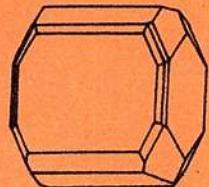


Romanian Journal of MINERALOGY

continuation of

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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 Ședințelor" (D.S.) has appeared as proceedings of geologists working with the Geological Institute of Romania. The journal (D.S.) appeared initially as a single volume (till volume 54, 1969), then with five series, the present issue being a direct continuation of the D.S./series 1 (Mineralogy-Petrology).

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MINERALS IN ROMANIA: THE STATE OF THE ART 1991

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Key words: Minerals. Native elements. Sulfides. Halides. Oxides. Hydroxides. Nitrates. Carbonates. Borates. Sulfates. Chromates. Molybdates. Wolframates. Phosphates. Arsenates. Vanadates. Silicates. Organic compounds. Classification. New minerals. New occurrences. Romania.

Abstract: The paper summarizes the data concerning the mineral species identified so far in Romania (about 550, including the mineral varieties). The mineral occurrences in our country are slightly "oversaturated" in sulfides (151 species) and silicates (176) as against the "undersaturation" in halides (5 species), borates (4) and arsenates-phosphates-vanadates (38). About 30 mineral species have been discovered in Romanian occurrences either early in the 18 century (e. g. native tellurium in 1792) or recently (e. g. paderaite in 1985). Other minerals first described on the Romanian territory are andorite, fizelyite, krennerite, nagyagite, petzite, semseyite, sylvanite, pseudobrookite, rhodochrosite, kotoïte, ludwigite, ardealite, felsöbanyite, klebelsbergite, krautite etc. The priority of the name lotrite (described in 1900) over pumpellyite (1925) is also discussed and it is proposed that the minerals pumpellyite, ferropumpellyite, julgoldite, shuiskite should be named lotrite-pumpellyite series. Some rare minerals have been identified in Romania in the last time e. g. awaruite, aikinite, chalcostibite, hetaerolite, huntite, zaratite, umohoite, huréaulite, tavorite, sonolite, leucophoenicite, tilleyite, spurrite, okenite, cymrite etc., some of them in great amounts or as crystals reaching uncommon size. For each class some less common assemblages or modes of presentation are included such as pyrrhotite concretions in anthracite-bearing rocks, stalactitic pyrite in a base metal ore deposit, cristobalite lepispheres in altered volcanic rocks, rutile crystals up to 10 cm in size in andalusite-bearing pegmatites, black and white calcite spheres up to 8 cm in size in the hydrothermal veins at Herja, big gehlenite crystals (up to 15-20 cm in size) in a high-temperature skarn occurrence etc. The paper ends with short presentations of some famous mineral occurrences in Romania such as Săcărîmb (Nagyag), Baia Sprie (Felsöbanya), Dogenecea, Ocna de Fier (Vaskö), Cioclovina, Băița Bihor (Rezbanya), Boteni, Cavnic, Roșia Montană (Verespatak), Uroi (Arany) etc., most of them being type localities of some mineral species.

1. Introduction

The number of mineral species and varieties described in Romania is now of about 550; therefrom some 30-35 species have been discovered on the Romanian territory; however, their status is different, as it will be later shown. The "Topographic Mineralogy of Romania" (Rădulescu, Dimitrescu, 1966) includes about 400 mineral species and varieties; thereafter, some 150 minerals have been found in various occurrence types. Excepting the subclass of arsenites, tellurites and selenites all the classes of the "symmetrical" classification of minerals (Fig. 1) are known in Romania although their frequency varies considerably. An inspection of the distribution histograms of minerals among classes (Figs. 2, 3) reveals that the Romanian occurrences are slightly "oversaturated" in sulfides and silicates as against the "undersaturation" in halides, borates and arsenates-phosphates-vanadates. The class dependence of mineral abundances has undergone only slight changes since 1966 as well as the ratio between the number of species identified in Romania and those worldwide (400 out of 1600 in 1966, 550 as against 2700 in 1991).

The following pages show the progress made in Romania with respect to the study of mineral species assigned to various occurrence types (see Appendix I). Although the lists are as complete as possible, the references must have remained selective in order to save space. For each class four items will be presented, i.e.:



- (1) short comments on the minerals included in the "Topographic Mineralogy of Romania" (TMR)
- (2) post-TMR species
- (3) new occurrences (the most important ones) and
- (4) less common assemblages (including the data available up to now).

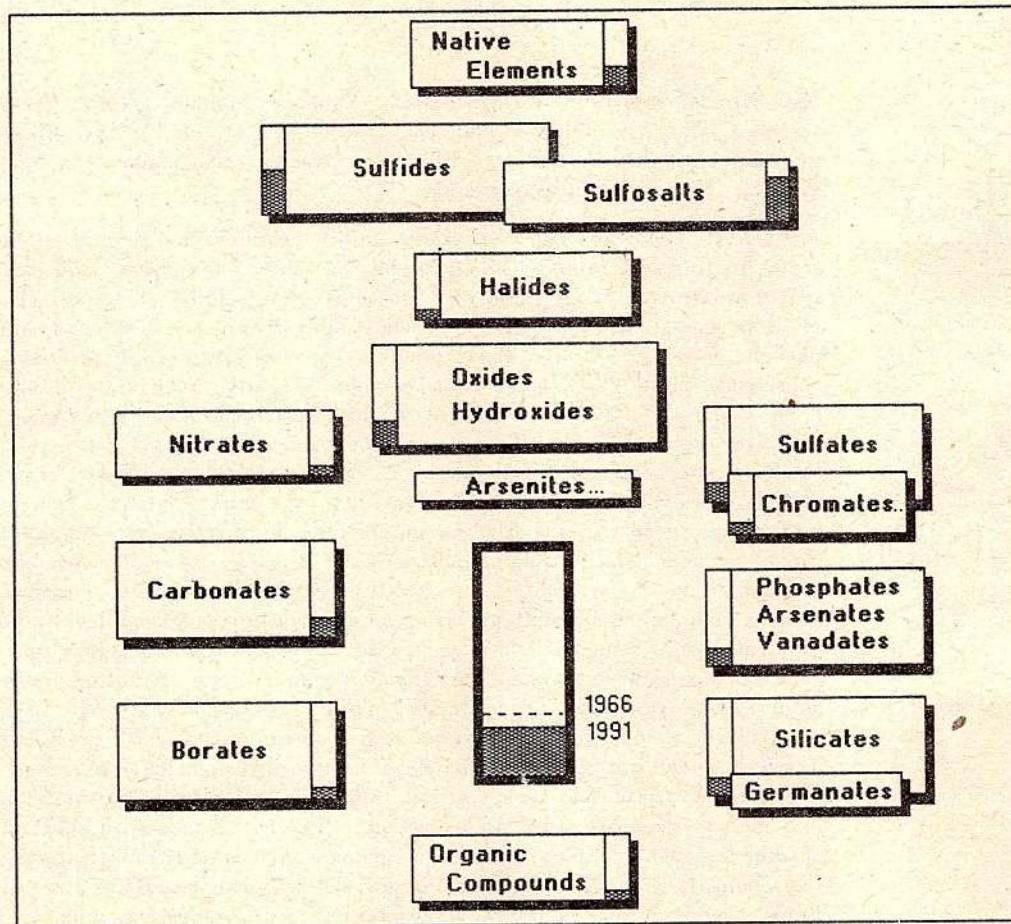


Fig. 1 - The symmetrical classification of mineral species showing the ratio of minerals known worldwide (quadrangles) and in Romania (black). Central quadrangle – total number of minerals in 1966 and 1991 in Romania and in the world.

2. Systematic presentation of minerals

I. Native elements

Short comments on the previously described species. There are 14 species described (Table 1) among which special mention should be made of gold and tellurium. Gold occurrences are numerous in Romania and they display very different genetic features (hydrothermal, shear-zone related and alluvial deposits). The most important are the occurrences related to the Neogene volcanic activity forming veins or stockworks. Especially the vein deposits contain beautiful crystals or aggregates (fibres, moss-like, leaves etc.). The gold fineness is variable depending mainly upon the mineral associations (Udubaşa, Anastase, 1989). The purest gold has been found in the Faţa Băii ore deposit containing native tellurium. Richer in silver has been proved to be the gold in the Roşia Montană ore deposit (Table 2), where abundant silver sulfosalts are known. In the sedimentary gold concentration of Tertiary age (placers) in the Roşia Montană-Bucium area the gold fineness is higher; so is the fineness of gold in the recent alluvial deposits in the northern part of the Sebeş Mts, i.e. at Pianu.



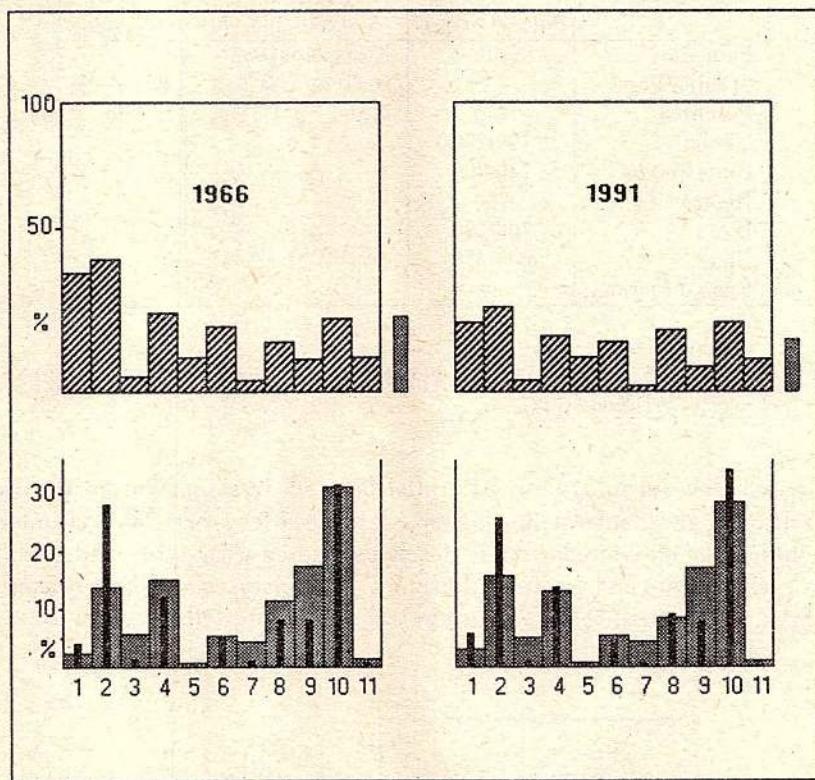


Fig. 2 - (upper diagrams). Class dependence of mineral abundances in Romania and worldwide (100 %) as known in 1966 and 1991. Outside bars - total percentage of Romanian minerals, i.e. 24 % in 1966 and 18 % in 1991.

Fig. 3 - (lower diagrams). Ratios between the number of minerals in each class identified in Romania (black) and known worldwide (quadrangles).
 Mineral classes: 1, native elements and related compounds; 2, sulfides and related compounds; 3, halides; 4, oxides and hydroxides; 5, nitrates; 6, carbonates; 7, borates; 8, sulfates; 9, phosphates-arsenates-vanadates; 10, silicates; 11, organic compounds.

Table 1
 Minerals includes in the TMR

Mineral sp.	Main occ. type (s)*	Mineral sp.	Main occ. type (s)
1. alle montite	III Cc	8. iron ?	VIII
2. antimony	III Cc	9. lead ?	VIII
3. arsenic	III Cc	10. mercury	III Cc
4. bismuth	III Cc	11. platinum	VIII
5. copper	III Cb, III Cc	12. silver	III Cc
6. gold	III Cc	13. sulfur	III Cc, VII
7. graphite	I Aa	14. tellurium**	III Cc
		(Fața Băii)	

* The most important for each mineral, see Appendix for explanation.

** Mineral first described in Romania.

? Doubtful identification.

Table 2
Gold fineness in some Romanian occurrences

Ore deposits*	Gold fineness (%.)	Tertiary placer(a) Alluvial gold (b)	Gold fineness
Fața Băii	930	Roșia Montană -	
Stănița/Popa	900	Bucium area (a)	875-1000
Porcurea	853	Pianu (b)	905
Căraci	795-750		
Ruda Barza	720-700		
Breaza	700		
Băița	700-600		
Căinel	680-580		
Roșia Montană	500		

* Mostly veins

Sources: MacLaren (1908), Haiduc (1940), Ghițulescu, Socolescu (1940), Brana (1958)

Native tellurium was discovered in 1792 by M.v. Reichenstein in samples from the Fața Băii ore deposit ("metallum problematicum") and named tellurium by Klaproth a few years later (Binder, 1958). In the ore deposits from the Metaliferi the native tellurium is closely associated with pyrite and gold (Fața Băii, Stănița), calcite (Ruda Barza) or with hessite and petzite (Săcărimb). The crystals show short prisms with well developed rhombohedron faces (Fig. 4). Sometimes the tellurium transforms into tellurite.

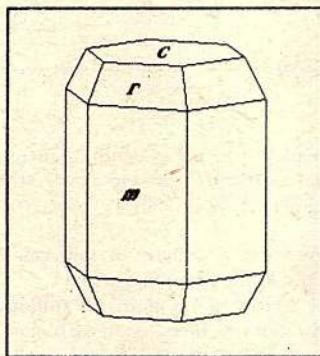


Fig. 4 - Native tellurium crystal from Fața Băii.

Post-TMR species. The identified minerals are presented in Table 3. Awaruite occurs closely associated with heazlewoodite in a sulfur-poor paragenesis hosted by a serpentinized ultrabasic body in the Poiana Rusca Mts (Udubașa et al., 1983, unpublished). Moissanite was found in heavy minerals concentrates from alluvial deposits formed mostly on basic and ultrabasic rocks of Mesozoic age in the Metaliferi Mts (Bălan, 1982, unpublished). Pre-graphite or graphitoide has been identified in Paleogene black shales near the contact with Neogene intrusive rocks of the Tibleș igneous complex, North Romania (Udubașa, 1976, unpublished); it occurs also in mineralized black shales of Cretaceous age at Coranda-Hondol, Metaliferi Mts (Udubașa et al., 1982b) and in similar rocks of Neogene age at Rotunda-Strîmbu, Gutii Mts (Udubașa, 1984a). Anchimetamorphic changes of the anthracite of the Liassic Schela Formation in the South Carpathians have been studied by Popescu et al. (1982).

New occurrences. Native tellurium in association with various tellurides was described by Berbeleac, David (1982) at Musariu, a Neogene gold deposit in the Metaliferi Mts. Metallic spherules with nuclei consisting of native iron in a matrix of magnetite intergrown with silicates have been proved to be quite frequent in alluvial heavy mineral concentrates on the southern slope of the South Carpathians (Udubașa, Arsenescu, 1987). Whether these spherules are artifacts or they represent cosmic dusts it is a matter of further research.

A general picture of the gold parageneses in the Tertiary deposits in Romania was given by Berbeleac (1986).

Table 3
Native elements: post-TMR species

Mineral sp.	Localities	Occ. type	References
awaruite	Vadu Dobrii	IDb	Udubaşa et al. (1983, unpubl.)
moissanite	Petriş	VIII	Bălan (1982, unpubl.)
pre-graphite	Dolhasca Tibileş	VIII IIIBCd	Bălan (1981) Udubaşa (1976, unpubl.) Udubaşa (1984a)
	Coranda Hondol	IIICc	Udubaşa et al. (1982b)
	Rotunda-Strîmbu	IIICc	Udubaşa (1984a)

Less common assemblages. Fine intergrowths of native gold with native arsenic have been observed in the gold ores at Hondol, Metaliferi Mts, in veins related to Neogene volcanics (Udubaşa, 1981, unpubl.). An unusual association of native gold with felsöbányite in a sample from the Baia Sprie base metal ore deposit was reported by Banyai (1969). Balintoni (1970) found primary inclusions of native sulfur in plagioclase phenocrysts of a subvolcanic quartz andesite body of Neogene age in the Călimani Mts; sometimes the native sulfur is closely intergrown with tridymite, considered by the author as a primary phase, too.

II. Sulfides and related compounds

Short comments on the previously described species. Over 100 species were known by the time the TMR appeared (Table 4), among which some tellurides and sulfosalts have the type localities in Romania. In addition, some ore deposits furnished rich material of mineralogical interest and thus became famous localities for museum samples. Only few examples are given below: "Rädelerz" (twinned bournonite crystals) from Cavnic and Rodna, hessite from Boteş (the famous "botesite"), nagyagite from Săcarimb, semseyite from Herja, sylvanite from Baia de Arieş, perfect tetrahedrite crystals (up to 4 cm in size) from Cavnic, all occurrences of IIICc type. Some typical crystals of these celebrated minerals are given in Fig. 5.

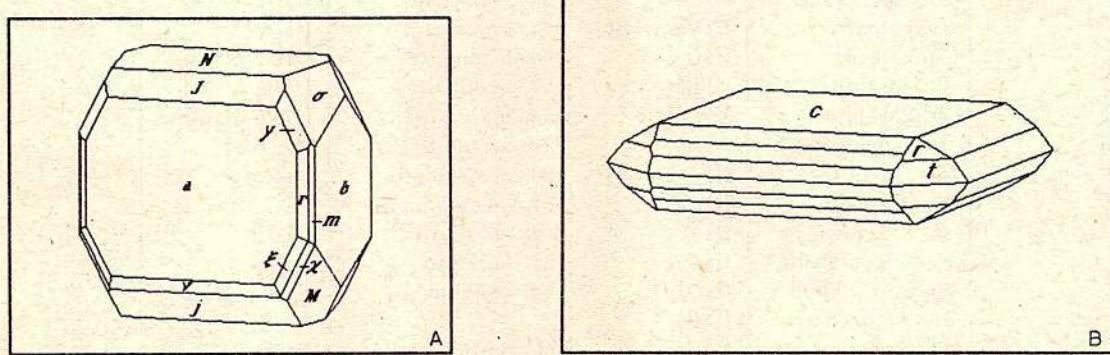


Fig. 5 - Crystals of sylvanite from Baia de Arieş (A) and of nagyagite from Săcarimb (B).

Most of the sulfide species are known in ore deposits or occurrences related to the $K_3\text{-}Pg_1$ or Neogene igneous activity; the 12 minerals first described in Romania were found in the following ore deposits:

- "allocrase" - Oravița (III**Bb**)
- andorite - Baia Sprie (III**Cc**)
- csiklovaite - Ciclova (III**Bb**)
- dognacskaite - Dogenecea (III**Bb**)
- fizelyite - Herja (III**Cc**)
- fülöppite - Dealu Crucii (III**Cc**)
- krennerite - Săcărîmb (III**Cc**)
- nagyagite - Săcărîmb (III**Cc**)
- petzite - Săcărîmb (III**Cc**)
- rezbanyite - Băița Bihor (III**Bb**)
- semseyite - Baia Sprie (III**Cc**)
- sylvanite - Săcărîmb (III**Cc**)

The ore deposit at Dogenecea, Banat (occurrence type III**Bb**) is quite famous as the richest in pyrite forms: about 200 among which 50 are more frequent. Very rich in forms are also the chalcopyrite crystals from Căvnici, the bournonite from Rodna, the hessite from Boteș, the miargyrite and the realgar from Baia Sprie etc.

Table 4
Sulfide minerals included in the TMR

Mineral sp.	Occ. type(s)	Mineral sp.	Occ. type(s)
1. alabandite	III Cc	35. fizelyite*	III Cc
2. algodonite	III Cc	36. freieslebenite	III Cc
3. "allocrase" (=alloclastic?)	III Bb	37. frieseite	III Cc
4. altaite	III Cc	38. fülöppite	III Cc
5. andorite*	III Cc	39. galena	III Bb , III Cc
6. argentite	III Cc	40. galenobismutite	VII Ac , II Aa
7. argentopyrite	III Cc	41. geocromite	III Cc
8. arsenopyrite	II Ba , III Cc	42. germanite (?)	III Cc
9. berthierite	III Cc	43. gersdorffite	I E
10. bismuthinite	III Bb	44. glaucodot	III Ce
11. bornite	III Bbe , III Bce	45. gratonite	III Cc
12. boulangerite	III Cc	46. greenockite	VI
13. bournonite	III Cc	47. hauerite	VII
14. bravoite	III Ab , III Ac	48. hessite	III Ce
15. calaverite	III Cc	49. huntilit (?)	III Cc
16. canfieldite	III Cc	50. jalpaite	III Cc
17. chalcocite	III Bb	51. jamesonite	III Cc
18. chalcopyrite	I Ab , III Bb	52. jordanite	III Cc
19. cinnabar	III Cc	53. joseite	III Bb
20. clauthalite	III Cc	54. kermesite	III Cc
21. cobaltite	III Ce , III Bb	55. krennerite*	III Cc
22. colusite	III Cc	56. loellingite	III Bb , III Cb
23. cosalite	III Bb	57. maldonite	III Bb
24. covellite	VI/III Bb	58. marcasite	III Bb , III Cc
25. csiklovaite*	III Bb	59. matildite (?)	III Cc
26. cubanite	III Ce	60. meneghinite	III Cc
27. diaphorite	III Cc	61. metacinnabar	III Cc
28. dyscrasite	III Cc	62. miargyrite	III Cc
29. dognacskaite*	III Bb	63. millerite	III Ad
30. domeykite	III Cc	64. molybdenite	III Bbe , III Bce ,
31. emplectite	III Bb		III Cf
32. empressite	III Cc	65. muthmannite*	III Cc
33. enargite	III Cc	66. nagyagite*	III Cc
34. eukairite	III Cc	67. nickeline	III Ac



Table 4 (continued)

68. orpiment	IIIBb, IIICc IVC	86. skutterudite**	IIIEc, IIIBb IDb
69. pearceite	IIICc	87. sperrylite	IA-Cb, IIIBb,
70. pentlandite	IDb, IIIAb-d	88. sphalerite	IIIB-C-D, VIIAc
	IIIICc	89. stannite	IIIICc
71. petzite*	IIIICc	90. stephanite	IIIICc
72. polybasite	IIIICc	91. sternbergite	IIIICe
73. proustite	IIIICc	92. stibnite	IIIICc
74. pyrargirite	IIIICc	93. stromeyerite	IIIIBb, IIICc
75. pyrite	IA-Cb, IIIB,C, VIIAc, XI	94. sylvanite*	IIIICc
76. pyrostilpnaite	IIIICc	95. tennantite	IIIICe, IIICc
77. pyrrhotite	IDb, IIIAb-d	96. tetradyomite	IIIIBb
78. rammelsbergite (?)	IIIAb	97. tetrahedrite	IBb, IAb, IIIBb, IIICc
79. realgar	IIIICb, c IVc	98. valleriite***	IDb
80. rezbanyite*	IIIBb	99. "voltzite"	IIIICc
81. safflorite	IIIEc	100. withneyite	IIIICc
82. samsonite (?)	IIIICc	101. wittichenite	IIIBb
83. schirmerite (')	IIIICc	102. wurtzite	IIIICc
84. seligmanite	IIIICc	103. xanthoconite	IIIICc
85. semseyte*	IIIICc	104. zinckenite	IIIICc

Note: Some species of doubtful validity have been described in various occurrences:

"argentopyrite" at Ruda Barza (occ. type IIICc) by Helke (1938) and Ramdohr (1960),

"grünlingite" in the ores of the Băița Bihor ore deposit (occ. type IIIBb) by Grassely (1948)

and Koch (1948), "warthaite" at Ocna de Fier (occ. type IIIBb) by Krenner (1925), all the papers quoted by Rădulescu, Dimitrescu (1966).

* Minerals first described in Romanian occurrences

** Described as smaltite

*** Mentioned also in IIICc occurrence type; however, in such ores there is no question of valleriite but of mackinawite; see discussion in Udubaşa (1976)

? Doubtful identification or occurrence type improbable

Post-TMR species. About 30 sulfide minerals, most of them rather rare species, were found in various occurrence types (Table 5). In the classical gold-silver telluride-bearing deposits in the Metaliferi Mts frohbergite, coloradoite, kostovite, weissite etc., have been identified in the last years. A new species of composition approaching SbTe₂ was also recently found in the telluride rich ores at Stanija (Ciolfica et al., this volume). Typically developed Bi-sulfosalts associations in ores related to the K₃-Pg₁ igneous activity become now much more enlarged by adding aikinite, cupropavonite, pekoite, krupkaite etc. A new Cu-Bi sulfotelluride having a composition near to but distinct from aleksite was discovered by Damian et al. (1988) in the ores at Jolotca - Ditrău. However, the structure of the mineral is still unknown and the name "jolotcaite" remains tentative (no approval by CNMMN/IMA yet).

The "chalcopyrrhotite" described by Udubaşa (1976) seems to represent in fact the naturally occurring *iss* known in the experimental studies of the Cu-Fe-S system. This isotropic compound occurs as quenched metastable phase within complex inclusions hosted by iron-rich sphalerite carrying also chalcopyrite, pyrrhotite, cubanite and mackinawite. An *iss*-like compound has been identified also in an ilvaite-bearing immiscible sulfide melt found as droplets in the Neogene pyroxene andesites in the Oaș Mts (Udubaşa, Segedi, Szakacs, in press).

The mineral greigite was found in many occurrences of various types.

New occurrences (Table 6). Alabandite at Iacobeni (Bălan, 1976) is the first occurrence of this mineral in stratabound deposit (occ. type I Bc); it occurs closely associated with pyrite within Mn-carbonates. Berthierite and molybdenite recently found in the Tibleş base metal ore deposits point to a zonal distribution of the ore mineral assemblages (Udubaşa et al., 1980. Udubaşa et al., 1984); the external, Sb-, Hg- and Ag-rich zone contains also Ag-sulfosalts such as freieslebenite and owyheeite (Pop et al., 1984). Popescu (1987) reports a



selenium-bearing cosalite at Bălan (occ. type IBb). Matildite at Dognecea and bravoite at Moldova Nouă (both of IIIBb occ. type) are recently found species (Udubaşa, Ilinca, in press). Another bravoite occurrence is that at Cioclovina, probably a shear-zone related mineralization rich in jamesonite and arsenopyrite (Udubaşa, Hărțopanu, 1992). At Musariu (occ. type III Cc) Berbeleac and David (1982) reported besides native tellurium nagyagite, sylvanite, empressite, petzite, frohbergite, weissite etc. An interesting telluride occurrence is also the one at Rodna (oc. type IICc), where Constantiniuc et al. (1987) described hessite and wehrlite as fine inclusions in iron-rich sphalerite.

