. The original size should not extend beyond the print area of the page: column width 8 cm, page width 16.5 cm, page length 23 cm for figures; the width of line drawings should not extend over a single (16.5/23) or double (23/33 cm) page area and must be selfexplanatory (including title, authors, legend etc.). The graphic scale is obligatory.

Photographic illustrations (black-and-white only) must be of high quality and should be grouped into plates 16/23 cm in size. Each plate should have the photos numbered, i.e. Pl. I, Fig. 1; Pl. II, Fig. 1.

Tables should be numbered and entitled. Original size of the tables should correspond to the above mentioned (8/16.5 or 16.5/23) dimensions of the printing area.

Author(s) will receive only one set of preprint proofs which must be returned, with corrections, 10 days after receiving them. Only printing errors should be corrected, no changes in the text can be accepted.

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