Table 5
Sulfides: post-TMR species

Mineral sp.	Localities	Occ. type (s)	References
1. aikinite	Băița Bihor	IIIBb	Cioflica, Vlad (1973)
2. arsenosulvanite	Baia Borsă	IBb	Udubaşa(1979, unpubl.)
3. benjaminitie	Băiuț	IIICc	Stecaci et al. (1976, unpubl.)
4. bursaite	Băița Bihor	IIIBb	Cioflica, Vlad (1974)
5. chalcostibite	Herja	IIICc	Udubaşa, Gorduza (in prep.)
6. cobaltpentlandite	Vilsan	IIIAb	Udubaşa et al. (1988)
7. coloradoite	Săcărimb	IIICc	Ramdohr's coll. Heidelberg Univ.
8. cupropavonite	Stănița	IIICc	Popescu, Constantinescu (1986, unpubl.)
	Tincova	IIIBb	Cioflica et al. (1990)
9. famatinite*	Pîrîul lui Avram	IIICc	Socolescu et al. (1963)
10. frohbergite	Săcărimb	IIICc	Ramdohr, Udubaşa (1973)
11. greigitie	Gilort (alluvia)	VIII	Udubaşa, Arsenescu (1987)
	Jitia	VIIIAc	Udubaşa in Săndulescu et al. (1988)
	Cioclovina	IIBa	Udubaşa, Hărțopanu (in press)
12. hammarite	Băița Bihor	IIIBb	Mumme, Žak (1985)
13. heazlewoodite	Vadu Dobrii	IDb	Udubaşa (1967, unpubl.)
14. idaite	Sasca Montană	IIIBb	Constantinescu, Udubaşa (1982)
15. kobellite	Oravița	IIIBb	Constantinescu et al. (1988a)
16. kostovite**	Coranda-Hondol	IIICc	Udubaşa (1981, unpubl.)
17. krupkaite	Sasca Montană	IIIBb	Simon(in press)
18. lautite**	Turț	IIICc	Udubaşa(1979, unpubl.)
19. lillianite	Jolotca	IIICc	Damian et al. (in press)
20. luzonite*	Pîrîul lui Avram	IIICc	Socolescu et al. (1963)
21. mackinawite	Rodna	IIICc	Udubaşa (1976)
	Oravița	IIIBb	Ramdohr's coll., Heidelberg Univ.
22. maucherite	Bădeanca	IIBd	Popescu (1968)
23. montbrayite**	Musariu	IIICc	Berbeleac, David (1982)
24. owyheeite	Tibileș Mts	IIICc	Pop et al. (1984)
25. padéraite	Băița Bihor	IIBb	Mumme, Žak (1985)
26. parajamesonite*	Herja	IIICc	Zsivny, Naray-Szabo (1947)
27. pekoite	Băița Bihor	IIIBb	Mumme, Žak (1985)
28. plagionite	Cavnic	IIICc	Petrilian et al. (1976, unpubl.)
29. siegenite	Sasca Montană	IIIBb	Constantinescu, Udubaşa (1982)
30. tapalpite**	Cavnic	IIICc	Petrilian et al. (1976, unpubl.)
31. robinsonite	Săsar, Hondol	IIICc	Udubaşa (1981, unpubl.)
32. tochilinite	Vilsan	IIIAb	Udubaşa et al. (1988)
33. violarite	Vilsan	IIIAb	Udubaşa et al. (1988)
34. weissite	Musariu	IIICc	Berbeleac, David (1982)
"jolotcaite"	Jolotca	IIICa	Damian et al. (1986)

* Not included in the TMR

** Preliminary identification; more precise data are needed

Some Ni-minerals have been found either in skarn-related occurrences (maucherite, by Cioflica et al., 1982) or in some base metal ores (nickeline, rammelsbergite, millerite by Lupulescu, 1982) located within sheared zones of Precambrian metamorphics. Other new occurrences are: cubanite and stannite at Băița (Cioflica et al., 1971, 1974), tellurobismuthite and enargite at Oravița (Popescu, Constantinescu, 1977).



Less common assemblages. Stalactitic pyrite exhibiting a radiating texture and a very low $\delta^{34}\text{S}$ value (i.e. of -35‰) occurs at Băiuț (occ. type III Cc). Collomorph, copper-rich (1.2% Cu) "gelpyrite" was reported by Lazăr, Ottemann (1973) at Stănița (occ. type III Cc). Zoned, As-rich (up to 4% As) pyrite crystals are quite typical of the ores at Coranda-Hondol ore deposits (III Cc occ. type). Worth of mention are also the pyrrhotite concretions (up to 10-15 cm in size) within Liassic anthracite beds at Schela (Udubașa, 1984a). Moțiu et al. (1972) described curved and ring-shaped jamesonite crystals from the Baia Mare area. Greigite concretions up to 0.3 mm in size were found by Udubașa, Arsenescu, 1987 in alluvia – a quite unusual occurrence type for this mineral.

Table 6

Sulfides: new occurrences

Mineral sp.	Locities	Occ. type	References
1. alabandite	Iacobeni	II Ba	Bălan (1976)
2. berthierite	Tibileș Mts	III Cc	Udubașa et al. (1980a)
3. bismuthinite	Sasca Montană	III Bb	Superceanu (1969)
4. bournonite	Sasca Montană	III Bb	Superceanu (1969)
5. bravoite	Cioclovina	II Ba	Udubașa, Hărtopanu (in press)
	Moldova Nouă	III Bb	Udubașa, Ilinca (in press)
6. cosalite	Bălan	II Bb	Popescu (1987)
7. cubanite	Sasca Montană	III Bb	Superceanu (1969)
	Băița Bihor	III Bb	Cioflică et al. (1974)
	Oravița	III Bb	Popescu, Constantinescu (1977)
8. enargite	Oravița	III Bb	Popescu, Constantinescu (1977)
9. frohbergite	Musariu	III Cc	Berbeleac, David (1982)
10. hessite	Rodna	III Cc	Constantiniuc et al. (1987)
11. jamesonite	Dogenecea	III Bb	Ramdohr's coll., Heidelberg Univ.
	Sasca Montană	III Bb	Constantinescu (1977)
	Cioclovina	II Ba	Udubașa, Hărtopanu (in press)
12. kermesite	Tibileș Mts	III Cc	Udubașa et al. (1984)
13. linnaeite	Sasca Montană	III Bb	Superceanu (1969)
14. matildite	Dogenecea	III Bb	Udubașa, Ilinca (in prep.)
15. maucherite	Băița Bihor	III Bb	Cioflică et al. (1982)
	East Făgăraș Mts	III Ce (?II Ca)	Lupulescu (1982)
16. molybdenite	Tibileș Mts	III Cc	Udubașa et al. (1982)
17. nickeline	East Făgăraș Mts	III Ce	Lupulescu (1982)
18. pekoite	Tincova	III Bb	Cioflică et al. (1990)
	Sasca Montană	III Bb	Simon (in press)
19. petzite	Baia de Arieș	III Cc	Ramdohr's coll., Heidelberg Univ.
20. pyrargirite	Rodna	III Cc	Ramdohr's coll., Heidelberg Univ.
21. pyrite			
- Cu-rich (1.2%)	Stănița	III Cc	Lazăr, Ottemann (1973)
- zoned, As-rich	Coranda-Hondol	III Cc	Udubașa et al. (1982b)
- stalactites	Băiuț	III Cc	Udubașa (1978, unpubl.)
- frambooidal	Tibileș	VII Ah	Udubașa (1977, unpubl., 1984a)
	Coranda-Hondol		
22. pyrrhotite	Schela	VII Ag	Udubașa (1984a)
(concretions)			
23. rammelsbergite	East Făgăraș Mts	III Ce	Lupulescu (1982)
24. stannite	Băița Bihor	III Bb	Cioflică et al. (1974)
25. stromeyerite	Dogenecea	III Bb	Ramdohr's coll., Heidelberg Univ.
26. tellurobismuthite	Oravița	III Bb	Popescu, Constantinescu (1972)
27. valleriite	Tibileș Mts	III Bc	Udubașa et al. (1982a)
	Vîlsan	III Ab	Udubașa et al. (1988)
28. wehrilit	Rodna	III Cc	Constantinescu et al. (1987)
29. "intermediate product" of pyrrhotite alteration	many	many types	Udubașa (in prep.)



Ramdohr collection of polished sections at the Mineralogisch-Petrographisches Institut, Heidelberg University, Germany contains descriptions of some minerals not included or mentioned in any published papers. The collection has been examined by the senior author of this paper during his fellowship by A.v. Humboldt Foundation (1970-1972). The minerals reported are: coloradoite from Săcărîmb (section no 10 777), jamesonite from Dognecea (no 3 690), mackinawite from Oravița (no 4 555), petzite from Baia de Arieș (no 11 654), pyrargirite from Rodna (no 6 892), stromeyerite from Dognecea (no 1 466a).

III. Halides

Short comments on the previously described species. Romania is a land very rich in evaporites due to its rock salt deposits of large size (e.g. Slănic Prahova, Ocnele Mari, Cacica etc.), but with only a few deposits of K-Na-Mg evaporites (i.e. those at Tg. Ocna, Tazlău etc.). The number of the identified halide minerals is small (Table 7).

Table 7
Halide minerals included in the TMR

Mineral sp.	Occ. type (s)
1. carnallite	VIIAa
2. fluorite	IIICb, IIICc
3. halite	VIIAa
4. chlorargyrite*	VI
5. sylvite	VIIAa

* Ackner, without later confirmation (see TMR)

Post-TMR species. No data.

New occurrences. Halite and sylvite within fluid inclusions in quartz and calcite were reported by Pomârleanu, Pomârleanu (1982) and Pomârleanu, Întorsureanu (1985) from Tîbles (occ. type IIIBc) and Lăpușnicu Mare (occ. type IIIBe), respectively. Some evaporitic deposits of Permo-Triassic age of the Moesian Platform (Brana, 1967) and certain Aquitanian or Badenian sedimentary rocks (Stoica, Gherasie, 1981) represent new loci of abundant halite concentration. The last ones contain also sylvite and carnallite.

Fluorite has been found in numerous and rather different environments, such as the matrix of a tectonic breccia in the Leaota Mts (Gurău, 1984), late deposition within skarns K₃-Pg₁ age (Ocna de Fier; Pavelescu, Kissling, 1971, Julești-Valea Fagului; Udubașa et al., 1980a) or of Neogene age (Tîbles, Udubașa et al., 1982a), vein fillings at Tarna Mare (Jude, 1986), Herja (Kissling, Szöke, 1971) and in the Harghita Mts (Tănăsescu, 1978), all of them related to the Neogene igneous activity.

IV. Oxides and hydroxides

Short comments on the previously described species. Among the minerals included in Table 8 special mention deserve the two species first described in Romania, i.e. pseudobrookite (in a highly oxidized pyroxene andesite of Neogene age, at Uroi, Metaliferi Mts) and tellurite (in telluride-bearing ores, at Săcărîmb, occ. type IIICc). Worth of highlighting is also the blue chalcedony from Trestia, Maramureș, forming cubic crystals the nature of which has been long time disputed. Pseudomorphs of magnetite after hematite and/or skarn garnets and of hematite after magnetite at Ocna de Fier (occ. type IIIBb) represent favourite museum samples. The well known "Maramureș/Marmorosch diamonds" (i.e. water-clear quartz "bipyramids") were found in Cretaceous sandstones as fissure fillings of diagenetic nature (the Flysch Zone of Northern Romania).

Wad and psilomelane, poorly defined manganese oxides, were described in many occurrences. The brostenite of Poni (1900) has been thoroughly studied by Bălan (1976) who suggested that this variety of wad was not a mixture but a mineral of varying composition.

Post-TMR species. Many of the recently described species are manganese oxides (Table 9). However, worth emphasizing is the discovery of geikielite in some ultrabasic rocks hosted by metamorphic in the Parâng Mts



(Udubaşa, Săbău, in prep.), in shear zone related sulfide occurrences in the Căpăţina Mts (Udubaşa et al., 1988, unpubl.) as well as in the ultrabasic granulites at Foltea, Cibin Mts (Udubaşa, unpubl.). Maghemite has proved to be a typical phase of the lava flows, formed at the expense of the primary magnetite in andesites (Udubaşa, 1984b). Interesting are also the Nb- and Ta-oxides in the Ditrău alkaline massif of Jurassic age in the Eastern Carpathians (Anastasiu, Constantinescu, 1984) and the identification of the rare minerals birnessite (Bălan, 1976), manjirite and todorokite (Ghergari et al., 1986), hetaerolite (Udubaşa et al., 1973), gahnite (Bălan, 1981) etc. A ferroan spinel (pleonaste) has been found by Ionescu et al. (1971) in the magnesian skarns at Băişoara.

Table 8
Oxide minerals included in the TMR

Mineral sp.	Main occ. type (s)	Mineral sp.	Main occ. type (s)
1. anatase	V Aa-c	23. ilsemannite	VI
2. arsenolite	VI	24. jacobsite	VI
3. baddeleyite	I E, VIII	25. lepidocrocite	VI, VII
4. bismite	VI	26. magnetite	I Bd, III Aa
5. brookite	VIII		III Bb, VIII
6. brucite	III Bb	27. manganite	VI
7. cassiterite	I Bb	28. massicot**	VI
8. chromite	III Ab-c	29. minium	VI
9. columbite	I E	30. opal	III D
10. coronadite	VI	31. periclase	III Bad
11. corundum	III Bab, d; V Cc	32. pseudobrookite*	V Ac (Uroiu/Deva)
12. cryptomelane**	VI	33. pyrochlore	V Ab
13. cuprite	VI	34. pyrolusite	VI
14. diaspore	VII Bb	35. quartz	I Abh, III Cbc
15. fergusonite**	VIII	36. quartz, var. chalcedony	IV Aab
16. franklinite	III Bb	37. rutile	I Aa
17. goethite	VI, VII	38. spinel	III Bd
18. hausmannite	VI	39. stibiconite	VI
19. hematite	III Bb, III Cc, III D	40. tantalite	I E
20. hercynite**	V Ac	41. tellurite*	VI/III Cc (Săcărîmb)
21. hydrogoethite	VI, VII	42. tridymite	V ACbc
22. ilmenite	I ABa, III Aa, VIII	43. tungstite	III Bb

* Minerals first described in Romania

** Poorly defined minerals

New occurrences. The most significant data are included in Table 10. Silica polymorphs (cristobalite and tridymite) exhibit a great variety of occurrence types and they are much more abundant than previously thought. Similarly, hausmannite has been proved to be an ubiquitous species, closely associated with manganese magnetite in many metamorphosed ores (Udubaşa, Hărtopanu, 1987, unpubl.). Savu (1970) found rutile megablasts in kyanite-, staurolite- and almandine-bearing metamorphics of the Semenic Mts; the rutile is substituted by iron-bearing rutile in the migmatic gneisses and by ilmenite or ilmenite solid solution in quartz veins cutting the micaschists. Relatively large rutile crystals (up to 4 cm in size), sometimes exhibiting geniculate twins, have been identified in quartz lenses hosted by garnet micaschists in the Rodna Mts (Udubaşa, 1979, unpubl.). Later on, Strusievicz, Strusievicz (1985) described large rutile crystals (up to 8 cm in size) in andalusite- and gahnite-bearing pegmatites (Strusievicz et al., 1987). Rutile as endproduct of the primary oxide minerals transformation during increasing alteration grade of various types of magmatic rocks and as a typical mineral of some quartz-gold veins been described by Udubaşa (1982). Intergrowths of rutile+anatase appeared in some metamorphics of the East Carpathians are interpreted by Nedelcu (1986) as a result of ilmenite transformation under conditions of increasing sulfur fugacity, using an empirical phase diagram of titanium minerals proposed by Udubaşa (1982) (Fig. 6). Hărtopanu, Hărtopanu (1978) found pyrophanite in the manganese-bearing rocks from the Sebeş Mts.

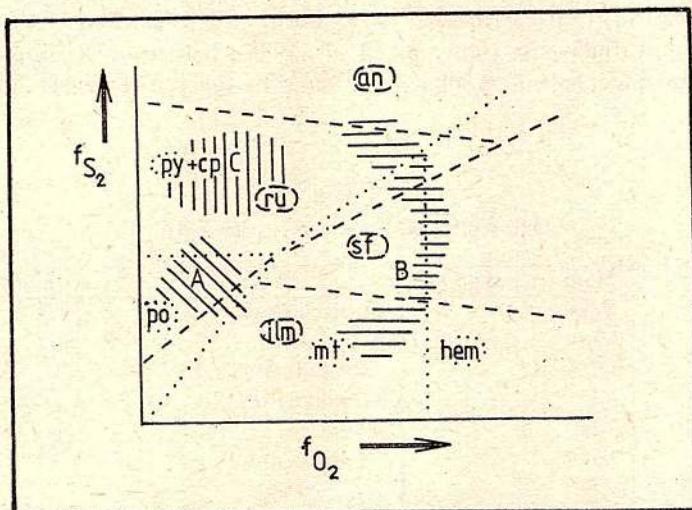


Fig. 6 - An empirical diagram showing the deduced stability fields of titanium minerals as compared to the calculated stability fields of iron minerals. Based on microscopic observation (after Udubaşa, 1982).

Table 9
Oxides and hydroxides: post TMR species

Mineral species	Localities	Occ. type	References
1. birnessite	Iacobeni	IBc	Bălan (1976)
2. bixbyite	Lotru Mts	IAc	Bălan, David (1978)
3. brannerite	Ruschiţa	IAdg	Tiepac, Anastase (1970)
4. cesarolite	Rodna	VI	Udubaşa et al. (1973)
5. cristobalite	Cavnic	III Ccd	Ionescu, Anton (1969)
6. gahnite	North Moldavia	VIII	Bălan (1981)
7. geikielite	Părîng Mts	IDb	Udubaşa, Săbău (1981, unpubl.)
8. groutite	Sebeş Mts	IAc	Hărtopanu, Hărtopanu (1978)
9. hetaerolite	Rodna	VI/IIICc	Udubaşa et al. (1973)
10. loparite	Ditrău	III Ca	Anastasiu, Constantinescu (1984)
11. maghemite	Baia Mare	VAc	Udubaşa (1984b)
12. niobite	Ditrău	III Ca	Anastasiu, Constantinescu (1984)
13. nsutite	Iacobeni	VI/IBc	Bălan (1976)
14. manjiröite	Ocna de Fier	III Bbg	Ghergari et al. (1986)
15. pyrophanite	Iacobeni	IBc	Bălan (1976)
16. todorokite	Ocna de Fier	III Bbg	Ghergari et al. (1986)
17. ulvöspinel*	Căzăneşti	III Aa	Ciofica (1962)
18. vredenburgite	Sebeş Mts	IAc	Hărtopanu P. (1988, unpubl.)
19. zincite	Băiţa Bihor	VI/IIIBb	Stoici (1974)

* Not reported in the TMR

Less common assemblages. Brookite and anatase of hydrothermal origin were reported by Constantinescu (1977) at Sasca Montană (occ. type IIIBb) and rutile of the same origin was described by Udubaşa (1978) in gold-bearing veins at Barza-Carpen, Metaliferi Mts (occ. type III Cc). Codarcea, Alexandrescu (1986) identified baddeleyite in some tuffaceous rocks and diatomites in the East Carpathians flysch zone. New data on the very old occurrence of blue chalcedony at Trestia, Maramureş were given by Moişiu, Ghiurcă (1979) and Ilinca (1989), with special reference to its colour, crystal form and genesis. Less common is also the mode

of presentation of todorokite and manjiroite at Ocna de Fier (Ghergari et al., 1986) as well as the presence of geikielite within ores rich in pyrrhotite, chalcopyrite and graphite in the Căpățina Mts (Udubașa et al., 1988, unpubl.) apparently related to a shear zone in Precambrian metamorphics. Cristobalite lepispheres have been recently found in altered volcanic rocks of the Călimani Mts (Seghedi et al., 1988, unpubl.). Some data on V-bearing Mg-columbite ("toddite") at Conțu, Lotru Mts (occ. type IE) were presented by Săbău et al. (1989). Secondary magnetite appeared by decomposition of pyrrhotite seems to be rather common in some

Table 10
Oxides and hydroxides: new occurrences

Mineral sp.	Localities	Occ. type	References
brucite	Băița Bihor	III Bb	Stoicovici, Stoici (1969)
	Moldova Nouă	III Bb	Gherasi (1969)
	Sasca Montană	III Bb	Gheorghită (1969)
	Julești-V. Fagului	III Bb	Constantinescu (1971)
	Budureasa	III Bb	Udubașa et al. (1980a)
cassiterite	Iara, Apuseni Mts	III Ba	Ionescu (1987)
	Fundu Moldovei,	IBb	Giușcă, Mârza (1976)
	Leșu Ursului		Kräutner (1966)
	Bălan	IBb	Petrulian et al. (1971)
	Altin Tepe	IAb	Mureșan (1969)
corundum	Conțu, Lotru Mts	IE	Săbău et al. (1989)
	Highiș Mts	III Bh	Tatu (1989, unpubl.)
	Julești-V. Fagului*	III Bbd	Udubașa et al. (1980a)
	Bătarci, Oaș Mts	III Ccd	Jude (1971)
	Călimani caldera	III Ccd	Stanciu, Medeșan (1971)
cristobalite	Orașu Nou	IV Ba	Giușcă et al. (1973)
	Gurasada	IV Bd	Crăciun (1975)
	Detunata, Racoș	V Cc	Măldărescu (1978); Măldărescu et al. (1982)
	Tălagiu	III Ccd	Ianovici et al. (1984)
	Codru Moma Mts	VCa	Stan (1983)
gahnite	Plopiș Mts	IE	Strusievicz et al. (1987)
	Sebeș Mts, Semenic Mts	IAc	Pavelescu, Pavelescu (1980)
hausmannite	Răzoare	IAc	Hărțopanu, Udubașa (1988, unpubl.)
	Sebeș Mts, Semenic Mts	IAc	Pavelescu, Pavelescu (1980)
jacobsite	Herja, Tibleș**	III Cc	Udubașa (1986b)
	Bihor Mts	III Bb	Manea (1983)
magnetite	Sebeș Mts	IAc	Hărțopanu, Hărțopanu (1978)
	Rodna Mts	IAa(?) II Aa	Udubașa (1974, unpubl.)
periclase	Plopiș Mts	IE	Strusievicz, Strusievicz (1985)
	Tibleș Mts	III Bcd	Kovacs et al. (1985)
pyrophanite	Semenic Mts		Savu (1970)
	Moldova Nouă	III Bb	Gheorghită (1969)
rutile	Muncelu	VCc	Mârza, Egri (1971)
	Julești-V. Fagului	III Bb	Udubașa et al. (1980a)
spinel	Dolhasca	VIII	Bălan (1981)
	Mașca Băisoara	III Bb	Lazăr, Întorsureanu (1982)
	Călimani	III Cc	Balintoni (1970)
	Tămășeni, Oaș Mts	V	Jude (1971)
	Muncelu	VCc	Mârza, Egri (1971)
	Huta-Certeze***	VII	Mârza, Ghiurcă (1981)
	Orașu Nou	IV B	Giușcă et al. (1973)
	Racoșu de Jos	VCc	Măldărescu et al. (1982)

* hornfelsized bauxite xenoliths in K₃-Pg₁ rhyodacites

** secondary magnetite formed by pyrrhotite decomposition

*** siderite-bearing chert



vein ores (Udubaşa, 1986b). Magnetite crystals lining fissures or forming disseminations in slightly altered monzodiorites or granodiorites of Neogene age in the Tibleş Mts seem to point to the presence of a hidden porphyry copper system (Udubaşa, 1977, unpubl.).

V. Nitrates

Only niter was mentioned in very old papers without later confirmation.

VI. Carbonates

Short comments on previously described species. Among the minerals shown in Table 11 the most interesting are the following: calcite (forming big crystals, very pure and rich in forms, located mainly in Mesozoic limestones), cerussite (crystals very rich in forms) and rhodochrosite (first described in Romania, at Cavnic, occ. type III_{Cc}).

Table 11
Carbonates included in the TMR

Mineral sp.	Main occ. type (s)	Mineral sp.	Main occ. type (s)
1. ankerite	I _{Bd}	10. leadhillite	VI/III _{Bb}
2. aragonite	XII _a	11. magnesite	IV _{Ac}
3. aurichalcite	III _{Bb}	12. malachite	VI/III _{Bb}
4. azurite	VI/III _{Bb}	13. parisite**	V _{Ba}
5. bismutite**	III _{Bb}	14. rhodochrosite*	III _{Cc} (Cavnic)
6. calcite	VII _{Bi} , XII, III _C	15. siderite	I _{Bd} , III _{Cc}
7. cerussite	VI/III _{Bb} , III _{Cc}	16. smithsonite	VI/III _{Bb}
8. dolomite	I _{Ba} , III _{Bbc/g}	17. natron**	VII
9. hydromagnesite	IV _{Ac}	18. witherite	III _{Eb}

* Mineral first described in Romania

** Poorly defined species (mainly in old papers only)

The "aragonite" from Corund (occ. type XII) has been proved to consist mainly of calcite forming collo-morph aggregates worked out for decoration objects. The cerussite at Băița Bihor (occ. type III_{Bb}) occurred in crystals very rich in forms (about 20) and frequently twinned. Big calcite crystals (up to 20 cm in size) are known from Intregalde and Cheia (occ. type VII_{Bi}), thoroughly studied by Popescu (1958). The most beautiful rhodochrosite samples originate in the veins from Capnic, Baia Mare area. Malachite needle-like crystals from Moldova Nouă, Dognecea and Ocna de Fier represent also well known museum samples. Manganese-bearing calcite (manganocalcite) has been described in many occurrences of type III_{Bb} and III_{Cc}.

Post-TMR species. There are few novelties but the new species include rather rare carbonates found in various environments (Table 12).

Although the strontium-bearing occurrences at Copăceni and Valea Sării have been known since long ago, the strontianite was mentioned much later without precise optical or other properties; these occurrences are celestite-dominated.

New occurrences. Artinite has also been recently found in Paleozoic serpentinites from Banat (Strusievicz, in press). At Budureasa (occ. type III_{Bb}) Ianovici et al. (1982) reported hydromagnesite. Calcium- and magnesium-bearing rhodochrosites are known from Iacobeni (Bălan, 1976), a Lower Paleozoic stratiform manganese deposit. Kutnohorite was reported by Lazăr, Anastase (1983) at Baia de Arieș; witherite was identified at Somova by Giușcă (1967) and at Hăldița-Broșteni by Vodă, Vodă (1982). Some supergene carbonates have new occurrences now: smithsonite in the base metal ores in the Rușasca Valley, East Făgăraș Mts (Ilinca, 1987, unpubl.), cerussite at Tibleş (Bedelean, 1987, unpubl.) and aurichalcite at Sasca Montană (Constantinescu, 1980). The calcite from Vărad-Moldova Nouă (occ. type III_{Bb}) was studied by Mares et al. (1970); the calcite crystals (up to 1.5 cm in size) have complex forms, are frequently zoned (with limpid nuclei) and possess coatings of fine crystalline aggregates of marcasite.

Less common assemblages. Black and white "kanonenspat"-calcite crystals containing jamesonite needles were described by Udubaşa, Gorduza (1980) at Dealu Crucii (occ. type III_{Cc}), Baia Mare area. Highlighted must be the nearly perfect spheres of black, white or black/white calcite from Herja; they consist of fine



Tabel 12
Carbonates: post-TMR species

Mineral sp.	Localities	Occ. type (s)	References
1. artinite	Carasu Valley, Dobrogea	IX	Găță et al. (1968)
2. bastnăsite	Ditrău	III Ca	Anastasiu, Constantinescu (1984)
3. huntite	Pietroasa, Bihor	X	Diaconu et al. (1977)
4. kutnohorite	Iacobeni	IBc	Bălan (1972)
5. strontianite	Copăceni/Turda	VII Aa	Brana, Gridan (1979), Brana et al. (1986)
	Valea Sării/Focșani	VII Ac	Brana, Gridan (1979), Brana et al. (1986)
6. vaterite	Cloșani Cave	X	Diaconu (1988)
7. zaratite	Tișovița, Banat	III Ac	Moțiu (1971)

flattened rhombohedrons of calcite disposed "en échelon"; the black spheres or their black parts contain also jamesonite needles. The biggest calcite spheres come from Ierja; they reach 7-8 cm in diameter (museum samples, Baia Mare). Such black calcite aggregates were recognized at Hărțăgani, Metaliferi Mts and Stînceni, Călimani Mts, too. According to the crystallographic diagram presented in Fig. 7 the "Kanonspat"-crystals formed at relatively low temperatures.

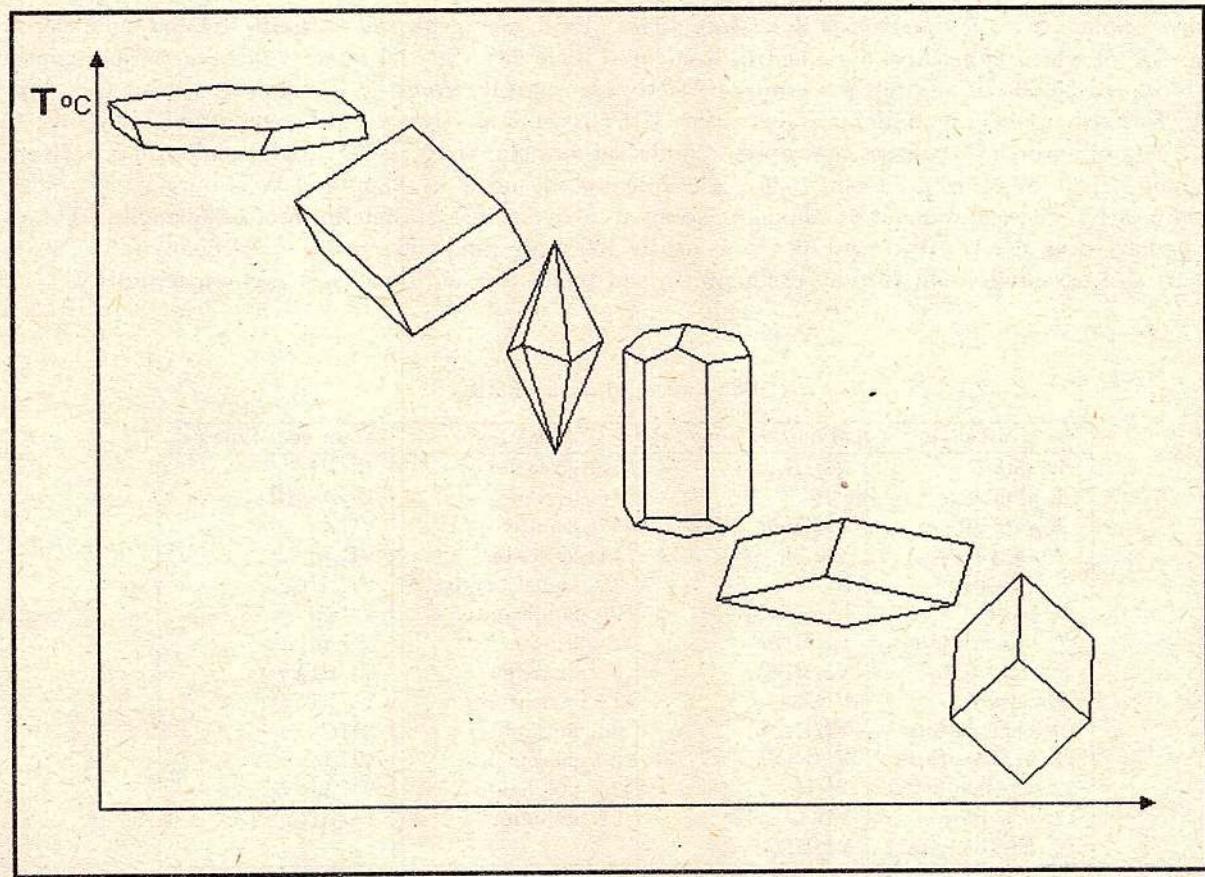


Fig. 7 – Habit dependence of calcite crystals on temperature and P_{CO_2} (from : Udubaşa, Gorduza, 1980).

VII. Borates

Short comments on the previously described species. Only three borates are known (Table 13) all of them first described in Romanian occurrences.

Table 13
Borate minerals included in the TMR

Mineral sp.	Main occ. type (s)	Localities
1. kotoite	III Bb	Băița Bihor; Korea
2. ludwigite	III Bb	Ocna de Fier
3. szaibelyite	III Bb	Băița Bihor

Post TMR species. Fluorborite was described by Gherasi (1969) and suanite by Aleksandrov (1982) at Băița Bihor.

New occurrences. Ludwigite at Moldova Nouă (Gheorghita, 1969), Băița Bihor and Pietroasa (Stoicovici, Stoici, 1969) and at Băișoara (Ionescu et al., 1971) as well as szaibelyite at Băișoara (Ionescu et al., 1971) are the few novelties regarding this class. All the occurrences are of type III**Bb**. Szaibelyite was also mentioned by Giușcă, Mărza (1976) within the skarn occurrence at Iara, Apuseni Mts (occ. type III**Ba**).

VIII. Sulfates

Short comments on the previously described species. Both supergene and evaporite-related sulfates were known, five of which being first described in Romania (Table 14). Special interest deserve the big gypsum crystals (up to 50-60 cm in size), sometimes perfectly transparent, from the Cavnic ore deposit (occ. type III**Cc**). Klebelsbergite from Baia Sprie (occ. type III**Cc**) occurs mostly as coatings on stibnite crystals; the basic sulfate of antimony possesses now a well established formula, $Sb_3^{3+}O_4(OH)_2(SO_4)$ and structure (Nakai, Appelmann, 1980; Menchetti, Sabelli, 1980). The recent study made by Papp and Weiszburg (1989) showed that the nearby identical mineral basaluminite seems to be a microcrystalline form of felsöbanyite. The two minerals have been described as new species at nearly 100 years time difference (i.e. felsöbanyite in 1853 by Kenngott and basaluminite in 1950 by Hollingworth and Bannister) and thus felsöbanyite has priority.

Table 14
Sulfates included in the TMR

Mineral sp.	Main occ. type (s)	Mineral sp.	Main occ. type (s)
1. alunite	VI/III Cc	15. goslarite	VI/III Bb
2. alunogen	VIa	16. gypsum	VIIAa, III Cc
3. anglesite	VI/III Bb , III Cc	17. kainite	VIIAa
4. anhydrite	VIIAa, III Cc	18. kieserite	VIIAa
5. ardealite*	X	19. klebelsbergite**	VI/III Cc
6. barite	Ia, III Cc	20. langbeinite	VIIAa
7. brochantite	VI/III Bb	21. leonite	VIIAa
8. caledonite	VI/III Bb	22. linarite	VI/III Bb
9. celestite	VIIAa	23. melanterite	VI/III Cc
10. chalcanthite	VI/III Bb	24. mirabilite	XI C
11. cyanotrichite	VI/III Bb	25. picromerite	VIIAa
12. dietrichite**	XI b	26. polyhalite	VIIAa
13. epsomite	VIIAa, XIIc	27. szmkite**	VI/III Cc
14. felsöbanyite**	VI/III Cc		

Minerals first described in Romania at Cioclovina (*) and Baia Sprie (**).

The sedimentary barite at Copăceni exhibits nice crystals rich in forms, forming three crystal types (Imreh, Imreh, 1963). In the hydrothermal veins of the Baia Mare mining district there are beautiful crystals (up to 10 cm in size) showing different colour shades such as red or reddish at Baia Sprie, blue or yellow at Cavnic etc.



Tatu (1989) presents newer data on some supergene sulfates including szmikite, a mineral first described as mineral species at Baia Sprie. The ardealite has recently been subject to a thorough investigation by Constantinescu et al.(1985, unpubl.).

Some varieties of sulfates were also described in the past but they are poorly defined and now are known only as synonyms, e.g. "zinkfauserite" at Baia Sprie, the "pisanite", a cuprian melanterite, at Deva (occ. type XIIIB), the "bosjemanite", a manganese-bearing pickeringite; the last one forms fine coating on metamorphic rocks or on Neogene andesites in the Eastern Carpathians.

Post-TMR species. (Table 15) It is worth mentioning that the mineral monsmedite is a new species of unusual composition, i.e. a K-Tl bearing sulfate (included in the "Glossary" of Fleischer, 1983). The composition needs confirmation and the structure must be solved; the study of the type material is now in progress. (Preliminary determinations by prof. J. Zemann, Wien highlight a structure very similar to that of voltaite).

Table 15
Sulfates: post-TMR species

Mineral species	Localities	Occurrence type	References
1. bassanite	Izv. Tuaușoarei, Rodna	VIIa	Jude (1972)
2. bloedite	Cucuietă	X	Papacostea (1977, unpubl.)
3. aphthitalite (glaserite)	Tazlău	VIIAa	Stoica, Gherasie (1981)
4. görgeyite	Praid	VIIAa	Mățza et al. (1988, unpubl.)
5. goslarite	Băița-Nistru	VI/IICc	Manilici (1988)
6. halotrichite	Borzaș-Baia Mare	VI/IICc	Tatu (1989)
7. hexahydrite	Tazlău	VIIAa	Rădan et al. (1982, unpubl.)
8. jarosite	Tarna Mare	VI/IICc	Jude (1986)
9. mallardite	Băița-Nistru	VI/IICc	Manilici (1988)
10. monsmedite*	Baia Sprie	VI/IICc	Götz et al. (1968)
11. pickeringite	Băile Herculane	X	Diaconu, Medeșan (1973)
12. plumbojarosite	Coranda-Hondol	VI/IICc	Udubașa (1984, unpubl.)
13. rozenite	Iacobeni	VI/IBc	Bălan (1976)
14. szomolnokite	Iacobeni	VI/IBc	Bălan (1976)

* Mineral first described in Romania (see the text)

Plumbojarosite at Coranda-Hondol is closely associated with supergene galena (fine coatings on the remnants of primary sulfides) and a fine-grained white mica (Udubașa, in prep.).

New occurrences. There are many data concerning sulfates in the Lower Miocene evaporite deposits; Stoica, Gherasie (1981) report many new occurrences of kainite, kieserite, epsomite, bloedite, langbeinite, picromerite, mirabilite, polyhalite. (Table 16).

Table 16
Sulfates: new occurrences

Mineral sp.	Localities	Occ. type	References
alunite	Cavnic	III Ccd	Anton (1970)
	Voia	III Ccd	Berbeleac (1970)
	Stolna-Hășdate	VIIb	Tătărim, Mares (1971)
	Negrești-Oaș	III Ccd	Kovacs et al. (1977)
	Tălagiu	III Ccd	Ianovici et al. (1984)
	Turț	III Ccd	Jude (1986)
anhydrite	Moldova Nouă	III Bbc	Gheorghită (1969)
	Gurghiu Mts	IV Ab	Tănărescu (1971)
	Voia	III Bce	Berbeleac (1985)
	Băița Bihor	III bb	Cioflca et al. (1974)
	Holdița-Broșteni	IBd	Vodă, Vodă (1982)



Table 16 (continued)

barite	Holdița-Broșteni	IBd	Vodă, Vodă (1982)
chalcanthite	Jitia	VIIAc	Cioflică et al. (1986)
jarosite	Somova	IIIEc	Giușcă (1967)
mirabilite	Somova	IIIEc	Giușcă (1967)
pickeringite	Vărbilău	VIId	Cehlarov et al. (1987)
	Izv. Tăușoare, Rodna	X	Moțiu et al. (1977)
	Borzaș-Baia Mare	VI/IIICc; XIIb/IIICc	Tatu (1989)
rozenite	Borzaș-Baia Mare	VI/IIICc; XIIb/IIICc	Tatu (1989)
szmkite	Borzaș-Baia Mare	VI/IIICc; XIIb/IIICc	Tatu (1989)
zincocopiatite	Băișoara	VI/IIIBb; XIIb/IIIBb	Tatu (1989)

VIII A. Chromates-Molybdates-Wolframates

Short comments on the previously described species. There are only four pre-TMR species (Table 17); the most complete data are those regarding the scheelite from Oravița (occ. type IIIBb) and the wolframite (Fe:Mn ratio about 2:1) from Baia Sprie (occ. type IIICc). The wolframite prismatic crystals may reach remarkable lengths (up to 20 cm) and some of them are rich in forms.

Table 17
Minerals included in the TMR

Mineral sp.	Main occ. type (s)
1. crocoite	VI/IIICe, IIIBb
2. scheelite	IIIBb, IIICc
3. wolframite	IIICc, IIIBb
4. wulfenite	VI/IIICe, IIIBb

Post-TMR species. Some older references concerning the presence of huebnerite at Băișoara (Superceanu, 1957, quoted in the TMR) have not been revalidated.

New occurrences. Reliable data are given by Vlad et al. (1984) on the scheelite at Mraconia (occ. type IIIBa) and by Bălan (1976) concerning the huebnerite at Iacobeni.

IX. Phosphates. Arsenates. Vanadates

Short comments on the previously described species. There are quite many species (Table 18) reported mostly in older references; some of them have not been refound, including the two species first described in Romania.

More data exist on vivianite, especially from Mușca, Metaliferi Mts (occ. type IIICc), where crystals up to 3 long were found; crystals rich in forms, sometimes bent. The vivianite from Rodna has been thoroughly studied by Ulrich (1925) who discovered also some new faces for this mineral, i.e. $\mu(102)$ and $\psi(183)$.

"Ehlite" from Moldova Nouă (TMR) is now considered as a synonym of pseudomalachite. The problem of "sterrettite" from Moldova Nouă is amazing: previously taken as cadmium silicate by Schrauf in 1879, later on shown to be an erroneous identification and redefined as a hydrous basic aluminium phosphate (see Embrey, Fuller, 1980), the name sterrettite disappeared from the new mineralogy books and was substituted by the name "kolbeckite", a hydrated scandium phosphate (Ramdohr, Strunz, 1978; Fleischer, 1983). Strunz (1957) gave for the kolbeckite a much more complicated formula, i.e. $(AlCaFe)Be_2[(P, Si)O_4]_2 \cdot 6H_2O$.



Table 18
Minerals included in TMR

Mineral sp.	Main occ. type(s)	Mineral sp.	Main occ. type(s)
1. annabergite	VIA	13. montebrasite	IE
2. apatite (group)	IE	14. phamacosiderite	VI/IAbd
3. brushite	X	15. pitticite	VI/IIBd, IIICc
4. chalcophyllite	VI/IIIBb	16. plumbogummite	VI/IIICc
5. carbonate-hydroxylapatite**	VIA***	17. pseudomalachite	VI/IIIBb
6. diadochite	VI/IIICc	18. pyromorphite	VI/IIIBb
7. erythrite	VI/III Eb, IIIBb	19. scorodite	VI/IIICc
8. evansite ?	VI/IIICc	20. symplesite	VI/IIICc
9. haidingerite	VI/IIICc	21. tyrolite	VI/IIIBb, IIICc
10. hoernesite*	IIIBb (Oravița)	22. veszelyite*	IIIBb (Ocna de Fier)
11. libethenite	IIIBb	23. vivianite	IIIBb, IIICc, VIIAd
12. monazite	IIICa, VIII	24. wavellite	VI/IIICc
		25. xenotime	IIICa

* Minerals first described in Romania occurrences

** Described under the old name dahllite

*** Phosphorite concretions formed on metamorphic limestones

Post-TMR species. It is a matter of phosphates and some arsenates; no vanadates are known in Romania so far. Most interesting is the pegmatite occurrence at Conțu, Cibin Mts (Table 19), where Săbău et al. (1989) describe such rare species as tavorite and huréaulite. Krautite is a new species, discovered by French mineralogists (Fontan et al., 1975) in the museum samples from Săcărîmb, Metaliferi Mts (occ. type VI/IIICc). Crandallite occurs in a very rich mineral assemblage within the deposits of the Cioclovina cave (Constantinescu et al., 1985, unpubl.). A manganoan apatite was described by Codarcea et al. (1967) in some Mesozoic magmatic rocks in the Poiana Ruscă Mts (occ. type VAb). The rare mineral gorceixite was found by Tokody et al. (1957) in museum samples from Baia Sprie.

Table 19
Phosphates-arsenates : post-TMR species

Mineral sp.	Localities	Occ. type	References
1. alluaudite ?	Conțu, Lotru Mts	IE	Săbău et al. (1989)
2. amblygonite	Conțu	IE	Săbău et al. (1989)
3. coeruleolactite ?	Iacobeni	IVAc	Bălan (1976)
4. crandallite	Cioclovina	X	Constantinescu et al. (1985, unpubl.)
5. gorceixite**	Baia Sprie	VI/IIICc	Tokody et al. (1957)
6. huréaulite	Conțu	IE	Săbău et al. (1989)
7. krautite*	Săcărîmb	IIICc	Fontan et al. (1975)
8. lithiophilite	Conțu	IE	Săbău et al. (1989)
9. purpurite	Conțu	IE	Săbău et al. (1989)
10. tavorite	Conțu	IE	Săbău et al. (1989)
11. triphyllite	Conțu	IE	Maieru et al. (1968)

* Mineral first described from Romanian occurrences

** Not reported in the TMR

New occurrences. (Table 20). Scorodite has been proved to be an ubiquitous mineral in the oxidation zones of some As-rich gold occurrences mainly located in Precambrian metamorphics such as Jidoștița (Andrei et al., 1974, unpubl.), Valea lui Stan (Udubașa et al., 1976, unpubl.), Văliug (Savu et al., 1977) or linked to hydrothermal mineralization associated with skarns, e.g. Sasca Montană (Constantinescu et al., 1988a). Vivianite is now known from some ore deposits (occ. type IIICc) in the Baia Mare area, from which the beautiful crystals at Ilba or Herja (many museum samples) are to be highlighted.



Table 20
Phosphates-arsenates : new occurrences

Mineral sp.	Localities	Occ. type	References
apatite (group)	Paring Mts	IIAa	Constantinescu, Săbău (1984)
	Tibleş	IIIBcd	Kovacs et al. (1985)
brushite	Iacobeni	VI/IBc	Bălan (1976)
carbonate-hydroxylapatite*	Baia de Fier	X	Diaconu, Medeşan (1975)
libethenite	Ditrău	IIICa	Mînzatu, Jakab (1986)
monazite	Sebeş Mts	IAa	Pavelescu, Pavelescu (1972)
scorodite	Jidoştiţa	IICa	Andrei et al. (1974, unpubl.)
	Valea lui Stan	IIBa	Udubaşa et al. (1976, unpubl.)
	Văliug	IIBa	Savu et al. (1977)
	Ciclova	IIIBb	Constantinescu et al. (1988a)
variscite	Iacobeni	VI/IBc	Bălan (1976)
vivianite	Ilba	IIICc	(Museum samples, Baia Mare, Bucharest)

* Labelled dahllite in the original description

Less common assemblages. Apatite crystals up to 3 cm in size were found in hornfelses at Tibleş, closely associated with rutile and pyrrhotite (Kovacs et al., 1985) as well as in Alpine-type veins in the Precambrian metamorphics of the Paring Mts (Constantinescu, Săbău, 1984).

X. Silicates

XA. Nesosilicates

Short comments on the previously described species. Excepting eulytite and topaz all the minerals included in Table 21 have been frequently found. Kyanite phenoblasts up to 20 cm in size exist in some Precambrian metamorphics of the South Carpathians and staurolite crystals, sometimes showing the cross twin, up to 5 cm in size are known from the metamorphics of the Apuseni Mts, near Baia de Arieş. Nearly pure forsterite has been found in skarns of the IIIBb type and forsterite-rich olivines (75-95 % Fo) have been identified in ultrabasic rocks of various age. Manganese-bearing olivines (tephroite and manganoan fayalite /"knebelite") are known from some Precambrian and Lower Paleozoic metamorphics in the South and East Carpathians, respectively. Garnets are abundantly developed in the K₃-Pg₁ magmatites related skarns in Banat, especially

Table 21
Nesosilicates : species included in the TMR

Mineral sp.	Main occ. type (s)	Mineral sp.	Main occ. type (s)
1. andalusite	IAa; IIIBa	10. olivine (group)	IDb, VCC, IIIAd
2. clinohumite	IIIBb	11. forsterite	IIIAd
3. dumortierite*	IAa	12. Mn-fayalite**	IAc, IBc
4. eulytite	IIIBb	13. sillimanite	IAa, IIIBd, VCC
garnets:		14. staurolite	IAa, VIII
5. andradite	IIIBb	15. tephroite	IAc, IBc
6. grossular	IIIBb	16. titanite	VA
7. pyrope	IAa	17. topaz	IAa, IBa, VIII
8. spessartine	IAc, IBc	18. zircon	VAA, VIII
9. kyanite	IAa, IE		

* Not included in the TMR; described by Mrazec, Murgoci (1897)

** Labelled knebelite in the original description

at Ocna de Fier and Dognecea, sometimes reaching 4-5 cm in size. As a peculiar feature of these occurrences are the magnetite pseudomorphs after garnets. Relatively large grains or even crystals of titanite occur in the rocks of the Ditrău alkaline igneous complex of Jurassic age in the East Carpathians.



Post-TMR species. There are few minerals present in small amounts in various occurrence types (Table 22). The Iacobeni manganese ore deposit was well studied mineralogically by Bălan (1976), who found about 70 species in all, from which two manganese nesosilicates previously known neither there nor elsewhere in Romania. Chondrodite seems to be a rather frequent species in skarns of type III**Bb**. The only occurrence of monticellite is that in Tibleş Mts, where a small body of manganesian skarns contains about 40 mineral species (Udubaşa et al., 1982a).

Table 22
Nesosilicates: post-TMR species

Mineral sp.	Localities	Occ. type	References
1. alleghanyite	Iacobeni	I Cc	Bălan (1976)
2. chondrodite	Moldova Nouă	III Bb	Gheorghita (1969)
3. humite	Băița Bihor	III Bb	Gherasi (1969)
4. monticellite	Tibleş Mts	III Cc	Udubaşa et al. (1982a)
5. thaumasite	Brad	IV A <i>b</i>	Bedelean, Nedopaca (1979) fide Bedelean, Stoici (1984)
6. thorite	Ditrău	V A <i>b</i>	Anastasiu, Constantinescu (1984)
7. topaz	Highiș Mts	III Bh	Tatu (1991, unpubl.)
8. sonolite	Iacobeni	I C	Bălan (1976)
9. leucophoenicite	Răzoare	I A <i>c</i>	Hârtopanu et al. (in press)
10. ribbeite ?	Răzoare	I A <i>c</i>	Hârtopanu et al. (in press)

New occurrences. (Table 23) Members of the olivine group were found in various occurrences. Forsterite is an important component of the magnesian skarns from the Tibleş Mts, where it occurs closely associated with spinel, tremolite, monticellite etc. (Udubaşa et al., 1982a). Quite mineral-rich is the skarn occurrence containing forsterite, chondrodite, phlogopite etc. described by Giuşcă, Mărza (1976) in the Gilău Mts (Iara Valley). The manganoan fayalite (knebelite) was described by Popa (1974) at Șarul Dornei and tephroite is now known in many manganese deposits of I**A***c* and I**C** occurrence types. The Răzoare Fe-Mn deposit in the Preluca Mts has been proved to contain numerous mineral species (about 60) among which manganoan fayalite, tephroite, sonolite, leucophoenicite and probably also alleghanyite and ribbeite are the most characteristic (Hârtopanu et al., in press). Dumortierite was reported in alluvia (Bălan, 1981) and retrograde cordierite-bearing gneisses in the Godeanu Mts (Săbău, 1987, unpubl.) or included in quartz from the spodumene-bearing pegmatites at Conțu, Lotru Mts (Săbău, 1991, unpubl.).

Andradite at the contact between igneous rocks of different ages was described by Berbeleac (1975) at Vălișoara, Metaliferi Mts and Seghedi (1987, unpubl.) in the Călimani caldera. Ștefan et al. (1978) found melanite (titanian andradite containing 4.41% TiO₂) in the high temperature skarns at Vața. A garnet of composition lying within the miscibility gap between grandites and pyralspites was identified at Ditrău by Jakab, Minzatu (1981) and Minzatu, Jakab (1986). Detailed studies on skarn garnet occurrences of type III**Bb** were carried out by Cioflica et al. (1967), Kissling (1967), Vlad (1974), Constantinescu (1976a, 1980) at Băița Bihor, Ocna de Fier, Dognecea and Sasca Montană, respectively. In heavy mineral concentrates from the Neogene sedimentary rocks in North Moldavia, Bălan (1981) found a pink garnet (61% pyrope, containing 1-2% Cr₂O₃) suggesting hidden kimberlite-like rocks in the source area. Garnets contained by metamorphic rocks were analysed by some authors (e.g. Savu et al., 1967; Dimitrescu, Ioachim, 1971; Dimitrescu, Kasper, 1978; Hârtopanu et al., 1983 etc.).

Less common assemblages. Special mention deserves the presence of andalusite crystals in some metamorphic pegmatites; it is associated with rutile and gahnite (Strusievicz, 1985; Strusievicz et al., 1987); in the Godeanu Mts it forms crystals reaching unusual dimensions (more than 20 cm length) (Conovici, 1982, unpubl.). Hârtopanu (1978) described in the Sebeș Mts a peculiar fabric within the kyanite and staurolite-bearing rocks, induced by a two direction advanced deformation and yielding randomly distributed kyanite megablasts epitaxially overgrown by staurolite. Kyanite described by Bergheș et al. (1988) in the "low grade metamorphics" in the Poiana Ruscă Mts suggests a retrograde character of the whole rock series.

Rather uncommon are the big grains (up to 8 cm in length) of manganoan fayalite and the large amounts of tephroite, sonolite and leucophoenicite recently found and described at Răzoare, Preluca Mts (occ. type I**A***c*) by Hârtopanu et al. (in press).



Table 23
Nesosilicates: new occurrences

Mineral sp.	Localities	Occ. type	References
andalusite	Plopiş Mts	I E	Strusievicz, Strusievicz (1985) Strusievicz et al. (1987)
chondrodite	Iara	III B a	Giuşcă, Mărza (1976)
	Ciclova	III B b	Gheorghieşcu (1975a)
	Băiţa Bihor	III B b	Cioflica et al. (1977)
	Tibileş Mts	III B c	Udubaşa et al. (1982a)
clinohumite	Băiţa Bihor	III B b	Gherasi (1969)
	Băişoara	III B b	Ionescu et al. (1971)
	Tibileş Mts	III B c	Udubaşa et al. (1982a)
dumortierite	North Moldavia	VIII	Bălan (1981)
	Godeanu Mts	I A a	Săbău (1987, unpubl.)
	Conţu	I E	Săbău (1991, unpubl.)
forsterite	Tibileş Mts	III B c	Udubaşa et al. (1982a)
	Iara	III B a	Giuşcă, Mărza (1976)
fayalite*	Şaru Dornei	I B c	Popa (1974)
manganese fayalite	Răzoare	I A c	Hărtopanu et al. (in press)
garnets:			
- andradite	Vălişoara	III B c d	Berbeleac (1975)
	Călimani Mts	III B c d	Seghedi et al. (1987, unpubl.)
- melanite	Vaţa	III B b	Ştefan et al. (1978)
- pyrope	North Moldavia	VIII	Bălan (1981)
tephroite	Şaru Dornei	I B c	Popa (1974)
	Sebeş Mts	I A c	Hărtopanu, Hărtopanu (1978)
	Răzoare	I A c	Hărtopanu et al. (in press)
sonolite	Răzoare	I A c	Hărtopanu et al. (in press)
alleghanyite	Răzoare	I A c	Hărtopanu et al. (in press)

* Manganoan, labelled knebelite in the original description

Mesozoic amygdaloid basalts at Vălişoara, Metaliferi Mts, have undergone contact metamorphic changes produced by quartz andesites of Neogene age; the calcite-bearing amygdales have been extensively replaced by other minerals, especially andradite (Berbeleac, 1975).

XB. Sorosilicates (including mixed structures)

Short comments on the previously described species. There are many occurrences but the minerals are present in small amounts (Table 24). Special mention deserves the lotrite, now known as pumpellyite (see details under "Discussion"); the mineral was described in the Paring Mts, closely associated with clinozoisite, garnets and vesuvianite, at the contact between serpentized ultrabasites and low grade metamorphic limestones. Best developed vesuvianite crystals rich in forms were reported from the Ciclova ore deposits (occ. type III B b). The minerals of the epidote group are generally abundant but only epidote appears significantly developed in some Paleozoic granites of North Dobrogea being considered of magmatic origin (e.g. Mrazec, Giuşcă, 1934) and in some Triassic basalts of North Dobrogea where it suggests that the host-rocks had been transformed under the ocean floor metamorphism (Savu, Colios, 1983).

Post-TMR species. Zunyite compact aggregates formed at the expense of Neogene volcanics in the Harghita Mts and tilleyite-spurrite dominating skarn at Vaţa, Metaliferi Mts are the most interesting minerals described (Table 25). The manganese-bearing zoizite (thulite) has been identified in the Sebeş Mts (occ. type I A c, Hărtopanu, Hărtopanu, 1978) and at Juleşti-Valea Fagului (occ. type III B b, Udubaşa et al., 1980a).

New occurrences. Ilvaite has been proved to be much more widespread than previously thought, especially in skarn related to K₃-Pg₁ magmatites. Beautiful vesuvianite crystals have been described at Sasca Montană by Constantinescu (1970); the same mineral occurs also at Iulia, Dobrogea (Mărza et al., 1981), an iron-copper ore deposits of disputed genesis. Other occurrences are given in Table 26.



Table 24
Sorosilicates: species included in the TMR

Mineral sp.	Main occ. type (s)	Mineral sp.	Main occ. type (s)
1. allanite**	V A, III B _d , VIII	8. meliphanite*****	V A _b
2. astrophyllite	V A _a	9. piemontite	I A _c
3. clinozoisite***	III B _d	pumpellyite (see lotrite)	
4. epidote****	I A B _A , III B _d , IV A _c	10. rhoenite	III C _a
5. hemimorphite	VI/III B _b , III C _c	11. vesuvianite	III B _b , II B _d
6. lotrite*	III B _d	12. wohelerite ?	V A _b
7. melilite	III B _b	13. zoizite	I B _a , III B _d , III B _b

* Mineral species first described in Romania (Murgoci, 1900), lately refound and named pumpellyite (Palache, Vassar, 1925)

** Labelled orthite in the original description

*** Not considered as a separate species in the TMR

**** Mainly Fe-rich (pistacite)

***** Labelled melinophane in the TMR

Table 25
Sorosilicates: post-TMR species

Mineral sp.	Localities	Occ. type	References
1. ilvaite*	Dognecea	III B _b	Vlad (1967)
2. spurrite	Vața	III B _b	Ştefan et al. (1978)
3. tilleyite	Vața	III B _b	Istrate et al. (1978)
4. zunyite	Virghiș	III C _d	Setel et al. (1985)

* Manganoan ilvaite (Vlad, 1974)

Table 26
Sorosilicates: new occurrences

Mineral sp.	Localities	Occ. type	References
allanite	Fundu Moldovei	I B _b	Kräutner (1966)
	South Carpathians	V A _d	Pavelescu, Pavelescu (1972)
	Tibileş Mts	III B _c	Udubaşa et al. (1982a)
gehlenite	Vața	III B _b	Ştefan et al. (1978)
ilvaite	Rușchița	III B _b	Kräutner, Medeșan (1969)
	Băișoara	III B _b	Popescu (1973)
	Bihor Mts	III B _b	Udubaşa (1978, unpubl.)
	Moldova Nouă	III B _b	Udubaşa, Ilinca (in prep.)
	Turț	III B _c	Jude (1981)
	Oaș Mts	*	Udubaşa, Seghedi, Szakacs (in press)
piemontite	Delnița	III E _b	Timpău (1975)
	Lotru Mts	I A _c	Bălan, David (1978)
zunyite	Călimani caldera	III C _d	Seghedi et al. (1988, unpubl.)
vesuvianite	Sasca Montană	III B _b	Constantinescu (1970)
	Iulia	XI	Mărza et al. (1981)

* in droplets of an sulfide-rich immiscible melt in pyroxene andesites.

Less common assemblages. Very interesting is the presence of ilvaite at Turț, Oaș Mts, in hydrothermal veins rich in galena (Jude, 1981). Highly uncommon is the presence of ilvaite as "matrix" of sulfide-magnetite intergrowths in droplets appeared by immiscibility in pyroxene-bearing andesites of Neogene age in the Oaș Mts (Udubaşa, Seghedi, Szakacs, in press). Special mention should be made also of gehlenite at Vața (Ştefan et al., 1987), where it occurs in a high temperature skarn assemblage and sometimes forms crystals up to 12-15 cm in size, probably the biggest known till now in the world.



XC. Cyclosilicates

Short comments on the previously described species. (Table 27) The best known beryl occurrence in pegmatites at Teregova, Banat (occ. type IE) contains crystals up to 30 cm in size (8 kg), translucent, yellow-green or blue-greenish. The dioptase from Băița Bihor forms crystals up to 1.5 cm in size and associates with wulfenite and hemimorphite. Tourmaline crystals were known only from the Teregova pegmatites; they reach sometimes 8 cm in size.

Table 27
Cyclosilicates: minerals included in the TMR

Mineral sp.	Main occ. types
1. beryl	IE, VIII
2. chrysocolla	IIB _b , IIIIB _b , IIIC _c
3. cordierite	IIB _a , IIIIB _{bd} , IIIB _{cd} , VCC
4. dioptase	VI/IIIB _b
5. tourmaline (group)*	IE, IA _a , IIIIB _{cd}

* Generally without specific determinations

Post-TMR species. Pavelescu (1988) reported axinite crystals in many skarn occurrences of IIIB_b type.

New occurrences. There are many tourmaline occurrences (Table 28) of which the one at Sasca Montană is best studied (Constantinescu, 1976). This and the new occurrences include mostly tourmaline as a hydrothermal alteration product. At Sasca Montană two tourmaline generations have been depicted; by decreasing the temperature the schorl-dominated tourmaline is gradually substituted by more elbaite-rich members forming tourmaline-quartz aggregates (Constantinescu, 1976b).

Table 28
Cyclosilicates: new occurrences

Mineral sp.	Localities	Occ. type	References
tourmaline	Sasca Montană	IIIB _{bg}	Constantinescu (1976b)
	Oravița	IIIB _{bg}	Popescu, Constantinescu (1977)
	Rodna	IIIC _c	Jude et al. (1984)
	Tibileș	IIIC _{cd}	Udubaşa et al. (1984)
	Harghita	IIIC _{cd}	Stanciu (1976, 1982)

In the Tibileș and Harghita Mts the tourmaline+quartz association seems to reveal some hidden or nearly situated porphyry-like systems (Stanciu, 1982) which constitute a kind of "remote parageneses" (acc. to Udubaşa, 1986b).

XD. Inosilicates

Short comments on the previously described species. (Table 29). There are many data (especially optical and wet chemical analyses) but they are somewhat difficult to accomodate the new and rather complicated nomenclature of amphiboles and pyroxenes. Crystals are rarely encountered. However, beautiful diopside crystals up to 10 cm in size were found at Ocna de Fier (occ. type IIIB_b), riebeckite crystals up to 2 cm were described in some granites from Dobrogea. At Ciclova (occ. type IIIB_b) some wollastonite crystals appeared, too, showing parts differently colored, i.e. yellow, reddish, brown. The hypersthene in andesites from Călimani was well studied crystallographically and chemically by Buțureanu (1909).

Post-TMR species. The minerals presented in Table 30 are the most reliable found by the authors and the list is by far not complete. Hastingsitic hornblende (carinthine) was described in some crystalline schists at Feneș, Semenic Mts by Savu, Vasiliu (1970) and as primary mineral in some eclogites from Leaota Mts by Săbău et al. (1986). Manganese hedenbergite, manganese salite and manganese ferrosalite were found by Vlad (1974) in the skarns at Dogenecea. Salite and ferrosalite were also described by Constantinescu (1980) at Sasca Montană: both occurrences are of type IIIB_b. According to the nomenclature of pyroxenes (Morimoto,



1988) the terms salite and ferrosalite represent in fact iron-rich diopside and hedenbergite, respectively. A manganoan variety of aegirine was described by Bălan (1976) at Iacobeni; the same author found also here a manganoan aegirine-augite.

Table 29
Inosilicates included in the TMR

Mineral sp.	Main occ. type (s)	Mineral sp.	Main occ. type (s)
1. acmite	I _{Fe}	15. glaucophane	I _{Bc} , III _{Bbd}
aegirine	I _{Fbd}	16. hedenbergite	III _{Bb} (one occ.)
2. actinolite	wid	hornblende***	wid
3. antophyllite	I _{Bc}	17. hypersthene	wid
4. arfvedsonite	I _{Fb}	18. inesite	III _{Cc}
5. augite	wid	19. katophorite	I _{Fh}
6. ferrohornblende*	I _{Fbd}	20. omphacite	I _{De}
7. bustamite	III _{Bb}	21. pigeonite	I _{Fg}
8. clinoenstatite	I _{Fg}	22. pyroxmangite	I _{Ac} , I _{Bc}
9. cummingtonite	I _{Aa}	23. rhodonite	I _{Ac} , I _{Bc} , III _{Bb}
10. dannemorite	I _{Ac} , I _{Bc}	24. riebeckite	I _{Fc} (alk)
11. diopside	wid III _{Bb}	25. schefferite	I _{Ac} , III _{Bb}
12. enstatite	wid	26. spodumene	I _E (one occ.)
13. fassaite	III _{Bb}	27. tremolite****	wid
14. gedrite**	III _{Bb}	28. wollastonite	III _{Ba} , III _{Bbd}

wid - widespread; alk - alkaline.

* Described as barkevicitic and also as brown hornblende

** In some gabbros without age relations from the Vilcan Mts

*** Usually described (optical data) as brown and green hornblende; the brown hornblende especially in alkaline rocks (occ. type I_{Fe}) or in some Mesozoic gabbros from the Drocea Mts

**** Very early (Fichtel, 1791) described it distinctly as sebesite (acc. to TMR)

Table 30
Inosilicates: post-TMR species

Mineral sp.	Localities	Occ. type	References
1. hastingsite	Birzava	I _{Aa}	Dimitrescu (1976)
2. johannsenite	Muncelu	V _{Cc}	Mărza, Egri (1971)
3. magnesioriebeckite*	Iacobeni	I _{Bc}	Bălan (1976)
4. okenite	Brad	IV _{Ab}	Istrate (1980a)
5. pargasite	Tismana	III _{Ba}	Berza et al. (1971)
6. richterite	Sebeș Mts	I _{Aa}	Pavelescu, Pavelescu (1980)

* Manganoan variety

New occurrences. There are many data but only the most reliable (better studied occurrences) are given in Table 31. Worth of mention is the study of the augite crystals (up to 2 cm in size) occurring in some Mesozoic basalts in the Metaliferi Mts (Berbeleac, David, 1977). The relationships between augite and hypersthene in Neogene andesites from the Baia Mare zone are discussed by Măldărescu (1977) who found that the substitution of hypersthene by augite is a feature typical of the subvolcanic andesites.

Less common assemblages. In the TMR some interesting associations of rhodonite are mentioned: (1) at Căvnice, closely intergrown with gold and (2) at Ocna de Fier, forming pseudomorphs after skarn garnets. Berbeleac (1975) described at Vălișoara, Metaliferi Mts, calcite amygdales substituted by actinote in Mesozoic basalts at the contact with Neogene andesites.



Table 31
Inosilicates: new occurrences

Mineral sp.	Localities	Occ. type	References
antophyllite	Moldova Nouă	III Bb	Gheorghita (1969)
	Sasca Montană	III Bb	Constantinescu (1971)
	Oravița	III Bb	Gheorghitescu (1975b)
hedenbergite	Dognecea	III Bb	Vlad (1974)
	Olteț Valley	III Ba	Schuster (1973)
	Iara	III Ba	Giușcă, Mărza (1976)
tremolite	Tibileș	III Bc	Udubașa et al. (1982a)
	Contu, Lotru Mts	IE	Maieru et al. (1968)
	Dognecea	III Bb	Vlad (1974)
spodumene	Băișoara	III Bb	Marincea (1991, unpubl.)
	Cacova Ierii	III Bb	Marincea (1991, unpubl.)

XE. Phyllosilicates

Short comments on the previously described species. There are many species recognized in various occurrence types (Table 32). One of the most interesting occurrences is the one at Iscroni (and Rafaila) in the Vulcan Mts containing chloritoid rosettes in low-grade coaly metamorphics. At Voineasa, Lotru Mts, the pegmatite contain big muscovite flakes, sometimes showing nearly regular interlayering with biotite (macroscopic observation scale!).

Table 32
Phyllosilicates: minerals included in the TMR

Mineral sp.	Main occ. type (s)	Mineral sp.	Main occ. type (s)
1. allophane	VI/III Bb	12. kaolinite	wid
2. antigorite	IFc	13. lepidolite	IAa
3. apophyllite	IIIBf	melanolite	wid
4. biotite	wid	14. montmorillonite	wid
bowlingite	IDb	15. muscovite	IE, wid
5. chamosite*	III Cc (???)	16. nacrite	VI/III Bb , III Cc
chlorite (group)		17. neotokite****	VI/IAc
6. chloritoid	IAa, IBa	18. nontronite	VI/III Bb
7. chrysotile	IFc	orthoclinochrysotile	IFc
8. clinochlore	IDb	19. phlogopite	IAa, III Bb
delessite**	IID	20. prehnite	IVAc
garnierite	III Ac	21. pyrophyllite*****	III Cb , III Cc
9. halloysite	III Ccd , IVB	22. saponite	IDb
10. hisingerite	VI/IAc	23. sepiolite	IID
iddingsite	IDb	serpentine (group)	IDb
11. illite	IVB	24. stilpnomelane	IAc
kaemmererite***	III Abc	25. talc	IABa, IFc

wid - widespread

* Now recommended to be named berthierine

** Magnesian chamosite/berthierine

*** Chromian clinochlore

**** Now known with the formula $(Mn, Fe^{2+})SiO_3 \cdot H_2O(?)$ (Fleischer, 1983); introduced here because Whelan and Goldich (1961) showed the neotokite having many properties similar to those of the montmorillonite group

***** At Băița Bihor it occurs in limestones and has been named biharite, too, probably a mixture of pyrophyllite + talc

?? Occurrence type given is highly improbable



Post-TMR species. More than 30 species have been described in various occurrences as a result of improved analytical methods (especially XRDA, IR spectrometry, SEM etc.). Some species previously described are now redefined according to the AIPPEA recommendations (Bailey, 1980). However, some minerals included in Table 33 must be regarded with caution either due to insufficient data presented by the authors or to the nomenclature evolution. Many of the minerals described so far in Romania belong to the chlorite group (aphrosiderite, berthierite, donbassite etc.); there are also some regular mixed-layers accepted now as independent species such as rectorite, corrensite and tosudite. Dioctahedral (beidellite) and trioctahedral (sauconite, stevensite) smectites have been identified, too. Unfortunately, the clay minerals murgocite (Ianovici, Neacșu, 1970a) and mrazecite (Neacșu, 1970) described within the hydrothermal alteration products at Moldova Nouă (occ. type III Bb) have not been accepted as new species by the CNMMN/IMA.

Some mineral varieties were described in quite typical occurrences such as: fuchsite (chromian muscovite) in sheared Paleozoic gabbros in Banat (Gurău et al., 1977); manganophyllite (manganesean biotite) and parset-tensite (manganesean stilpnomelane) in the Lower Paleozoic Mn ores from the East Carpathian crystalline belt (Bălan, 1971; Bălan, 1976); phengite in Liassic anthracite-bearing rocks from Parâng Mts (Mutihac, Popescu, 1982); schuchardite (nickeloan clinochlore) in some ultrabasites in the Parâng Mts (Pavelescu, 1983); xylotile (iron sepiolite) in Lower Proterozoic iron-bearing crystalline schists at Palazu Mare, Dobrogea (Giușcă, 1972). Deweyllite (a mixture of talc + serpentine) was reported from Sasca Montană by Neacșu et al. (1978) and a variety of clinochlore, sheridanite was found by Manea et al. (1978) at Budureasa, both occurrences of type III Bbf.

Table 33
Phyllosilicates: post-TMR species

Mineral sp.*	Localities	Occ. type	References
1. amesite	Tibileș Mts	III Bcf	Udubașa et al. (1982a)
2. aphrosiderite	Schela-Gorj	ICc	Paliuc (1972)
3. beidellite*	Palazu Mare	VII Ad	Ghergari, Mărza (1961)
4. bementite	Iacobeni	IBc	Bălan (1976)
5. clintonite	Oravița	III Bbf	Constantinescu, Popescu (1977, unpubl.)
6. corrensite(?)	Alba Iulia	IV Bb	Neacșu (1969)
7. dickite	Șuncuiuș	VII Ad	Ianovici, Neacșu (1968)
8. donbassite	Talagiu	III Ccd	Ianovici et al. (1984)
9. friedelite	Sebeș Mts	IAa	Pavelescu, Pavelescu (1980)
10. hydrotalcite	Tibileș Mts	III Bcf	Udubașa et al. (1982a)
11. leuchtenbergite	Lotru Mts	IAa	Bălan, David (1978)
12. lizardite	Tismana	III Ba	Medeșan, Berza (1974)
13. metahalloysite (=halloysite 7 Å)	Tarna Mare	III Ccd	Mărza (1974)
14. palygorskite	Ocna de Fier	III Bbf	Kissling (1967)
15. paragonite	Parâng Mts	ICa	Mutihac, Popescu (1978)
16. pennantite	Sebeș Mts	IAa	Hărtopanu, Hărtopanu (1978)
17. prochlorite (?)	Ocna Mureș, Alba Iulia	IV Bb	Neacșu (1969)
18. rectorite (-like)	Talagiu	III Ccd	Ianovici et al. (1984)
19. sauconite	Cavnic	III Ccd	Anton (1971, unpubl.)
20. stevensite (?)	Moldova Nouă	III Gbd	Neacșu (1969)
21. tosudite (-like)	Talagiu	III Ccd	Ianovici et al. (1984)
22. vermiculite (?)	Alba Iulia	IV Bd	Neacșu (1969)
23. zeophyllite	Ditrău	III Ca	Constantinescu et al. (1983)

* Not included in the TMR

(?) Doubtful or incomplete data to characterize the species

New occurrences. About 150 new occurrences have been meantime reported (Table 34). Various layer (mainly clay) minerals appear frequently described by Neacșu (1969), Anton (1969, 1971), Ianovici, Neacșu (1970b), Berbeleac et al. (1978), Ianovici et al. (1984) etc. New data have been obtained concerning occurrences of the common clay minerals such kaolinite, illite, montmorillonite proved to be, each of them, the dominant species in sedimentary rocks of various ages. Papiu et al. (1969-1971, unpubl.; 1988a, b, c) and Rădan et al. (1971-1975, unpubl.; Rădan, 1978) carried out detailed studies and contributed a lot to the knowledge of



the minerals contained by the refractory clays (kaolinite dominant) and the Oligocene and Miocene clays in the East Carpathians (illite dominant). The last author (Rădan et al., 1971-1988, unpubl.) collected many data concerning the mineralogy and distribution of the clay minerals associated or not with coals in many sedimentary basins or in recent sediments of the Danube, Danube Delta, lagoonal lake systems Razelm-Sinoe near the Black Sea (Mihăilescu et al., 1983) and of the Black Sea itself.

Worth to mention is the kaolinite predominance in the Aptian clays in Dobrogea (Rădan et al., 1969, 1970, 1977, unpubl.) and in the Oligocene deposits of the north-western part of Transylvania (Rădan et al., 1979, unpubl.); the same author studied the clay mineralogy of the Romanian bentonites pointing out their smectite-dominated character. Illite and chlorite are abundant species in the Cretaceous Black Shale Formation developed in the East Carpathians (Papiu et al., 1975, 1977).

Detailed study on biotite in the metamorphic rocks of the Semenic Mts has been made by Savu et al. (1967) and on phlogopite from Ocna de Fier by Kissling (1967). Using the Sc and Li distribution in biotite and phlogopite, respectively, Savu et al. (1971) and Pomărleanu et al. (1986) give supplementary supports for the biotite and phlogopite geothermometers. A chloritoid belt was depicted within the medium grade metamorphics (kyanite-bearing) of the Central South Carpathians by Hârtopanu, Hârtopanu (1976).

Table 34
Phyllosilicates: new occurrences

Mineral sp.	Localities	Occ. type (s)	References
allophane	Apuseni Mts	X	Coman, Ianc (1974)
	Talagiu	III Ccd	Ianovici et al. (1984)
antigorite	Julia-Dobrogea	XI	Mărza et al. (1981)
apophyllite	Criscior	IV Ab	Istrate (1980a)
	Tibileş Mts	IV Ab	Istrate, Udubaşa (1981)
	Pietroasa	III Bbf	Marincea (in press)
beidellite	Talagiu	IV Ab	Ianovici et al. (1984)
berthierine*	Munteana-Banat	VII Af	Rusu (1968)
	Moesian Platform	VII	Vinogradov (1986)
chloritoid	Vilcan Mts	ICa	Pieptea et al. (1975)
	Sebeş Mts	IAa	Hârtopanu, Hârtopanu (1976)
	Retezat Mts	ICa	Solomon et al. (1976)
	Parîng Mts	ICa	Mutihac, Popescu (1982)
clinochlore	Moldova Nouă	III Cbd	Neacşu (1970)
dickite	Cavnic	III Ccd	Anton (1969b)
	Talagiu	III Ccd	Ianovici et al. (1984)
	Ohaba Ponor	VII Ab	Papiu et al. (1971)
	Anina	VII Ab	Papiu et al. (1988b)
	Cristian-Hobav	VII Ab	Papiu et al. (1988c)
gyrolite	Brad	IV Abc	Istrate (1980c)
halloysite	Racşa-Oaş	III Ccd	Rădan et al. (1982, unpubl.)
(=halloysite 10 Å)	Talagiu	III Ccd	Ianovici et al. (1984)
illite**	Cavnic	III Ccd	Anton (1969b)
	East Carpathians	VII dh	Papiu et al. (1975-1977)
	Harghita Băi	III Ccd	Neacşu, Urca (1978)
	Topleş	II Cc	Rădu (in press)
kaolinite	Anina	VII d	Papiu et al. (1988b)
	Sunciuş	VII d	Treiber, Bedelean (1967a,b)
	Cristian-Hobav	VII d	Papiu et al. (1988c)
	Boteşti-Gladna	VII d	Papiu et al. (1973)
	Voia	III Ccd	Berbeleac et al. (1978)
montmorillonite	Gurasada	IV Bb	Crăciun (1975)
	Palazu Mare***	VII ad(BIF)	Ghergari, Mărza (1961)
	Alba Iulia	IV Bb	Neacşu (1965)
	Bahna	IV Bb	Zanfirescu et al. (1968)
nacrite	Talagiu	III Ccd	Ianovici et al. (1984)
nontronite	Sunciuş	VII Ad	Treiber, Bedelean (1967a,b)
	Poiana Codrului	VII Ad	Kalmar, Ionescu (1970)



Table 34 (continued)

pennine phlogopite	Răzoare Moldova Nouă Sasca Montană Tîbles Mts	IVBc III Bb III Bb II Bc	Giușcă, Anton (1968) Gheorghită (1969) Constantinescu (1971) Udubașa et al. (1982a)*
prehnite	Băița Bihor Godeanu Mts	III Bd IAa	Udubașa et al. (1982a)* Cioflica et al. (1974) Bercia (1975)
pyrophyllite	Vâlisoara Vilcan Mts Cavnic	VBc ICa III Ccd	Berbeleac (1975) Neacșu (1965) in Paliuc (1970) Anton (1969b)
rectorite	Roșia Poieni	VIIBc	Ianovici et al. (1981)
saponite	Petroșani Bloaja	III Cc III Ccd	Rădan et al. (1984, unpubl.) Rădan et al. (1987, unpubl.)
sepiolite	Gutii Mts Palazu Mare Moldova Nouă	IAd III Cbd Iad	Minzăraru, Bîrlea (1968) Giușcă (1972) Ianovici et al. (1983)
stilpnomelane	Palazu Mare**** Vărad Preluca Mts	III Cbd III Eb III Bbf	Giușcă (1971) Gheorghiescu, Medeșan (1972) Pop, Angelescu (1981)
talc	Budureasa East Carpathians Maramureș Locva Mts Bălan Moldova Nouă*****	IBa IBa IBa IBb III Bbf XI	Manea et al. (1978) Strckeisen (1968) Ciornei (1970) Maier (1969, 1974) Popescu (1971) Neacșu (1970)
vermiculite	Somova Răzoare Black Sea sediments Tîrgu Mureș	III Ea IVBc VII d VII d	Frîncu-Avramescu (1982, unpubl.) Stiopol et al. (1976) Brana et al. (1969) Rădan, Jipa (1975) Matei (1983)

* Labelled chamosite in the original descriptions

** Labelled hydromica in some papers

*** Not included in TMR

**** Iron varieties; ferrisepiolite named xylotite by author

***** Doubtful or incomplete data

Some mineral varieties are also described such as kämmererite (chromian clinochlore) in Paleozoic ultrabasites from Banat (Bercia, Bercia, 1962), manganophyllite (manganian biotite) in some Mn-bearing rocks from the Lotru Mts (Bălan, David, 1978), Mn-stilpomelane at Iacobeni (Bălan, 1976), metahalloysite (halloysite - 7 Å) at Tarna (Mărza, 1974), fluorphlogopite in the magnesian skarns from the Tîbles Mts (Pomărleanu et al., 1986) and ripidolite (ferroan clinochlore) in various occurrences of IAa type (Dimitrescu, Covali, 1974), IBa (Bălan, 1976), II Aa (Ionescu, Anton, 1971; Constantinescu, Săbău, 1984) and of III Ccd type (Jude, 1986).

Less common assemblages. Ripidolite, clinochlore, prehnite and pyrophyllite are now known in Alpine-type veins in Precambrian metamorphics (Constantinescu, Săbău, 1984). Less common is the presence of dickite and nacrite in the refractory clays (fireclays) at Suncuiuș (Neacșu, 1966, unpubl.), of dickite in the coal-bearing beds at Anina and Cristian-Holbav (Papiu et al., 1970, unpubl.) as well as in the Hațeg bauxites (Papiu et al., 1971), i.e. in purely sedimentary environments lacking in hydrothermal supply. Pyrophyllite occurs also in the matrix of some Badenian gravels in the Petroșani coal basin and it has been concluded that it represents an inherited mineral from the underlying Schefă Formation of Liassic age. Biotite "concretions" up to 1x10 cm in size were described by Pavelescu (1959) in some greisses of the Sebeș Mts; however, their nature has not been solved yet. Apophyllite pseudomorph after wollastonite was described by Marincea in hornfels within Pietroasa area (Bihor Mts); the same assemblage has been previously described at Ciclova (TMR).

XF. Tectosilicates

Short comments on the previously described minerals. There are quite widespread minerals (Table 35), many of them being poorly defined. Special mention deserves adularia, forming large halos around the ore



veins (especially gold-bearing) in the Neogene volcanics of the Baia Mare zone. Cancrinite, nepheline and sodalite form locally big aggregates in the syenites of the alkaline igneous complex at Ditrău (occ. type IFe). Nepheline from here has been minutely described by Anastasiu, Constantinescu (1975).

Table 35
Tectosilicates: minerals included in the TMR

Mineral sp.	Main occ. type (s)	Mineral sp.	Main occ. type (s)
adularia	III Ccd	12. heulandite	IV Aa, IV Ab
1. albite	wid.(IE)	13. laumontite	IV Aa, IV Ab, IV Ac
2. analcime	IV Aa	14. mesolite	IV Ac
3. anorthite	V Cc	15. microcline	wid.
4. anorthoclase	IFb	16. natrolite	IV Aa, IV Ab, IV Ac
5. bytownite	IFf	17. nepheline	IFe
6. cancrinite	IFe	18. oligoclase	IFa
7. chabasite	IV Aa, IV Ac	19. phillipsite	IV Ac
8. danburite ?	IE	20. sanidine	IFi
9. epistilbite	IV Aa, IV Ac	21. scapolite (group)	III B ad, III B bd
10. gmelinite ?	IV Aa	22. sodalite	IFe
11. helvite	III Cc	23. stilbite*	IV Aa, IV Ab, IV Ac

* Described as desmine

wid. - widespread (in brackets: most interesting occurrence type)

? Uncertain identification

It is interesting to note the presence of helvite in some ore deposits related to the Neogene igneous activity; at Cavnic it occurs as tetrahedral crystals of yellowish colour, closely associated with quartz and rhodochrosite.

The optical properties of some plagioclase feldspars in Neogene andesites in the East Carpathians have been thoroughly studied by Nichita (1939) and Mînzăraru (1962).

Table 36
Tectosilicates: post-TMR species

Mineral sp.	Localities	Occ. type	References
1. celian	Arpaş (Făgăraş Mts)	I Ab	Iliescu (1970)
2. clinoptilolite	Mîrşid	IV Bb	Popescu et al. (1975), Popescu, Asvadurov (1978)
3. cymrite	Blazna Valley	I Ab	Udubaşa (1986a)
4. epistilbite	Remetea		Bedelean (1972)
5. erionite	Mîrşid	IV Bb	Bedelean, Stoici (1984)
6. faujasite ?	Boldeşti	VII	Pircălabescu et al. (1967)
7. gismondine	Tibileş Mts	IV Ab	Săbău, Urcan (in press)
8. harmotome	Vorja, Furcşoara	IV Aa	Cioflica et al. (1985)
9. hyalophane	Iacobeni	I Bc	Bălan (1970, 1976)
10. mesolite	Iuţi	IV Ac	Istrate (1980b)
11. mordenite	Hărțăgani	IV Ab	Istrate (1980b)
12. paracelsian	Iacobeni	I Bc	Bălan (1976)
13. scolecite	Vlădeasa Mts	IV Aa	Istrate, Medesan (1977)
14. thomsonite	Moldova Nouă	IV Aa	Gheorghită (1975)

? Uncertain identification

Post-TMR species. There are few species reported so far (Table 36). The rare mineral cymrite, $\text{BaAl}_2\text{Si}_2(\text{O},\text{OH})_8 \cdot \text{H}_2\text{O}$ has been identified in a base metal ore deposit located in Precambrian carbonate rocks (Udubaşa, 1986a). Some other barium silicates are known from the Iacobeni manganese deposit (Bălan, 1976). Members of the scapolite group occur in the Sasca Montană skarn deposit, e.g. dipyre (Constantinescu, 1980). Zeolites are contained by different rock types occurring mainly in the western part of the country, i.e. the Apuseni and the Metaliferi Mts. The magnesiolaumontite from Musariu (Börcoş, 1960) has not been accepted as a new species because of the too low MgO content and the lack of any structural data.



New occurrences. Scapolite group minerals have been identified (although not always specifically determined) in various occurrence types (Table 37). A monography concerning zeolites in Romania has been made by Bedelean, Stoici (1984). High confidence data on magmatogene zeolites provided Istrate et al. (1981) and Cioflica et al. (1985); authigene clinoptilolite, heulandite and mordenite in Neogene sands have been described by Ceclarov, Basarab (1983). Partially dehydrated laumontite (metalaumontite) has been found at Rușchița (occ. type IV Aa) by Kräutner, Medeșan (1966).

Table 37
Tectosilicates: new occurrences

Mineral sp.	Localities	Occ. type	References
adularia	Parâng Mts	II Aa	Constantinescu, Săbău (1984)
celsian	Iacobeni	IBa	Bălan (1976)
clinoptilolite	Perșani Mts	IV Bb	Popescu, Asvadurov (1978)
	Apuseni Mts	V Bb	Istrate et al. (1981)
	Cistei	VII	Ceclarov, Basarab (1983)
	Subcarpathians	IV Bb	Cosma et al. (1984a,b)
epistilbite	Metaliferi Mts	V Bb	Cioflica et al. (1985)
mordenite	Călimani caldera	V Bc	Seghedi, Pomărleanu (1983, unpubl.)
	Slănic	IV Bbg	Cosma et al. (1984)
	Vorța	IV Aa	Cioflica et al. (1985)
natrolite	Ditrău	V Bbg	Constantinescu, Anastasiu (1979)
phillipsite	Moldova Nouă	III Cb-d	Gheorghieș (1975)
scapolite group	Lotru, Căpățina Mts	IAa	Pavelescu (1976)
	Băița Bihor	III Bb	Stoici (1974)
	Racoș	VCc	Măldărescu et al. (1982)
	Sasca Montană	III Bb	Constantinescu (1980)
	Oravița (meionite)	III Bb	Constantinescu et al. (1988b)
	Eșelnita*	IAa	Dinică (1987, unpubl.)
	Baia de Arieș**	IAa	Săbău (1989, unpubl.)
	Ostoroș***	III Cd	Stanciu, Săbău (1989, unpubl.)
thomsonite	Sasca Montană	III Bbg	Constantinescu (1977)

* mizzonite-meionite

** dypire

*** marialite

Less common assemblages. The barium feldspars from Iacobeni occur closely associated with manganese silicates, either forming concordant beds (celsian, paracelsian) or cutting across the metamorphic foliation (hyalophane)(Bălan, 1976). Plagioclase tachiblasts in some Neogene andesites in the Apuseni Mts were described by Constantinescu, Anton (1983).

XI. Organic Compounds

Short comments on the previously described species. (Table 38) Only whewellite has been reported in the TMR; it occurs in hydrothermal veins at Cavnic (occ. type III Bc) forming translucent crystals, very rich in forms. Elaterite has been discovered in the gold-bearing ore deposit at Valea Borcutului, Baia Mare zone (Tokody, 1963); it occurs closely associated with marcasite, forming flakes or spheroidal aggregates (some mm in size) of brown colour; it is amorphous and optically isotropic.

Table 38
Organic compounds: minerals known before TMR

Mineral sp.	Main occ. type (s)
1. amber*	VII Ae, VIII
2. elaterite ? *	III Cc
3. whewellite	III Cc

* Not included in the TMR



Largely developed in Romania and quite well studied by Istrati (1895), Munteanu-Murgoci (1903, 1957) and Protescu (1937) the amber has been variously named; the most widely used amber varieties are: romanite (Rumänit), almashite, schraufite and muntenite. The sedimentary rocks hosting primary amber are Paleogene in age. The properties of the Romanian amber varieties are given in Table 39. Mention should be made of the devitrification processes showed by the romanite, yielding triclinic crystals, sometimes twinned; extinction angle of such crystals is of 18° and the refraction index higher than 1.55.

Table 39
Some properties of the Romanian ambers
(acc. to Munteanu-Murgoci, 1903, 1957)

Occ. (variety)	Colour,	Hardness	Density	n	Melting point/ interval ($^{\circ}\text{C}$)	Succinic acid obtained by distillation
Buzău (romanite)	red, brown-black	2.5-3	1.03-1.12	1.4377	300-350	~ 5%
Olănești	yellow,	2.5-3	1.094	n.d.	165	not present
Vama (schraufite)	hyacinth red	2.3	1-1.12	n.d.	326	small amount

The chemical composition of the romanite is quite constant; the average of seven chemical analyses gives the following figures (Table 40):

Table 40
Chemical composition of the Romanian amber
(wt.)

Elements	Mean	Variation interval
C	81.18	77.79 - 83.31
H	10.46	9.80 - 11.11
O	6.61	3.88 - 9.98*
S	1.22	0.93 - 1.72
ash	0.52	0.18 - 0.85

* Obtained by difference

The Olănești amber is higher (85.5%) and the schraufite lower (73.33%) in carbon than the romanite.

The data presented suggest that the amber may be considered as a compound resembling somehow the metamict minerals.

Many new data exist now on the most celebrated amber occurrence at Colți, District of Buzău. Ghiurcă and Drăgănescu (1986) gave a general view concerning the sedimentation conditions of the amber-bearing rocks (the so-called Lower Kliwa Sandstone). Petrescu et al. (1989) have carried out special researches on the mineralized wood fragments contained by the Kliwa Sandstone; they studied also the palynological associations of the same rocks and of the amber itself. By using gas liquid chromatography Ghiurcă and Vávra (1990) concluded that the Colți amber can be easily discerned from the classical succinate (Baltic amber).

3. Discussion

All the mineral classes are quite well represented in Romanian occurrences but the number of species is variable (Figs. 1-3). Highly reliable data exist now on many minerals, especially sulfides and silicates including chemical analyses, X-ray diffraction, IR spectrophotometry as well as Mössbauer spectrometry (e. g. on pyroxenes of the diopside-hedenbergite-johannsenite series; Ionescu, Filotti, Gomolea, 1971). Some rare mineral species have been also identified in the last time e. g. chalcostibite, idaite, owyheeite, hetaerolite, cymrite, sonolite, leucophoenicite etc. The classical, partly very old mineral occurrences in Romania still furnished some new mineral species such as monsmedite (at Baia Sprie), krautite (Săcarimb), the new Cu-Bi sulfotelluride tentatively named "jolotcaite" (Jolotca-Ditrău), the new telluride SbTe_2 (Stănița), paderaite (Băița Bihor).



Unfortunately, only few new data could be obtained on the minerals firstly described in Romania because most of the type localities (generally very old occurrences) are now nearly totally exhausted and the museum samples are scarce and/or the original samples are lacking.

However, new data do exist concerning ardealite properties and associations (Constantinescu et al., 1985, unpubl.), szmikite properties (Tatu, 1989), szaibelyite occurrences and associations (Marincea, this volume) etc. The status of the mineral broștenite has been revised (Bălan, 1976). The some author gave suggestions regarding the classification of the Ca-, Fe-, Mg-, Mn-bearing carbonates. Bologa (1977) and Gorduza (1977) summarized the data on the minerals discovered in the Baia Mare mineral zone (North Romania) and partly available in the Maramureş District Museum.

Still open remain some problems of identification, first descriptions and of priority. Studies on monsmedite, a unique thalium sulfate are now in progress. Sample from two occurrences, i. e. from the type locality Baia Sprie and from the nearby situated Săsar ore deposit, probably representing two mineral species, have been analyzed in different laboratories producing thus conflicting results.

In spite of careful examination of many samples from Bădeni, type locality of badenite, $(\text{Co}, \text{Ni}, \text{As})_3(\text{As}, \text{Bi})_4$, no indications on the existence of such a mineral could be obtained. In addition, Bayliss (1983) undoubtedly showed that his specimen labelled badenite was a mixture of native bismuth, safflorite and modderite. However, no modern analyses on the original sample have been made.

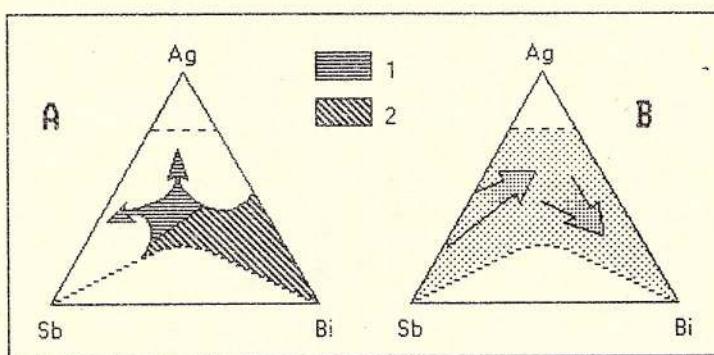


Fig. 8 – Ternary diagrams of minor elements in galena.
A, Field of galena related to K₃-Pg₁ (hachures) and Neogene (dots) magmatites. Vertical lines – specific plotting points for some deep seated Neogene ores related to subvolcanic structures. B, Distribution points of analyzed samples (mainly from Romanian occurrences) showing two maxima on the Ag-Sb and Ag-Bi edges, corresponding to Neogene and K₃-Pg₁ magmatites, respectively. Arrows indicate the increasing formation temperatures of galena-containing mineral assemblages.

The nagyagite is one of the "oldest" minerals first described in Romanian occurrences. Giușcă (1937) gave the most probable formula of this complex telluride species and Udubaşa (1986b) has shown that the nagyagite is the earliest mineral among tellurides identified in ores from the type locality – Săcarimb (formerly Nagyag). The "two nagyagites" mentioned by Giușcă (1935) have been identified by one of the authors (G.U.) in the Ramdohr's collection of polished sections (Collection number 1030; i.e. very old sample, from Săcarimb-Nagyag). The uniqueness of sample prevented further investigations.

The status of rezbanyite remains nuclear. Padéra (1956) was the first who showed that rezbanyite seems not to exist. Subsequent studies made by Cioflica, Vlad (1973, 1974), Cioflica et al. (1977, 1982) on the ores from Băița Bihor, i.e. the type locality of rezbanyite (old name: Rezbánya) did not lead to rezbanyite "rediscovery"; however other Bi-bearing minerals have been encountered, i.e. aikinite, bursaite etc. In addition, the new mineral padéraite has been discovered in very old museum samples labelled "rezbanyite" (Mumme, Žak, 1985).

The andorite of Krenner (1892) suffered also some detailed work made especially by Moëlo et al. (1984) who showed that the old andorite IV and andorite VI seem to represent two distinct species named quatrandorite and senandorite, respectively, with slight different compositions and structural features.

The problem of the so-called lotrite is more complex as the name has priority (Munteanu-Murgoci, 1900; 1901) over pumpellyite (Palache, Vassar, 1925). Using new analyses of the type material Rădulescu (1961) and Kissling (1973) demonstrated that the two minerals are identical. In order to conciliate this priority conflict it is here proposed that the minerals pumpellyite, ferropumpellyite, julgoldite and shuiskite should be named lotrite-pumpellyite series.

A still open but intriguing problem is that concerning the existence of diamond in Romania. The references are very old and the data contained are very scarce. Fichtel (1780) only mentioned two diamond grains in the central part of the country. The second reference (Eremeev, 1897) could not be seen (cited in Fersman, 1955). No later confirmation does exist.

*
* *

Sphalerite is one of the best studied sulfide minerals. The relationships between the iron content and cell edges of sphalerites ranging in composition from 0.04 wt.%Fe to 14.36 wt.%Fe (Romanian occurrences) have been presented by Udubaşa et al. (1974). A microprobe study of the sphalerite from Baia de Arieş (occ. type III Cc) pointing out the grain inhomogeneity was carried out by Lazăr, Farbaş (1986). Petreus, Kasper (1970) studied the surface structures of some sphalerite crystals from Rodna ore deposit (occ. type III Cc) concluding that the twinning takes place during crystal growth.

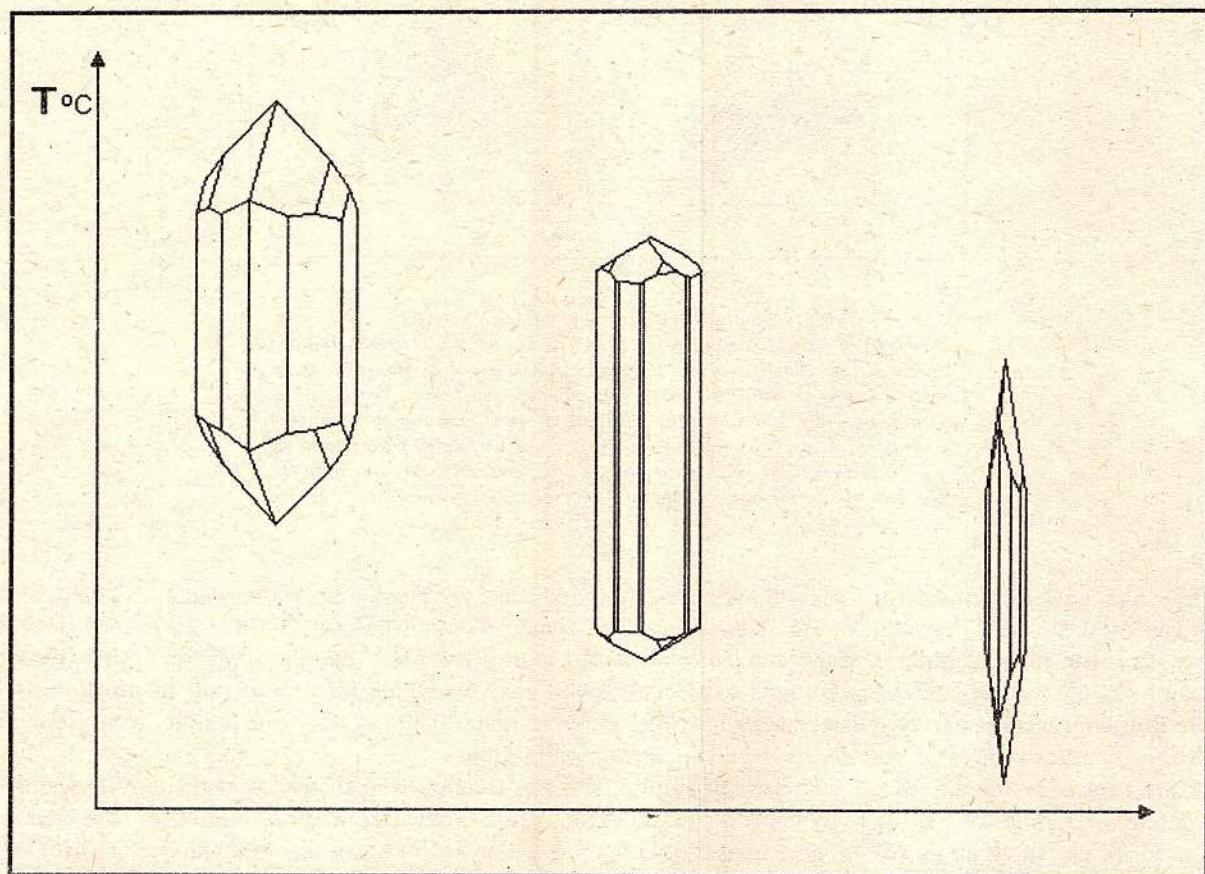


Fig. 9 – Crystallogenetic diagram of stibnite (Romanian occurrences mainly from the Baia Mare mining district). From left to right: crystal habits typical of the Băiuț, Herja and Baia Sprie ore deposits (decreasing temperature).

A study regarding habit variations of pyrite as a function of the sample position in the veins at Bucium, Metaliferi Mts, as well as of the grain size was thoroughly carried out by Stiopol, Drăghici (1970); they show that by increasing crystal size the pyrite habit changes from (100) through (111) to (210). The same authors (Stiopol, Drăghici, 1972) studied also the dependence of crystal habit of pyrite, galena and sphalerite upon the minor elements, suggesting a general trend of decreasing contents of minor elements by increasing grain size. Nedelcu et al. (this volume) carried out a detailed study of the pyrite from the Main Vein at Baia Sprie correlating the crystal morphology, minor elements, sulfur isotopes and other data.

The gold distribution in pyrite, sphalerite and galena from the Baia de Arieș ore deposit has been studied by Lazăr, Anastase (1983) and a study concerning trace elements in pyrite from the Bihor Mts gave the opportunity to delineate a regional zoning of the ore occurrences (Lazăr et al., 1982). Some ideas about the geochemical features of pyrite, galena and sphalerite in occurrences of various ages in Romania have been obtained by Udubaşa (1974) and Udubaşa et al. (1975); specific geochemical trends appear by plotting minor elements on ternary diagrams, such as for galena (Ag-Bi-Sb diagram), pointing out the characteristic field Ag-Bi for the galena related to K₃-Pg₁ ores and the Ag-Sb field for the Neogene galenas (Fig. 8). Sulfur isotopes of pyrite, sphalerite, galena, pyrrhotite, chalcopyrite from alpine deposits in Romania have been studied by Udubaşa, Gaftoi (1985) and from the Neogene porphyry coppers by Borcoş, Gaftoi (1985).

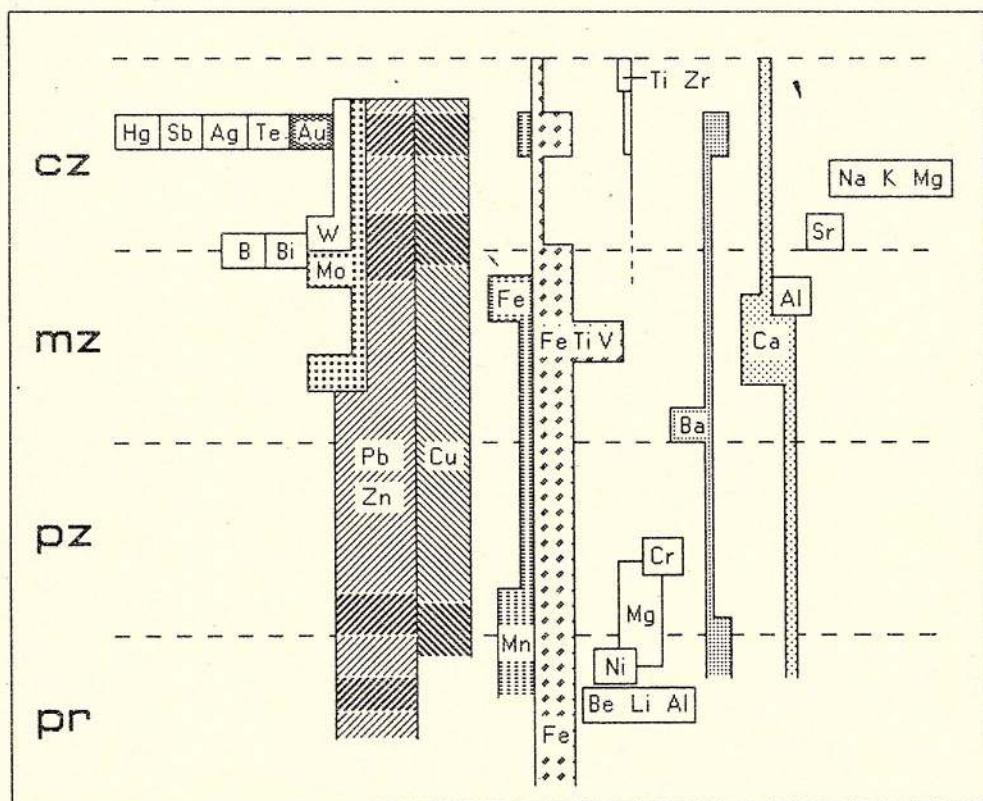


Fig. 10 – Schematic representation of different mineral groups (expressed by their main metals) as a function of age (without genetic support). The Cainozoic time is by far the richest in mineral species.

A very typical mineral of the Baia Mare zone, the stibnite, displays habit variations primarily as function of temperature (Fig. 9). Studies are in progress for a detailed analysis of the minor elements and of the sulfur isotope composition of the three (at least) habit types of stibnite (Udubaşa, in press).

Mention should also be made of some papers containing much mineralogical data used in solving various geological problems. By a detailed study of the sedimentary pyrite crystals Petreuş (1976) generalized his idea about the sectorial crystal growth (Petreuş, 1974, 1978, 1981). Some petrological problems of the quite complex alkaline igneous massif at Ditrău, East Carpathians have been solved by Anastasiu, Constantinescu (1978) by

using the feldspar minerals. Similar data were presented by Anastasiu (1971) for the Ogradena granitoids. Attempts were made to separate lava flows from shallow intrusives either on the basis of the relationships between clinopyroxene and orthopyroxene (augite and hypersthene) (Măldărescu, 1977) or by using specific intergrowths of the Fe-Ti oxide minerals and titanite (Udubaşa, 1984b).

The crystallinity index and other data on some clay minerals were used by Rădan (in Iancu et al., 1984) to distinguish low grade metamorphic rocks of similar appearance but of different ages.

Careful mineralogical studies in the Leaota Mts carried out by Săbău et al. (1986) led to new ideas about the eclogite genesis in this area. Robu, Robu (1988; this volume) give an overall picture concerning the zircon in many granitoid massifs in Romania and its use (mostly its morphology) in solving petrological problems. The Al_2SiO_5 minerals were largely used by Hărtopanu (in press) in deciphering the long and rather complex history of the metapelitic rocks belonging to the Precambrian Sebeş-Lotru Series (or Group) in the South Carpathians. Supplementary arguments in this respect were offered by a careful study of the manganese minerals and their textural relationships (Hărtopanu, Hărtopanu, 1981; Hărtopanu, 1986).

Taking into account the age of the main occurrences in Romania a general picture of different mineral associations or parageneses can be established as shown in Figure 10. A similar approach was made by Rădulescu, Dimitrescu (1971) but for the Alpine time only. Some minerals (expressed by their main elements) have formed practically during the whole time interval since the Precambrian till Recent, i.e. iron-, copper-, lead-zinc, and calcium (mostly calcite) minerals. Some other show a clear enrichment during certain time periods, such as the minerals of Mo, Mn, Cr etc. Finally, there are time-bound mineral assemblages, i.e. minerals of Au, Ag, Sb, Bi, Hg. Regarding the species number, the richest mineral-forming processes are those related to the Neogene igneous activity, producing locally clear and intense remobilization of some elements from the pre-Neogene basement. Very conspicuous are such processes in Northern Romania (Baia Mare zone), where abundant rhodochrosite appears associated with important vein sulfide assemblages (e.g. Căvnic ore deposit, Popescu, 1978). Much more complex seem to be the remobilization processes in the Metaliferi Mts, where a typical geochemical triad, i.e. Au-Te-Mn has been depicted in connection with the active role of the basement (mostly ophiolitic) in furnishing at least Mn, if not Au and Te, too (Udubaşa et al., 1985). In the same region, a "metallic area" (in the sense of Routhier, 1977) rich in Mo has been found, which was repeatedly activated during the Lower Cretaceous-Miocene time yielding some molybdenite occurrences located mostly along the Mureş mobile zone.

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4. Famous mineral occurrences in Romania

(for location see map - Fig. 11; in brackets - the old names of the localities)

Baia de Aries (Offenbánya; Offenburg). Occ. type: III Cc. The ores consist both of lead-zinc minerals forming metasomatic bodies in metamorphic limestones and native gold and tellurides in stockworks located in Neogene andesites. There are about 50 minerals described here, among which the most interesting (or abundant) are the following: alabandite, sylvanite, kutnohorite, bustamite (in locally developed skarn bodies), tetrahedrite, pyrargirite, pittcite, wad etc.

Baia Sprie (Felsőbánya). Occ. type: III Cc. A vein system about 2 km long with a well developed vertical zoning (Au-Ag, Pb-Zn, Cu-W), located in Neogene andesites. The ores contain more than 70 minerals, among which some of them were discovered here (italics): *andorite*, *berthierite*, *arsenopyrite*, *felsőbányite*, *klebelsbergite*, *dietrichite*, *scheelite*, *semseyite*, *szmikite*, *wolframite*, *zinkenite*, *sfalerite* (containing up to 1.8 wt% Fe), *barite* (colored crystals: blue, yellow, red, brownish), *siderite* (usually forming globular aggregates) etc. Antimonite needle-like crystals are very frequent, sometimes piercing tabular barite crystals. The supposed new mineral *monsmedite* has been found in the oxidation zone.

Băița Bihor (Rezbánya). Occ. type: III Bb. A skarn ore deposit related to Laramian magmatites containing about 100 minerals. The bismut and boron species are the most typical. Worth of mention are the following: bismuthinite, aikinite, bursaite, emplectite, wittichenite, *szaibelyite*, cosalite, *rezbányite*, tetradyomite, diopside, wollastonite, dioptase, *kotoite*, molybdenite, pseudomalachite, scheelite, crocoite, native metals (bismuth, copper, gold, silver), wulfenite (forming crystals in vugs, associated with malachite). Dioptase (first



occurrence in Europe, described in 1879) forms crystals up to 1.5 mm in size, being associated with wulfenite and hemimorphite.

Blazna Valley, Rodna Mts. Occ. type: IAb. Stratiform ores in metamorphic limestones forming superposed lenses or tabular bodies. About 20 minerals. Very interesting is the presence of cymrite (first occurrence in Europe). Other minerals: rutile (enclosed in sfalerite), proustite-pyrgirite (contained by highly deformed galena rich ores), barite etc. Rutile crystals up to 4 cm in size (sometimes twinned) occur in the host micaschists containing quartz lenses and almandine crystals up to 3 cm in size.

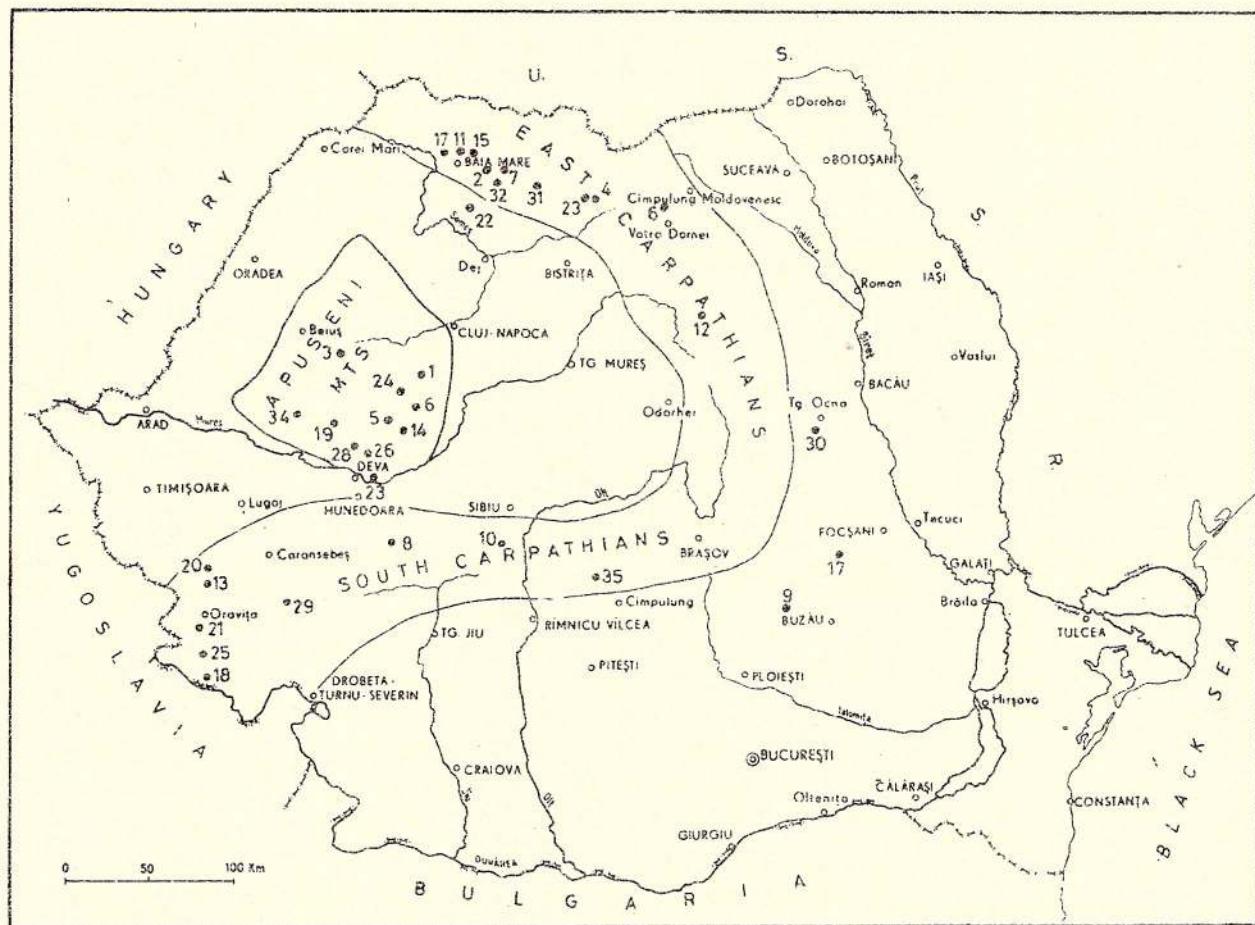


Fig. 11 - Distribution of the main mineral occurrences in Romania. (In brackets old names and occurrence type, respectively).

- 1, Baia de Aries (Offenbanya)(III Cc); 2, Baia Sprie (Felsöbanya)(III Cc); 3, Băița Bihor (Rezbanya) (III Bb); 4, Blazna Valley (IAb); 5, Boteș(III Cc), 6, Buciumu (III Cc); 7, Cavnic (Kapnikbanya)(III Cc); 8, Ciclovina (X, II Ba); 9, Colți-Buzău (VII); 10, Conțu (IE); 11, Dealul Crucii (Kereszthegy)(III Cc); 12, Ditrău (III Ba, III Ca); 13, Dognecea (III Bb), 14, Fața Băii (Facebanya, III Cc); 15, Herja (Kisbanya) (III Cc); 16, Iacobeni (IBc); 17, Jitia (VII Ac); 18, Moldova Nouă (III Bb); 19, Musariu (Ruda Barza)(III Cc); 20, Ocna de Fier (Vaskö)(III Bb); 21, Oravița-Ciclova (III Bb); 22, Răzoare (Macskaméző)(IAc); 23, Rodna (III Cc); 24, Roșia Montană (Verespatak)(III Cc); 25, Sasca Montană (III Bb); 26, Săcărimb (Nagyag)(III Cc); Săsar (III Cc); 28, Stănița (III Cc); 29, Teregova (IE); 30, Tîrgu Ocna (VII Ac); 31, Tibieș (III Cc); 32, Trestia (XII); 33, Uroiș (Arany) (VBe); Vața (III Bb); Vilsan (III Ab).

Boteș. Occ. type: III Cc. Veins in Neogene andesites. About 20 minerals. Very typical is the hessite, occurring as isometric crystals (botesite). Other minerals: chalcopyrite (forms rich crystals), pyrite (with crystals

showing a rare form (15.4.0), tetrahedrite (associated with calcite and adularia), manganite, pyromorphite.

Bucium. Occ. type: IIIICc. Vein deposits, copper-dominated. The best vein has been named Arama ("Copper"). About 20 minerals. Beautiful enargite crystals, big pyrite crystals (the biggest pentagon-dodecahedra found in Romania, up to 10 cm in size), form-rich chalcopyrite crystals. Tellurides: hessite, petzite, sylvanite. Compact tetrahedrite aggregates. The only germanite occurrence in Romania.

Cavnic (Kapnik, Kapnikbanya). Occ type: IIIICc. A system of parallel base metal ore veins located in Neogene andesites capping a deep intrusion of intermediate composition. The veins are characterized by a great amount of rhodochrosite, generally forming altering bands with sulfides or even small crystals; locally pseudomorphs after alabandite. Other minerals: tetrahedrite (beautiful crystals up to 4 cm in size) gypsum (big transparent crystals up to 50-60 cm in size, sometimes twinned); helvite (rare !), wavellite, whewellite; skeletal quartz crystals; pseudomorphs of calcite after quartz (typical of the Gavra vein and thus named Gavra quartz); barite (perfect crystals up to 7-8 cm in size, of yellowish or bluish color, sometimes coated by marcasite). More than 50 species are known here. Pseudomorphs of bournonite after tetrahedrite.

Cioclovina, Sebeș Mts. Occ. type: X, IIIBa. The type locality of *ardealite* occurring with gypsum, brushite, crandallite, etc. Near the cave a shear-zone related occurrence of base metal ores was found later in Precambrian metamorphics; the ores rich in sphalerite and contain also greigite, jamesonite, arsenopyrite, bravoite, etc.

Colți-Buzău. Occ. type: VII. The best known amber occurrence in Romania (romanite) located in Paleogene sedimentary rocks. The biggest masses found here reached 1-2 kg. Although the amber amount is small the romanite is of gemmological interest; in the 19th century the price of this amber was as high as that of the Baltic Sea amber.

Conțu, Lotru Mts. Occ. type: IE. Metamorphic pegmatites hosted by Upper Proterozoic rocks displaying an unusual enrichment in Li for this genetic type. Some 15 minerals are described by now. A large variety of phosphate minerals are present in small amounts. Rare minerals: U-bearing Mg-columbite. Spodumen-rich pegmatite bodies contain also lithiophilite, triphylite, amblygonite-montebrasite, purpurite, favorite, alluaudite (?), topaz, cassiterite, sphalerite.

Dealul Crucii (Kereszthegy). Occ. type: IIIICc - Gold-silver bearing veins in Neogene andesites. The ores are rich in sulfosalts (andorite, fülöppite, jamesonite, pearceite, semseyite, zinckenite, etc). Type locality of *fülöppite*. Classical vertical zoning, with Au-Ag minerals near the surface and Pb-Zn minerals toward depths. About 25 minerals described. Small silver octahedrons in quartz; beautiful miargirite crystals, very rich in forms.

Ditrău (Ditró). Occ. types: IIIBa, IIIICa. Veins and stockworks in an alkaline igneous complex of Jurassic age very complex in structure. About 50 minerals found. Worth of mention are: baddeleyite, cancrinite, meliphanite, molybdenite, phlogopite, rhoenite, scapolites, monazite, xenotime, etc. The new data show the presence of picroilmenite, some Bi sulfosalts, mackinawite, Nb-Ta oxides, lillianite, "jolotcaite", etc.

Dogenecea (Dognacska). Occ. type: IIIBb. Skarn deposit related to banatitic ($K_3\text{-}Pg_1$) magmatites with base metal ores. Over 60 minerals have been described here and *dognacskaite* as a new species. Typical minerals: manganese ilvaite, manganese diopside, manganese hedenbergite, pyrite crystals very rich in forms (about 200 !), ludwigite, compact aggregates of smithsonite of varying colours, manganite, pyrolusite, eulytite, blue kidney-like aggregates of aurichalcite, cerussite crystals up to 7 mm in size, sometimes twinned, very rich in crystallographic forms, etc.

Fața Băii (Facebánya). Occ. type: IIIICc. Gold-base metal ore veins in Neogene andesites containing relatively few minerals (about 15), among which tellurium, krennerite, nagyagite, jamesonite are the most interesting. Fața Băii ore deposit is the type locality of *native tellurium*, described here by von Reichenstein as early as 1792. It forms columnar crystals up to 1 mm in size, as a rule closely associated with pyrite, gold and quartz; it contains up to 5.83% Se.

Herja (Kisbánya). Occ. type: IIIICc. A system of veins located either in Neogene sedimentary rocks or in andesitic lavas capping a subvolcanic body. Type locality of *fizelyite*. Other 25-30 minerals are contained by these ores. Tetrahedrite crystals (sometimes freibergite) in vugs coated by fine-grained quartz; needle-like berthierite aggregates, cronstedtite spheroidal aggregates of small crystals, flower-like pyrrhotite crystals sometimes completely substituted by marcasite, spheroidal black and white aggregates of small rhombohedral calcite crystals, felt-like plumosite (jamesonite), semseyite, mackinawite, vivianite, siderite ball-like aggregates, black iron-rich sphalerite, galena crystals with takenof ("melted") edges.

Iacobeni. Occ. type: IBc. Stratabound manganese deposit in Lower Paleozoic low grade metamorphics. Over 70 minerals known. Type locality of "ponite". Rare minerals: tephroite, paracelsian, pyrophanite,



sonolite, alleghanite, nsutite, birnessite, högbomite, neotokite etc. Here, Bălan (1974) was able to redefine mineral "brostenite", which he proves to be not a mixture but a mineral of varying composition. Extensive solid solution series within the Ca-Fe-Mn-Mg carbonates, for which the same author has proposed a new, useful classification. Worth of mention is also the presence of alabandite, the only occurrence in stratiform ores in Romania.

Jitia. Occ. type: VIIAc. Typical sedimentary Pb-Zn ore occurrences in evaporite-rich rock sequences of Lower Miocene age. Galena and sphalerite are the most widespread ore minerals. Compact pyrrhotite masses, greigite (often transformed in pyrite and marcasite), celestite, barite etc. have also been described.

Moldova Nouă (Uj Moldova). Occ type: IIIBb. Skarn and porphyry copper ore deposits related to K₃-Pg₁ magmatites. Some 45 mineral species were described here, among which malachite acicular aggregates as well as massive aggregates or crystals of realgar and orpiment constitute celebrated museum samples. Compact masses of anhydrite representing a remote paragenesis of the porphyry system have been recently described.

Musariu-Brad (Ruda-Barza, Rudaer 12 Apostel). Occ. type: IIICc. Gold-bearing vein system related to Neogene magmatites passing at depth to a typical porphyry gold-copper deposits. A great variety of native gold samples was produced here, being preserved at the Gold Museum in Brad (Metaliferi Mts). A complex paragenesis of native tellurium accompanied by a great number of tellurides (of Au, Ag, Fe, Cu) has been described here lately.

Ocna de Fier (Moravicza; Vaskö). Occ. type: IIIBb. Iron ores in skarns related to K₃-Pg₁ magmatites. Some 90 mineral species are known here. Special mention deserve the garnet (grossular and andradite) crystals – up to 4 cm in size, the magnetite and hematite crystals; these minerals also form beautiful pseudomorphs after garnets. Of interest is also the growth of small andradite crystals over the pyrite hexahedrons some 8-12 mm in size. *Ludwigite* was described at Ocna de Fier for the first time in the world. It contains 15-20% paigeite moles and forms as a rule radiating prismatic crystals. The Cu-Zn hydrated phosphate, *veszelyite* has also the type locality at Ocna de Fier (first description: 1880 by Schaller). Worth of mention are also the stalactite-like forms of the supergene Mn-oxides, e.g. pyrolusite. Calcite is very rich in crystallographic forms. Japanese twin of quartz has also been described. Some rare minerals: schefferite, paligorskite, franklinite, szaibelyite etc.

Oravița-Ciclova (Csiklova). Occ. type: IIIBb. Polymetallic skarn related ore deposit associated with K₃-Pg₁ magmatic rocks (granodiorites, monzodiorites). Elaborately patterned skarns containing grandites, vesuvianite (tetragonal bipyramids up to 10 cm in size), gehlenite, chondrodite, wollastonite etc. Numerous hydrothermal ore bodies are hosted either by the igneous rocks or by skarns and hornfelses. Within these ore deposits more than 80 minerals were described, among which some were found here for the first time in the world, i.e. *csiklovaite*, *hoernesite*, or in Romania, i.e. glaucodot, kobellite, gehlenite. An open problem is that of *alloclase*, maybe a precursor of alloclasite.

Răzoare (Macska Mts; Mașca) (Preluca Mts). Occ. type: IAc. Stratabound Mn-Fe ores in Upper Precambrian metamorphics; nearby some pegmatite bodies containing apatite, beryl and uncommon great amounts of tourmaline. The Mn-Fe ores consist of silicates (manganan-fayalite, tephroite, manganan cummingtonite (dannemorite), spessartine, pyroxmangite, sonolite, leucophoenicite etc.), carbonates (rhodochrosite) and oxides (magnetite, jacobsite, pyrolusite). Of special mineralogical interest are the pyrolusite acicular aggregates associated with perfectly transparent minute quartz crystals in vugs contained by amorphous Mn-oxides as well as the pyroxmangite crystals (up to 4 cm in size) in some pegmatoid segregations.

Rodna. Occ. type: IIICc. Metasomatic Pb-Zn ore bodies in Precambrian metamorphic limestones. The epigenetic ores are related with Neogene andesites and microdiorites and cut sometimes the Precambrian stratabound Pb-Zn pyrite ores of Blazna Valley type. Some 40 minerals described. Beautiful pyrite crystals (most pyritohedra), iron-rich (black) sphalerite crystals up to 5 cm in size, tabular (twinned) galena crystals. The cerussite is here of special interest; it forms massive aggregates in the upper parts of the deposits and beautiful crystals (multiple twins). Also typical these ores are: bournonite crystals (Rădelerz), semseyite, boulangerite ("plumosit") and white dolomite crystals up to 3 cm in size. Other minerals: mackinawite (first occurrence in Romania), hetaerolite (first occurrence in Europe), vivianite etc.

Rosia Montană (Verespatak). Occ. type: IIICc. Vein and stockwork in Neogene rhyodacites. About 40 mineral species. Gold was the most important mineral often forming beautiful aggregates (leaves, moss-like etc.), sometimes associated with silver sulfosalts (pearceite, proustite, stephanite). One of the two helvite occurrences in Romania. Interesting are also the quartz phenocrysts of the rhyodacites, reaching sometimes 2-2.5 cm in size; short bipyramids, often translucent; paramorphs of α -quartz after β -quartz (the transformation is complete). One of the oldest mines in Romania; gold exploitation since the Roman times. Type locality of



the Verespatak twin law of high quartz (twin plane $11\bar{2}2$).

Sasca Montană (Szászka). Occ. type: III**Bb**. Skarn related copper ores with locally developed porphyry-like mineralizations in granodiorites. Over 50 minerals described. Vesuvianite crystals up to 6 cm in size are very typical of these deposits. Compact aggregates of chalcocite have been found in the oxidation zones. First occurrence of idaite in Romania. A variety of smithsonite has been described here under the name "szaszkaite".

Săcărîmb (Nagyag; Szekeremb). Occ. type: III**Cc**. Vein systems in a complex volcanic structure of Neogene age (andesite prevail). One of the best known Romanian ore deposits, very rich in Au-Ag tellurides, type locality of many tellurides, i.e. *nagyagite*, *sylvanite*, *krennerite*, *petzite*, *muthmannite*, *stützite*. Also type locality of *krautite* (recently described), *tellurite*. First European occurrence of frohbergite. Over 80 minerals described; very frequently found is the association gold tellurides + rhodochrosite + alabandite. Crystals of bournonite, nagyagite (biggest in the world - 6 cm long, hosted by the Naturhistorisches Museum in Wien), silver sulfosalts, sphalerite (iron-poor), galena etc. were found here. Pseudomorphs of calcite after quartz crystals.

Săsar. Occ. type: III**Cc**. Gold veins in Neogene andesites. The ores contain few, common minerals (about 20) but the occurrence is interesting as it contains also monsmedite as well as hard hydrocarbons (e.g. elaterite) in vugs contained by the vein quartz.

Stănița. Occ. type: III**Cc**. Several vein systems in Neogene volcanic structures. The ores contain some tellurides (altaite, hessite, sylvanite), stibnite (rosette-like aggregates typical for the few stibnite occurrences in the Metaliferi Mts, as against the stibnites of the Baia Mare district, where this mineral forms bush-like aggregates of acicular or prismatic crystals). Gold lamellae or thread-like aggregates, sometimes included in/or associated with fluorite (dark green or pink crystals). Apophyllite crystals up to 1 cm in size. First locality of the naturally occurring SbTe_2 .

Teregova. Occ. type: II**E**. Metamorphic pegmatites known as the beryl-rich occurrence (crystals up to 8 kg) in Romania. Also described here: columbite, montebrasite, spodumen, tantalite, phlogopite etc.

Tîrgu-Ocna. Occ. type: VII**Aa**. The most important salt rock and K-salts deposit in Romania containing carnallite, kainite, langbeinite, picromerite, polyhalite, silvite etc. The host rocks are Lower Miocene age.

Tibles. Occ. type: III**Cc**. Vein systems and stockwork mineralizations in a polyphase intrusion of Neogene age (monzodiorites-diorites). Some 60 minerals described. Special interest deserves: fluorphlogopite crystals up to 10 cm in size associated with tremolite (grammatite) crystals in skarns; apatite and rutile associated with pyrrhotite in hornfelses; molybdenite intergrown with tourmaline in stockworks; mackinawite and cubanite inclusions in black, iron-rich sphalerite. Also perfect pyrite cubes up to 10-20 cm in size are known from some veins containing only pyrite and quartz. Apophyllite crystals (some 8-10 mm in size) have been described from the late barren veinlets. Rare minerals: owyheeite, freieslebenite, berthierite (intergrown with arsenopyrite in quartz), kermesite (rosettes) etc. Of special interest are the massive rutile aggregates forming a network (veinlets up to 3 cm in width !) within the hornfelsized Paleogene sandstones; also breccias with tourmaline matrix.

Trestia (Gutii Mts). Occ. type: XII. Celebrated occurrence of the blue chalcedony, known since the 18th century. The sky-blue fragments (5-15 cm in size) are scattered in soil or alluvial material, being formed by solidification of some silica gel originating in hot springs. Sinter-like reniform masses, thin radial-fibrous or parallel banded structures, surfaces imprinted by irregular reliefs or plates and druses inlaid with cubic crystals. Though considered to represent quartz-chalcedony pseudomorphs after fluorite or galena, even a rare species of rhombohedral quartz or a new silica species named "cubosilicite", it is more likely that the blue cubes are quartz-chalcedony paramorphs after melanophlogite.

Uroiul (Arany; Aranyer Berg)(near Deva). Occ. type: V**Bc**. Type locality of *pseudobrookite*. This mineral occurs in a highly oxidized pyroxene andesite of Neogene age. It forms crystals up to 2 mm in size in vugs containing also hematite and hypersthene crystals. The xenoliths in andesites contain cordierite, hydrogrossular (hibschite), tridymite etc.

Vața. Occ. type: III**Bb**. High temperature calc skarns at contacts of quartz-monzodiorites of K₃-Pg₁ age with Jurassic reef limestones. They contain either gehlenite associated with garnet, vesuvianite, melanite (4.41% TiO₂), wollastonite (Cerboai Valley) or spurrite-tilleyite dominated assemblages containing also garnets, wollastonite, vesuvianite, gehlenite (Cornet Hill). Unusually large sized gehlenite crystals up to 12/3 cm are to be noted in the Cerboai Valley occurrence.

Vilsan Valley (Făgăraș Mts). Occ. type: III**Ab**. A metamagnetic ore-mineralisation within Precam-



brian metamorphics. About 20 ore minerals were recognized as disseminations or massive ore parts within the metagabbros enveloped by biotite paragneisses. Along with the "standard" association in such ore type, i.e. pyrrhotite, chalcopyrite and pentlandite there are some rare minerals such as cobalt-pentlandite and tocilinite. Vilarite is quite frequently found, as well as millerite and mackinawite formed at the expense of pentlandite and bravoite developed on the secondary Ni-bearing pyrite. A chromium-poor spinel phase occurs as euhedral grains exhibiting regular ilmenite or rutile laths.

Note added in proof. No published data do still exist concerning the U-bearing minerals in Romania although interesting occurrences are known in the South and East Carpathians as well as in the Apuseni Mts, related to sheared metamorphic rocks and Permian sedimentary deposits respectively.

The main minerals are:

- uraninite and/or pitchblende
- autunite
- torbernite

Umohoite was also recognized in the copper-dominated ore at Rănușa, Apuseni Mts (Dr. S. Vlad, pers. communication). Autunite and torbernite were found and recently described in the Drocea mts (Savu, in press). Uraninite is known from many occurrences in the Bistrița Mts, Leaota Mts, South Banat and Bihor Mts. The next overview "Minerals in Romania" will give more details on the U-bearing minerals and generally on the minerals containing radioactive elements.

Appendix I

Types of occurrences

- I. Precambrian (*A*), Paleozoic (*B*) and Mesozoic (*C*) metamorphic rocks (*a*), base metal (*b*), Mn-bearing (*c*) and other stratabound (*d*) ores; anchimetamorphic (*e*) and retrograde (*f*) rocks; A_2 ores reworked during Laramian (K_3-Pg_1) igneous activity (*g*); metamorphic differentiates (*h*).
- ID. Metabasites (*a*), metaultrabasites (*b*), ultrabasic granulites (*c*), granulites (*d*), eclogites (*e*) in Precambrian metamorphics.
- IE. Precambrian metamorphic pegmatites.
- IF. Precambrian granitoids (*a*), Paleozoic granites (*b*) and other rocks (*c*); Triassic acidic, alkaline and basic rocks (*d*), Jurassic alkaline rocks (*e*); Mesozoic ophiolites (*f*); K_1 -island arc magmatites (*g*), K_3-Pg_1 subduction magmatites (banatites) (*h*), Neogene subduction magmatites (*i*), Pliocene intraplate volcanics (*j*).
- IIA. Alpine type veins in Precambrian (*a*) or Paleozoic (*b*) metamorphics.
- IIB. Shear-zone related occurrences in metamorphics (*a*), Paleozoic gabbros (*b*) and granitoids of different ages (*c*); fahband-related veins in Precambrian metamorphics (*d*).
- III A. Fe-Ti-V ores in Mesozoic gabbros (*a*) and chromite+Ni minerals in Precambrian (*b*) and Paleozoic metabasites or ultrabasites (*c*).
- III B. Skarns related to older (*a*), K_3-Pg_1 -banatitic (*b*) and Cenozoic (*c*) magmatites; hornfelses (*d*), porphyry copper/molybdenum deposits (*e*); subsequent transformation of skarn minerals (*f*), subsequent hydrothermal deposition (*g*); greisens related to Hercynian granitoids (*h*).
- III C. Hydrothermal vein or stockwork-type ore deposits related to Jurassic alkaline complexes (*a*), calc-alkaline K_3-Pg_1 (*b*) or Cenozoic (*c*) magmatites; related alteration zones (*d*); other veins of uncertain age (*e*); veins related to K_1 -island arc magmatites (*f*).
- III D. hydrothermal veins (*a*) and alteration zones (*b*) in Mesozoic ophiolites (*c*) or island arc volcanics (*d*).
- III E. Hydrothermal-metasomatic deposits of Triassic (*a*) or unknown (*b*) age.
- IV A. Late (mostly barren) veinlets or nests in Mesozoic (*a*), Cenozoic (*b*) magmatites or in other rock types (*c*).
- IV B. Altered (sometimes bentonitized) perlites (*a*), pyroclastics (*b*), pegmatites and aplites (*c*).
- V. Accessory minerals (*A*), vug fillings (*B*) or xenoliths (*C*) in igneous rocks of Paleozoic (*a*), Mesozoic (*b*) or Cenozoic (*c*) age; accessory minerals in Precambrian granitoids (*d*).
- VI. Oxidation zones of ore deposits or of different rock types (*A*).
- VII. Sedimentary rocks; authigene (*A*) or allogene (*B*) minerals; evaporites (*a*), laterites and bauxites (*b*), base metal occurrences (*c*); clays (*d*), detrital rocks (*e*), carbonate rocks (*f*); coals (*g*); black shales (*h*); "diagenetic" veins (*i*).
- VIII. Heavy mineral concentrates from alluvia.
- IX. Soil minerals.
- X. Cave minerals.
- XI. Occurrences of uncertain genesis and/or ages.
- XII. Depositions from mineral springs (*a*), recent deposition in old mining galleries (*b*) or in salt lakes (*c*).



Appendix II

Mineral names related to Romanian occurrences

Over 14 percent of the total number of minerals known worldwide have been identified in Romanian occurrences and about one percent, i.e. 30 species have their type localities in Romania. Besides the valid mineral names there are numerous names of varieties, of minerals with uncertain status or synonyms that are related to the historical development of mineralogy.

A. Valid mineral species

Native elements

1. *Tellurium*. First recognized by von Reichenstein in 1783 ("aurum paradoxum", "metallum problematicum"), then indentified and named "tellurium" (from tellus-Earth) by Klaproth in 1792. Type locality (TL)=Fața Băii (old name Facebánya), mine Maria Hülf.

Sulfides and sulfosalts

2. *Nagyagite*. "Aurum galena" of Born (1772), "Blättererz" of Karsten (1800), "elasmose" of Bendant (1832) was named nagyagite by Haidinger in 1845. TL: Săcărîmb (Nagyag).

3. *Sylvanite*. "Weissgolderz" of von Reichenstein (1785), "Aurum graphicum", "or blanc d'Offenbánya" of Born (1790) was named sylvanite by Necker (1835). TL: Baia de Arieș (Offenbánya).

4. *Petzite*. Haidingen (1845) TL: Săcărîmb.

5. *Rezbanyite*. Name initially used for an impure cosalite (Hermann, 1859); the formula $Pb_3Cu_3Bi_{10}S_{19}$ was found in 1883 by Frenzel. Recent works on old sample labelled rezbanyite failed to find such a formula and the status of the mineral remains in doubt. TL: Băița Bihor.

6. *Krennerite*. von Rath (1877). TL: Săcărîmb.7. *Stuetzite*. Schrauf (1877). TL: Săcărîmb.8. *Semseyite*. Krenner (1881). TL: Baia Sprie (Felsöbanya)

9. *Andorite*. Krenner (1892). Early observed andorite IV and andorite VI were found to represent distinct mineral phases named quatrandorite and senandorite, respectively (Moëlo et al., 1984), closely related to nakaseite and ramdohrite. TL: Baia Sprie.

10. *Muthmannite*. Zambonini (1911). TL: Săcărîmb.11. *Fizelyite*. Krenner, Loczka (1926). TL: Herja (Kisbánya).12. *Fülöppite*. Koch (1926). TL: Dealul Crucii (Kereszthegy).13. *Parajamesonit*. Zsivny, Naray-Szabo (1947). TL: Herja.14. *Csiklovaite*. Koch (1948). TL: Ciclova-Oravița.15. *Padéraite*. Mumme, Žak (1985). TL: Băița-Bihor.

16. *Allocrase*. Tschermak (1866) described under the name alloclasite or allocrase a bismuthian glaucodot from Oravița. The initial analysis was probably wrong as no bismuth was present by later reexamination of the type material by Krenner (1929). The present status of alloclasite is that of an orthorhombic dimorph of (Co, Fe)AsS with significant nickel contents (Maurel, Picot, 1974) and the typical occurrence is Bou Azzer (Marocco).

Carbonates

19. *Rhodochrosite*. Hausmann (1813). First use of name rhodochrosite for material from Cavnic, analyzed by Lampadius in 1800, previously named "manganèse oxydé carbonaté" (Haüy, 1809). TL given by Rădulescu, Dimitrescu (1966) as Săcărîmb is wrong. TL: Cavnic.

Sulfates

20. *Felsöbanyite/-banyaite*. Kenngott (1853). TL: Baia Sprie. New data by Papp and Werszburg (1989) show that basaluminite with the same composition is actually a fine grained variety of felsöbanyite, which has priority.

21. *Szmikite*. Schroekinger (1877). TL: Baia Sprie.22. *Dietrichite*. Schroekinger (1878). TL: Baia Sprie.

23. *Kleibergsite*. Initially described by Zsivny (1929) as basic antimony sulfate, the mineral was later defined by Nakai and Appleman (1980) and Menchetti and Sabelli (1980) as concerns the chemical formula and structure, respectively. TL: Baia Sprie.

24. *Ardealite*. Schadler (1932). TL: Ciclovina Cave, Sebeș Mts.

Borates

25. *Szaibelyite*. Previously named sjajbélit by Peters (1861). Dana (1868) gave the spelling szaibelyite, which has priority over ascharite of Feit (1891) and camsellite of Ellsworth and Poitevin (1921). See Schaller (1942) for further details. TL: Băița Bihor.

26. *Ludwigite*. Tschermak (1874). TL: Ocna de Fier (Vaskö, Moravicza).

27. *Kotoite*. Watanabe (1939). Simultaneously described using materials from Korea and Băița Bihor.

Phosphates-Arsenates

28. *Hoernesite*. Haidinger (1860). TL: Oravița-Ciclova.

29. *Veszelyite*. Schrauf (1874). TL: Ocna de Fier.

30. *Krautite*. Fontan et al. (1962). TL: Săcărimb.

Silicates

31. *Lotrite*. Murgoci (1900, 1901). See text for details concerning the relationships to pumpellyite and the proposal "lotrite-pumpellyite series". Similarity to prehnite (Embrey and Fuller, 1980) is questionable. Name still used in some text books, e.g. Winchell and Winchell (1951), Winchell (1958), Ramdohr, Strunz (1967). TL: Urdele Peak, Lotru Mts.

- *Cronstedtite*. Opinion of Ramdohr (pers. comm. 1971) that the type locality of cronstedtite is Herja is seemingly wrong. The mine of Herja (Kisbánya) furnished only great amounts of samples with well developed spheres of brownish cronstedtite but the type locality is probably Kutna Hora (Kuttenberg) in Bohemia.

B. Poorly defined and/or non-validated mineral species

32. *Dognacskaite*. Krenner (1884) gave the formula $Cu_2Bi_4S_7$ for which a mixture was supposed (Short, 1931). Earlier text books include it as a variety of cuprobismuthite (e.g. Lapparent; 1899). TL: Dognecea.

33. "Jolotcaite" - tentative name for a new $CuBi$ sulfotelluride (Damian et al., 1988). Lack of any structural data. TL: Jolotca-Ditrău.

34. *SbTe₂* - still unnamed new telluride found by Cioflică et al. (this volume) lacking X-ray data. TL: Stănița.

35. *Monsmedite*. Götz et al. (1962). Original description without X-ray data, as well as later work by Manilici et al. (1965). The formula of $H_8K_2Tl^{+3}(SO_4)_8 \cdot 11H_2O$ is given by Fleischer (1983) for dark green pseudocubic crystals found in the oxidation zone of the Baia Sprie ore deposits. Needs further research. Thalium content questionable, especially for the similar material from the gold ore deposit at Săsar. TL: Baia Sprie (Latin name: Mons Medius).

36. *Broștenite*. Poni (1900). Later on, the name was given for a variety of mixtures dominated either by pyrolusite (Palache et al., 1961) or by chalcophanite (Embrey, Fuller, 1980) or consisting of birnessite, todorokite and $\gamma-MnO_2$ (Persicil, 1973). Recent work of Bălan (1976) on similar material from Iacobeni shows that the broștenite-like material is amorphous for X-rays but is quite homogeneous. Several DTA-curves constantly show the same strong endothermic peak at about 150-170°C and new chemical analyses gave fairly uniform Mn and Fe contents. TL: Broșteni, East Carpathians ("paratypus": Iacobeni).

C. Discredited species

37. *Badenite*. Poni (1900). Highly probably a mixture. However, the original sample from Bădeni (TL)(not found yet) has been not reanalyzed.

38. *Warthaite*. Krenner (1909, 1926). The acicular, stell-grey aggregates from Ocna de Fier seems to be either identical with goongarite or a mixture of cosalite and galena.

39. *Egonite* of Schrauf (1879), erroneously described as cadmium silicate from Baia Sprie has been shown to be identical with sterrettite from Fairfield Utah, which has priority.

40. *Magnesiolaumontite*. Borcoș (1960). The needle-like mineral from Musariu has a MgO content too low to justify a new name. X-ray data are also lacking.

41. *Valachite*. Gâță, Gâță (1962). Soil mineral belonging to the open illite or ammersooite (Embrey, Fuller, 1980).

42. *Mrazekite*. Neacșu (1970). The mineral resembles saponite, stevensite and talc...; a magnesian montmorillonoid (Fleischer, 1972, Amer. Min., 57, p. 595).

43. *Murgocite*. Ianovici, Neacșu (1970). The material from Moldova Nouă is a mixture of saponite, chlorite and stevensite (Fleischer, 1972, Amer. Min., 57, p. 594).

D. Old names: unnecessary varieties or synonyms

43. *Biharite*. Pyrophyllite variety (agalmatolite, pagodite) from the Bihor Mts.

44. *Botesite*. A "museum variety" of hessite from Boteș.

45. *Capnite* or *Kapnite*. Iron-bearing smithsonite from Cavnic.

46. *Kapnicile*. Wavellite variety from Cavnic.

47. *Kapnikite*. Synonymous with rhodonite from Cavnic.

48. *Kennngottite*. Lead-bearing myargirite from Baia Sprie.

49. *Oraviczite*. Zn-bearing halloysite from Oravița.

50. *Partschin*. Pseudomorph of spessartine on a unknown monoclinic mineral (Lapparent, 1899) from alluvia, Pianu de Jos.

51. *Ponite*. Iron-bearing rhodochrosite. New data given by Bălan (1976) show a rather narrow compositional field for ponite, i.e. calcite (0-15), siderite (3.3-30), magnesite (0-15) and rhodochrosite (70-90)(values in mole percent). However, following the IMA recommendations no names should be given for the intermediate members of solid solution series.

52. *Protocalcite*. Acicular calcite crystals with oblique optical extinction found in the Comarnic cave (Semenic Mts). A calcite variety similar to lublinitite, for which the X-ray pattern is the same as that of calcite (Stoops, 1976, Am. Min., 61, p. 172).

53. *Săcărimbite*. Synonym of nagyagite (Toponomical translation).



54. *Sebesite*. Synonym of tremolite (from Sebeș Mts).
 55. *Sommarugaite*. Gold-bearing gersdorffsite from Băița Bihor.
 56. *Szaboite*. Altered hypersthene from Măgura Uroiu.
 57. *Szaszkaite*. Synonym of smithsonite from Sasca Montană.
 58. *Zinkfanserite*. A zinc-and manganese-bearing variety of epsomite from Baia Sprie.
 D. Varieties of amber
 59. *Romanite* or *Rumänit*. Amber from Colți, the most important occurrence in Romania.
 60. *Muntenite*. Amber from Olănești, similar to copalite or gedanite.
 61. *Almashite* (*almasit*, *Almaschit*). Amber from the Neamț District.
 62. *Schraufsite*. Amber from South Bukowina.
 63. *Delatinite*. Amber from North Bukowina.
 64. *Telegdite*. Amber from Apuseni Mts.
 E. Osocerite varieties
 65. *Moldovite* (*moldavite*). The oldest name for osocerite in Europa, coming from the occurrence in the Slănic Valley, Bacău District.

References

Due to the great number of entries and in order to save space some unusual abbreviations have been used, mostly for the Romanian journals. They are as follows:

- AIGG - *Anuarul Institutului de Geologie și Geofizică*, București.
 AUB - *Analele Universității București*, seria șt. naturii, București.
 DS - *Dări de Seamă ale ședințelor (Comtes Rendus)* Institutul de Geologie și Geofizică, București.
 RRG - *Revue Roumaine de Géologie, Géophysique et Géographie série Géologie*, Academia Română, București.
 SCG - *Studii și Cercetări de Geologie, Geofizică, Geografie, seria Geologie*, Academia Română, București.
 STE - *Studii tehnice și economice*, Institutul de Geologie și Geofizică, București
 SUC - *Studia Universitatis Babeș-Bolyai, Geologia - Geografia*, Cluj.
 TISR - *Trav. Inst. Spéol. "E. Racoviță"*, București.

For the same reason the titles of the papers were omitted. This reference list includes most (but not all) the papers published after the printing of "Mineralogia topografică a României" (Topographic Mineralogy of Romania) (MTR) (Rădulescu, Dimitrescu, 1966) as well as some older papers of special interest or not included in the TMR. The selection of papers was mainly based on the amount of contained mineralogical data. Therefore, no claim of completeness is thereby expressed.

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**GEOLOGICAL SOCIETY OF ROMANIA
SECTION MINERALOGY**

First circular

The FIRST NATIONAL SYMPOSIUM ON MINERALOGY is being organized to be held in Cluj-Napoca from 15 to 21 October, 1992. The aim of the symposium is to promote mineralogical studies and to record the state of knowledge of minerals in Romania.

The Symposium is intended to be unfolded on the following sections:

- (1) New mineral data and parageneses
- (2) New methods and techniques of mineral investigations
- (3) Typomorphism of minerals
- (4) Elemental and isotopic geochemistry of minerals
- (5) Technical and applied mineralogy
- (6) Growth of synthetic crystals.

Deadlines:

15.04.1992 - Receiving of titles

1.07.1992 - Receiving of abstracts

15.09.1992 - Confirmation of participation and remittance of participation fee.

The abstracts must not exceed 300 words (one double-space typed page).

A two-days post-symposium field trip will be organized for visiting both classical occurrences and museums (such as Gold Museum in the city of Brad).

Further information will be send only to persons responding to this circular.

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MORPHOLOGY OF THE PYRITE CRYSTALS FROM THE MAIN VEIN AT BAIA SPRIE. GENETICAL SIGNIFICANCES

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Key words: Mineralization. Pyrite. Crystals. Habit. Minor elements. Isotopes. ^{34}S . Zoning. Models. East Carpathians – Neogene – Quaternary eruptive – Gutin.

Résumé: La morphologie des cristaux de pyrite du Filon Principal de Baia Sprie. Significations génétiques. La morphologie de la pyrite du Filon Principal de Baia Sprie présente sept habitus cristallographiques: cubique, cubo-octaédrique, cubo-pentagonal, pentagonal, pentagonal-cubique, pentagonal-octaédrique et octaédrique. On signale aussi pour la première fois la présence des formes négatives de pyrite. Le caractère zonal de la distribution des séries de variation des habitus de la pyrite (Sunagawa, 1957) dans le Filon Principal est en corrélation avec la distribution de quelques éléments mineurs dans la pyrite (Cu, Pb, Zn, Bi, Ni, Co). On remarque l'affinité des formes de cube-dodécaèdre pentagonal (CP) pour la zone plombifère, celles de cube-octaèdre-dodécaèdre pentagonal (COP) pour la zone zincifère et les formes négatives à teneurs anomalies en Bi, Ni et Co pour la zone cuprifère. Sur base de la corrélation de la morphologie de la pyrite avec la zonalité de la minéralisation et avec celle hydrometasomatique du Filon Principal on a imaginé un modèle génétique bistadiel.

1. Introduction

The dependence of the crystals morphology on the control factors of the mineralization processes called the attention of the researchers, especially as "the morphological aspects of crystals provide the most important key codes in interpreting the paragenetic history of crystals...." (Sunagawa, 1984). Such relationships could be observed at highly persistent minerals, among which pyrite can be mentioned.

Among the most important papers dealing with pyrite morphology mention should be made of those belonging to Goldschmidt (1920), Tokody (1931), and the studies carried out by Paulitsen (1951), Smithson (1956), Sunagawa (1957), Sunagawa, Endo (1968), and Petreus (1976).

Sunagawa (1957) made the first attempts to correlate pyrite habit with its conditions of formation. The negative and positive forms of the pyrite were studied by Endo, Sunagawa (1973); the röentgenographic method of their discrimination was elaborated by Paulitsch (1949). Aspects of pyrite twinning were studied by Donnay et al. (1955), Shafranovsky (1961), Strunz, Tennyson (1965), Pabst (1971). Recently the theoretical and experimental studies on the growth mechanisms of the crystals were mostly concerned with the modelling of the morphological relationships – growth conditions in terms of the molecular kinetics (Sunagawa, 1984).

The tackling of problems connected with the significance of the pyrite morphology in the ore studies have recently been made (Nedelcu et al., 1988, unpublished report) and it represents a novelty as well as an attempt to introduce a sensitive instrument of research of the base-metal mineralizations. In this respect, our investigations were concentrated on a single mineralization, that is the Main Vein at Baia Sprie, which met all the compulsory conditions: large opening and vertical zonality, persistence and ubicity of pyrite in all parageneses of the vein. The results of these first researches constitute the subject of this paper.

2. Morphology of the Pyrite Crystals

Pyrite belongs to the cubic system, diploidal class 2/m 3, $a_0 = 5.42\text{ \AA}$, $D=5.1$. It represents one of the best-crystallized minerals, displaying a multitude of types of faces and of crystalline habits.

The study of the morphology of the Main Vein pyrite at Baia Sprie was carried out on 60 samples taken off from seven active horizons (X-XVI). Their processing was made mechanically, with a view to a best preservation of the crystalline forms and of the relationships with the other minerals of the paragenesis. In order to achieve

a very good statistic confidence from each sample about 500 pyrite crystals were selected. Their statistic study was effectuated (Nedelcu et al., 1988, unpublished report) on habits and granulometric classes. Crystal morphology was studied both under the stéréomicroscope and by scanning. Scanning analyses were effectuated by eng. Carmen Bunescu in the IMRA laboratories – Bucharest, using ISM 50A-JEOL with an acceleration voltage of 25 KV. On the basis of these analyses four main dominant faces were recognized for the pyrite from the Main Vein: {100}, {111}, {210}, {110}, with the highest frequency, three subordinate faces – {321}, {311}, {121} – as well as several nondeterminable faces {hkl} and {hko} with a lower frequency. Negative forms of pyritohedron {210} (Pl. I, Figs. 5, 6; Pl. II, Figs. 1, 2) were also observed.

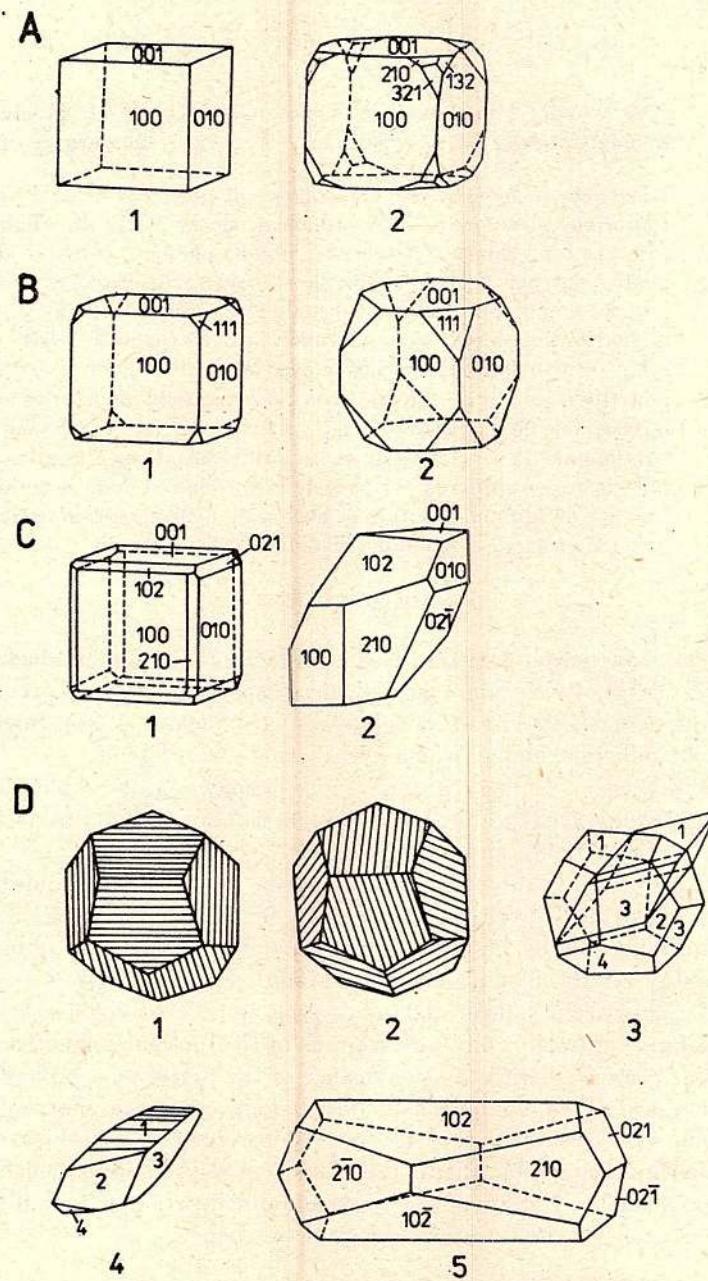


Fig. 1 – Habit of pyrite crystals from the Main Vein, Baia Sprie.
A – cubic (1, 2); B – cubic-octahedral (1, 2); C – cubic-pentagonal (1, 2); D – pentagonal (1-5, after Goldschmidt, 1920).

The combinations of dominant faces with the highest persistence constitute seven habits frequently found (Tab. 1, Figs. 1A-D, 2E-G): cubic (C), cubic-octahedral (CO), pentagonal (P), cubic-pentagonal (CP), pentagonal-octahedral (PO), and octahedral (O).

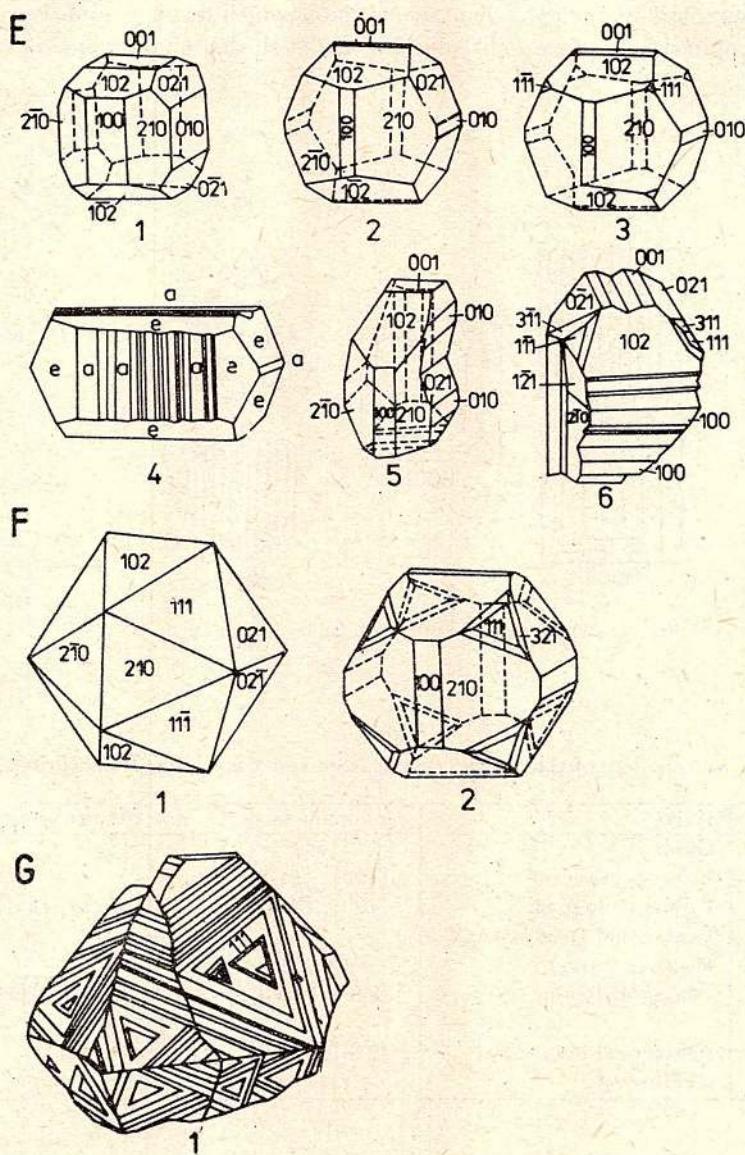


Fig. 2 - Habits of pyrite crystals from the Main Vein, Baia Sprie.
E - pentagonal-cubic (1-4 after Goldschmidt, 1920; 5-6); F - pentagonal-octahedral (1, 2 after Goldschmidt, 1920); G - octahedral (1 after Goldschmidt, 1920).

For each face type the microtopography of the surface (striae, growth beds, dissolution traces), which directly indicated the growth mechanisms (Pl. I, Figs. 1-4) was studied. Structure details of the pyrite faces are schematically presented in Figure 3 (adapted after Sunagawa, 1957).

2.1 Cubic Habit

Dominant face : {100}; subordinate face: {321} (Tab. 1, Fig. 1A). Crystal forms are variable – from a perfect cube, especially at the smallest sizes, to tabular forms. Dissolution processes point out growth beds from face {100} (Pl. I, Fig. 1).

2.2 Cubic-octahedral Habit

Dominant faces: {100} and {111} (Tab. 1, Fig. 1B). A higher frequency is observed only at horizon XVI. Frequently, one can notice the growth mechanism by superposition of thick, polygonal beds on the cube face {100} (Pl. I, Fig. 2) whose edges form octahedral faces {111}.

2.3 Cubic-pentagonal Habit

Dominant faces: {100} and {210} (Tab. 1, Fig. 1C); subordinate faces: {111}, {321} and {hkl}. Generally, crystals are isometric, with a crenellated morphology due to the combination of faces {100} with faces {210}.

These aspects are characteristic of the cubic-pentagonal habit which displays quite varied morphologies. The growth striae are well emphasized on face {210} due to the dissolution and deposition of carbonates.

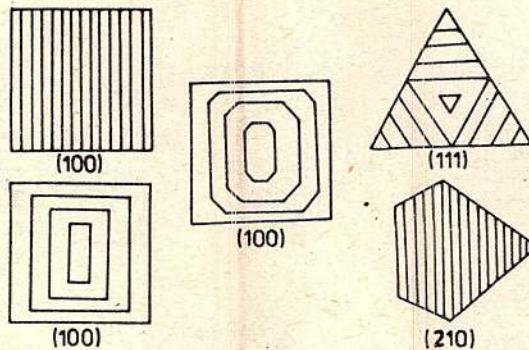


Fig. 3 - Characteristics of the pyrite faces structures.

Table 1
Morphology of the pyrite crystals from the Main Vein, Baia Sprie

	Habit	Dominant faces	Subordinate faces
A	Cubic	{100}	{321}
B	Cubic-octahedral	{100}, {111}	
C	Cubic-pentagonal	{100}, {210}	{111}, {321}, {hkl}
D	Pentagonal (positive and negative forms)	{210}	
E	Pentagonal-cubic	{210}, {100}	{111}, {321}, {311} {121}, {hkl}
F	Pentagonal-octahedral	{210}, {111}	{100}, {311}
G	Octahedral	{111}	{100}, {210}

2.4 Pentagonal Habit

Dominant face: {210} (Tab. 1, Fig. 1D 1-2). Both positive and negative forms are observed according to the position of the growth striae (Fig. 1 D1-2; Pl. I, Figs. 5, 6; Pl. II, Figs. 1, 2). Elongated edge-like forms (Fig. 1 D3-5) are more rarely observed.

2.5 Pentagonal-cubic Habit

Dominant faces: {210} and {100} (Tab. 1, Fig. 2 E1-5); subordinate faces: {111} {311}, {321}, {121}, {hkl} (Fig. 2 E6). Their combination gives rise to quite varied forms: elongated, flattened, crenellated, sandglass-type, more rarely isometric. In case of this habit several observations are to be made: a) it displays the highest diversity of forms and combinations; b) negative forms show the highest frequency; c) growth mechanism is best emphasized both at positive forms and at negative ones, in the latter the growth is after face {210}, not after face {100} (Pl. I, Fig. 6; Pl. II, Figs. 1, 2); d) frequent dissolution traces which emphasize the topography and, implicitly, their growth mechanism; these dissolution traces indicate, at the same time, significant modifications of the thermodynamic parameters of their formation medium (pH, fugacity O_2 , pressure).

2.6 Pentagonal-octahedral Habit

Dominant faces: {210} and {111}; subordinate faces: {100} and {311} (Tab. 1, Fig. 2F 1,2). The frequency of the pyrite forms belonging to this habit is very low. The displayed forms are generally isometric, more rarely tabular, and they present a crenellated topography.

2.7 Octahedral Habit

Dominant faces: {111}; subordinate faces: {100} and {210} (Tab. 1, Fig. 2G). Crystals are generally twinned. Details concerning the face topography are shown by the growth mechanism of faces {111}. They consist of the edges of the growth beds incompletely developed after the cube face {100} (Pl. I, Fig. 2).

2.8 Pyrite Negative Forms

One of the characteristics of the morphology of the pyrite from the Main Vein is the negative form, which is very rarely known.

Most of the pyrite crystals show striae parallel to the [001] zone axis of faces {100} and {210}. However, it is well known that only a reduced number of pyrite crystals show striae perpendicular to it. The first striae are called positive and the last ones negative (Fig. 1D, 1, 2; Pl. I, Figs. 5, 6; Pl. II, Figs. 1, 2). Their form would be due (Endo, Sunagawa, 1973) to different growth mechanisms which would indicate the different origin of the respective pyrites.

Positive striae are determined by the development of the growth beds on face {100}, whereas the negative striae are closely connected with the free development of the growth beds on face {210} (Endo, Sunagawa, 1973). The relationships between the two types of striae on the same crystal (Endo, Sunagawa, 1973) point out that positive striae would have formed during an earlier stage, and negative striae, during a more recent one. Such relationships are rendered evident in case of a pyrite from Baia Sprie, pseudomorphosed by marcasite (Pl. II, Fig. 3). In this case, the marcasitization process develops along the positive striae of pyrite (Pl. II, Fig. 4) rendering evident an orthogonal structure of the "growth pyramids" of marcasite which would point out the simultaneous existence, on the same pyrite crystal, of positive and negative striae (Pl. II, Figs. 5, 6).

2.9 Variation Series of the Crystallographic Habit

The crystallographic studies effectuated under the stereomicroscope on about 60 samples and by scanning on 22 samples taken off from the Main Vein at Baia Sprie (levels X-XVI) pointed out a great bulk of data, statistically processed according to the granulometry and morphology (habit) of the pyrite crystals, on the basis of which the frequency and distribution of the crystallographic forms of pyrite from the Main Vein were established. In order to point out the zonal character of the distribution of these forms the variation series of the crystallographic habit were taken into account (Sunagawa, 1957). These series are based on the combination trends of the crystal faces. For instance, in some cases crystal habits vary from cubic to pentagonal, without the octahedral face {111}, in other cases they vary from cubic to octahedral, without the pentagonal dodecahedron face {210}, and others show variations of combination of the three types of faces.

Considering that the dominant faces, the most persistent ones, of the pyrite from the Main Vein are those of cube {100}, pentagonal dodecahedron {210} and octahedron {111}, the variation series representative for this deposit, pointed out by the statistic study of the habit, are the following:

- (1) cube (C)
- (2) cube - pentagonal dodecahedron ($C \rightarrow P$)
- (3) cube - octahedron - pentagonal dodecahedron ($C \rightarrow O \rightarrow P$)
- (4) cube - octahedron - faces $\{hkl\}$ ($C \rightarrow O \rightarrow \{hkl\}$).

Series (4) was, moreover, separated not due to the dominant of faces $\{hkl\}$, but due to their persistance in a certain part of the deposit.

The transposition of the crystallographic data thus processed in the Main Vein plane (Fig. 4) reveals the zonal character of the distribution of the pyrite habits, as follows:

- a) zone with habit C occupies two restricted areas within the deposit, situated at the transition zone towards zone $C \rightarrow P$;
- b) zone with the variation zone $C \rightarrow P$ is situated in an upper position in the median part of the deposit (levels X-XIV);
- c) zone with the variation series $C \rightarrow O \rightarrow P$, situated under zone $C \rightarrow P$ from levels XIV downwards (median part), is found up to level X and, more likely, above it in the extreme parts of the vein;
- d) zone with the variation series $C \rightarrow O \rightarrow \{hkl\}$, with a relatively inferior position versus zone $C \rightarrow O \rightarrow P$, occupies only the westernmost part of the deposit, between levels XIII and XIV, obviously trending eastwards. It corresponds to the occurrence zone of the pyrite negative forms and to the cupriferous zone of the deposit.



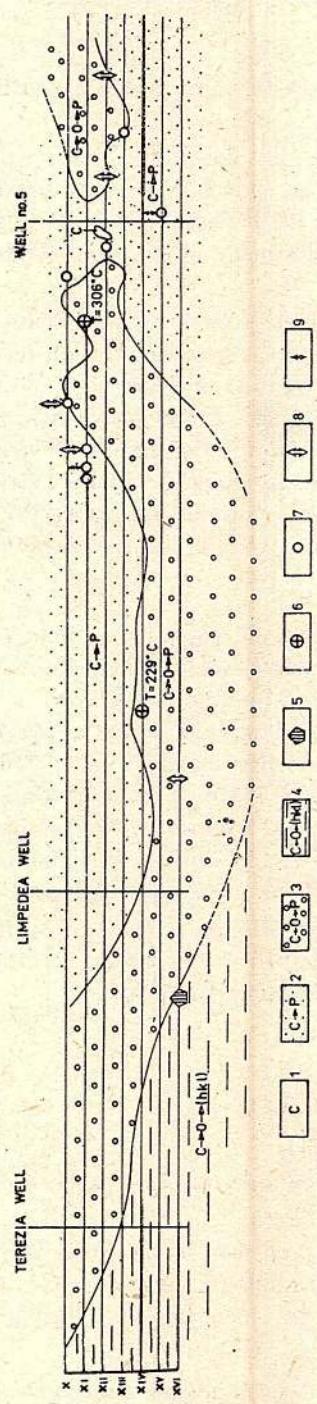


Fig. 4 - Zonality of the morphological variation of pyrite from the Main Vein, Bala Sprică.

1, cubic habit zone (C); 2, cube→pentagonal dodecahedron zone ($C \rightarrow P$); 3, cube→octahedron zone ($C \rightarrow O \rightarrow \{hkli\}$); 4, cube→octahedron→faces ($C \rightarrow O \rightarrow \{hkli\}$); 5, isotopic equilibrium; 6, negative form; 7, isotopic equilibrium; 8, pyrite dissolution processes; 9, quartz dissolution processes.

3. Correlations between the Pyrite Morphology and Chemistry

The morphologic study of the pyrite was accompanied by a study of the trace elements with a view to establishing possible relationships between habit and chemistry. Spectrographic analyses carried out on pyrite monomineral samples (Tab. 2) pointed out anomalous contents of Cu, Pb, Zn, As, Bi, Ni, and Co.

TABLE 2
Trace elements and gold contents of principal pyrite crystallographic forms in some samples from the Main Vein Baia Sprie

Horizon	Sample no.	Trace elements (ppm)									Crystallographic forms	
		Au (relative values)		Cu	Ps	Zn	As		Bi	Ni		
		Average	horizon					Average				
X	B 19	11.45	11.09	3 800	3 300	10 000	8 500	8.875	<10	<10	360	CoP
	B 23	10.74		1000	4 200	13 000	7 000		<10	<10	240	CoP
XI	B 26	1.00	3.20	>30 000	2 500	1 400	1 500	3.650	10	<10	17	CP
	B 116	5.40		16 000	6 000	13 000	4 100		<14	<10	70	CoP
	B 121	-		4 400	9 800	2 400	1 800		210	82	230	CP
	B 122	-		7 700	4 500	11 000	4 900		<10	13	130	CoP
XII	B 107	1.41	4.86	26 000	22 000	10 500	1 900	4.383	26	90	145	CP
	B 111	8.31		7 500	11 000	14 500	5 000		65	26	65	CoP
	B 114	-		1 200	1 900	6 500	4 600		<10	<10	210	CoP
XIII	B 127	7.73	7.73	8 200	5 000	5 700	1 750	1.750	70	55	440	CP
XIV	BS 46	9.16	9.16	7 000	>30 000	>30 000	5 200	7.700	160	24	180	CoP
XV	B 120	16.74	16.74	9 500	9 300	290	12 500	12.500	<10	-	40	CP
XVI	BS 65	1.69	1.69	>30 000	110	9 20	3 200	3.067	580	285	600	PC (-)

Abbreviations: C = cube; O = octahedron; P = pentagonal dodecahedron

Observations : C, P = dominant faces; O = subordinate faces; (-) = negative forms

Analysts: A. Zamîrcă
S. Anastase

All these data and their correlation with the relative values of the gold contents and with the pyrite morphology (Tab. 2) point out the following conclusions:

a) there is a positive correlation between Au and As (Fig. 5) both as regards the average contents on levels and the contents of the analysed samples; an exception is sample B 127 (level XIII) whose contents of Au and As are not correlated because they fall beyond the regression line of their average contents on levels;

b) dependence of the pyrite morphology on its association with Pb, Zn and Cu sulphides is suggested on the Cu-Pb-Zn diagram (Fig. 6) by the outlining of three distinct fields: A – in which CP forms (cube-pentagonal dodecahedron) are correlated with the mostly plumbiferous zone of the vein; B – forms COP (cube-octahedron-pentagonal dodecahedron) are connected with the more zinciferous zone; C – the occurrence of the pyritohedron negative forms (PC-) is associated intimately with the cupriferous zone;

c) the differentiation of the negative pyrite form from the positive one according to the anomalous contents of Bi, Ni and Co (Tab. 2; sample BS 65 – pyrite negative form versus the other samples of pyrite positive form).

Considering all this one can conclude that there are some correlations between the morphology and chemistry of the pyrite. Thus, the development and persistence of forms of the type CP, COP and PC (-) would be determined by the plumbiferous, zinciferous and cupriferous character of the respective zones within the vein.

Although negative pyrite form occurs only in the cupriferous zone, a situation similar with that pointed out by Endo, Sunagawa (1973) in the Ani deposit (Japan), its anomalous contents of Bi, Ni and Co would indicate their part played within the growth mechanisms of the negative forms. In this situation both the negative pyrite forms and the trace elements Bi, Ni and Co from pyrite could be considered as typomorphic for the cupriferous zone of the Main Vein at Baia Sprie.



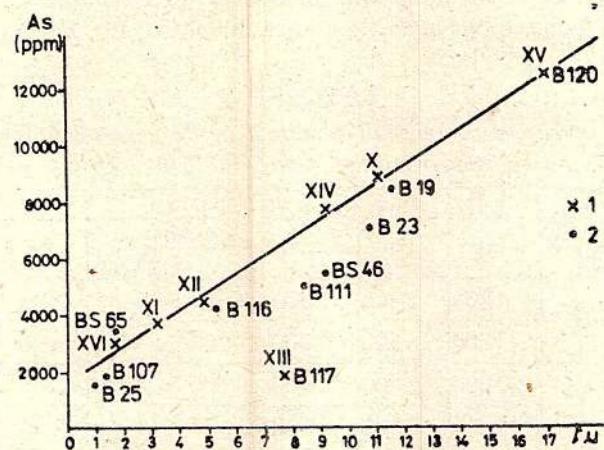


Fig. 5 Correlation between the contents of Au (relative values) and of As (ppm) of the pyrite from the Main Vein, Baia Sprie.
1, average contents on levels (X-XVI); 2, contents of some samples (B 19, B 127, BS 46, BS 65).

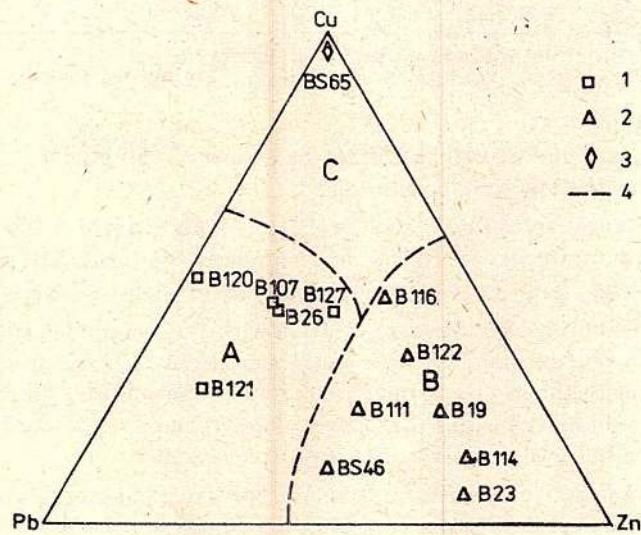


Fig. 6 Correlation between the morphology of the pyrite from the Main Vein, Baia Sprie, and its contents of Cu, Pb, Zn.
1, cube - pentagonal dodecahedron form (CP); 2, cube - octahedron - pentagonal dodecahedron form (COP); 3, negative forms of pentagonal dodecahedron - cube (PC-); 4, fields: plumbiferous (A), zinciferous (B), cupriferous (C).

4. Isotopic Composition of Sulphur

Analyses of the sulphur isotopes were effectuated on monomineral samples of sphalerite and galena, spatially located along the strike and dip of the Main Vein (Tab. 3).

TABLE 3
*Isotopic composition of sulphur in the sphalerite
 and galena from the Main Vein, Baia Sprie*

Horizon	Sample no.	$\delta^{34}\text{S}/\text{CDT} (\text{\textperthousand})$	
		sphalerite	galena
X	B 8	-3.73	-3.59
X	B19	+1.29	-4.67
X	B20	+4.82	-6.28
XI	B26	+3.17	-2.28
XI	B28	-0.62	+7.69
XI	B115	+8.27	-0.84
XI	B116	-1.56	-3.66
XII	B 107	+18.84	+4.83
XIII	B 135	+1.90	+21.35
XIV	BS46	+6.45	+7.62
XIV	BS48	-3.64	-6.40
XV	B 120	+4.87	-6.45

CDT = Cañon Diablo Troilite
 with $^{34}\text{S}/^{32}\text{S} = 0.0450045$

Except for sample B135 (galena) and B107 (sphalerite), which display very high values of the heavy isotope of sulphur $\delta^{34}\text{S} = +21.35\text{\textperthousand}$ and $+18.84\text{\textperthousand}$, respectively, the values $\delta^{34}\text{S}$ for the analysed sulphides show a dispersion between $-6.45\text{\textperthousand}$ and $+8.27\text{\textperthousand}$, a field common for the hydrothermal deposits (Nielsen, 1979). The two anomalous values might be explained either by the "training" by fluids of the isotope $\delta^{34}\text{S}$ from the adjacent sedimentary rocks, or by drastic variations of the pH, fO_2 (oxygen fugacity) and temperature T during the crystallisation process of the minerals from hydrothermal solution, the variations of the mentioned parameters leading to significant modifications of the values $\delta^{34}\text{S}$ from sulphides versus $\delta^{34}\text{S}$ of the initial sulphur. This conclusion seems plausible if we consider that the variation $\delta^{34}\text{S}$ with 20% was proved experimentally (Ohmoto, 1972); Nielsen (1979) also emphasized the influence of the respective parameters when establishing the isotopic equilibrium.

The results point out a fractionation of the sulphur with a normal trend (an enrichment in the heavy isotope of the sulphur from galena towards pyrite), except for sample B8 which displays a reverse fractionation. The ratio of the sulphur isotopes in the studied samples points to the lack of an isotopic equilibrium as a result of significant variations of the thermodynamic factors which controlled the hydrothermal process during its evolution stages.

The estimation of the formation temperatures using the isotopic geothermometer (Nielsen, 1979) was possible only for two sets of sulphides, pointing to temperatures of 229°C (sample BS 48, level XV) and 306°C (sample B 116, level XI). All the other sets analysed reflect strong isotopic lack of balance, the temperatures being, consequently, nondeterminable.



5. Genetical Significances

The interpretation of the significance of the morphology of the Baia Sprie pyrite was based on data of chemistry, on the sulphur isotopes, and on the study of the quartz inclusions from the same vein (Pintea, in Nedelcu et al., 1988, unpublished report), for a better specification of the thermodynamic and chemical parameters of the hydrothermal system in which pyrite was formed and, implicitly, the mineralization of the Main Vein.

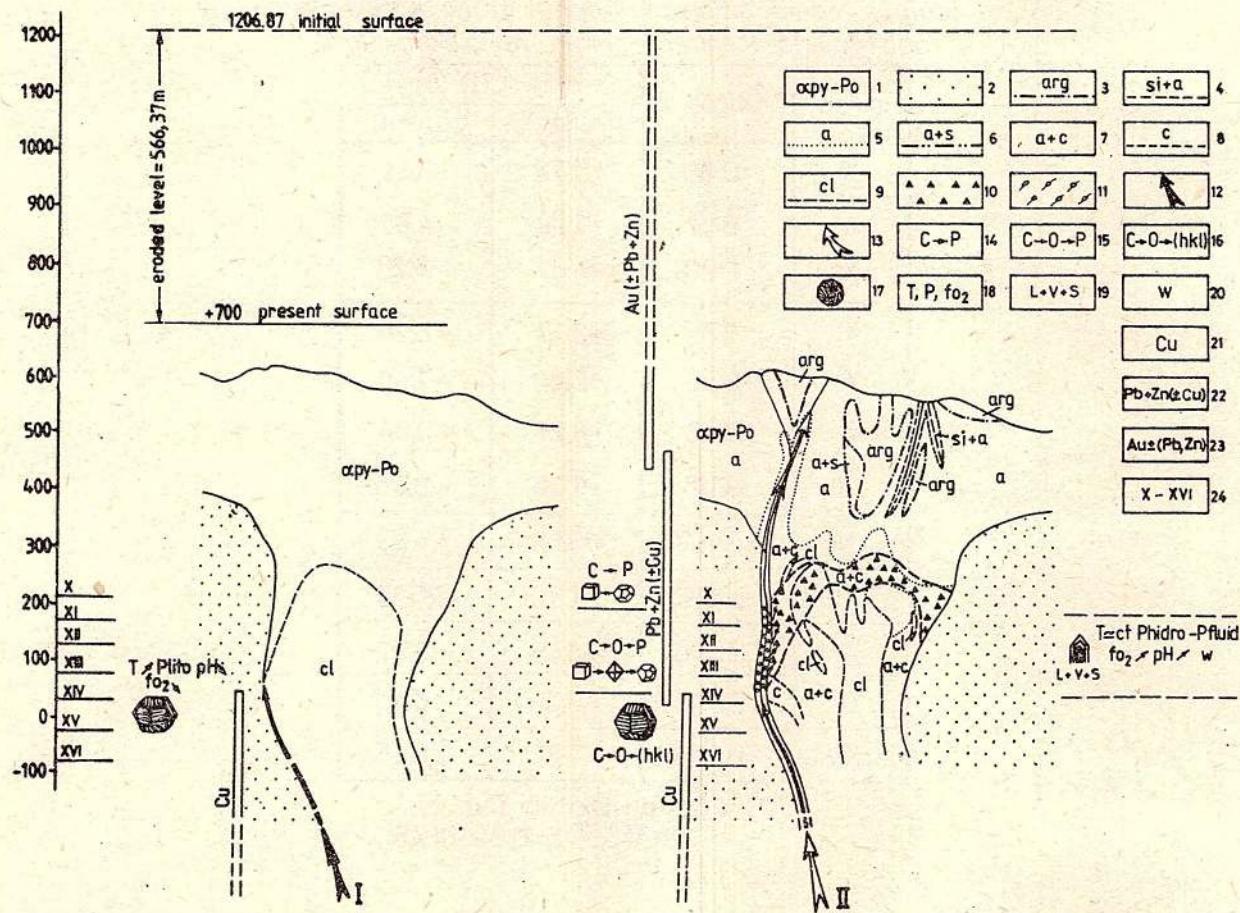


Fig. 7 – Bistage genetical model of the Main Vein, Baia Sprie on the basis of the correlation of the pyrite morphology with the mineralization and hydrometamorphic zonality.

1, Pontian pyroxene andesites; 2, Pannonian sedimentary rocks; 3, argillization zone; 4, silicification and argillization zone; 5, adularization zone; 6, adularization and sericitization zone; 7, adularization and carbonatation zone; 8, carbonatation zone; 9, chloritization zone; 10, breccias; 11, boiling zone; 12, solutions flux of the 1st stage; 13, solutions flux of the 2nd stage; 14, cube → pentagonal dodecahedron variation series; 15, cube → octahedron → pentagonal dodecahedron variation series; 16, cube → octahedron → faces {hkl} variation series; 17, negative form; 18, temperature, pressure, fugacity O_2 ; 19, inclusions with liquid (L), with vapours (V), with solid (S) in quartz; 20, tungsten occurrence zone; 21, cupriferous zone; 22, lead-zinciferous±cupriferous zone; 23, auriferous±Pb, Zn zone; 24, mining levels.

For a better understanding the respective elements were integrated in a bistage evolution model (Fig. 7): Stage I is marked by:

- formation of a closed hydrothermal system, whose thermodynamic parameters were: relatively high temperature ($300 - 330^\circ C$ determined on the basis of the fluid inclusions), sulphur isotopic equilibrium ($\delta^{34}S$ indicating equilibrium temperatures of $229^\circ C$ and $306^\circ C$), pressure equal to the lithostatic pressure, low pH (acid), reduced oxygen fugacity (strongly reducing medium which facilitated the precipitation of pyrite and chalcopyrite);

- synchronous crystallization of the pyrite negative forms with the precipitation of copper from solution and advanced chloritization of the Pannonian pyroxene andesite.

Stage II is defined by:



- increase of the hydrothermal fluid pressure;
- opening of the system by access ways towards the surface for the hydrothermal fluid, followed by an adiabatic extension, formation of breccia zones and setting of a boiling process due to a sudden decrease of pressure. The estimated parameters of the new system, according to the study of the fluid inclusions (Pintea, in Nedelcu et al., 1988, unpublished report), are: approximately constant temperature, fluid pressure equal to hydrostatic pressure, oxygen fugacity and pH higher than in stage I. All this facilitates the deposition of the other sulphides (sphalerite, galena), concomitantly with the massive precipitation of the carbonates in a neutral-poorly alkaline medium;
- formation of zoned quartz and large number of external zones associated with carbonate depositions (Pintea, in Nedelcu et al., 1988, unpublished report) pointing out the lability of the system. This lability is rendered evident both by the morphology of the pyrite crystals (variation series C → O → P), which tend to form variable combinations, and by the lack of an isotopic equilibrium of sulphur in sulphides;
- tungsten deposition under conditions of a low-alkaline medium (Pintea, in Nedelcu et al., 1988, unpublished report).

The whole process of this stage is marked by the almost constant deposition of the carbonates.

Towards the upper part of the structure, under the changing conditions of fluid pH by mixture with acid descendent waters, took place the deposition of gold and the alteration of the volcanic rocks by adularization and silicification (Stanciu, 1973).

Considering all this when correlating the morphology of the pyrite crystals with the mineralization and the zonality of the hydrothermal alterations (Stanciu, 1973) of the Main Vein at Baia Sprie the following conclusions can be inferred:

- pyrite negative forms occur at the lower part of the known mineralized column (levels XIV-XVI, western zone) and they are closely connected with the copper mineralization and the chloritization zone; they are included in the variation series C → O → {hkl}. Endo and Sunagawa (1973) mentioned similar pyrite negative forms in the epithermal deposit of chalcopyrite, pyrite and chlorite from Ani mine (Japan). The anomalous contents of Bi, Ni and Co displayed by the Baia Sprie pyrite negative forms suggest the dominant part of these minor elements in the trend of the growth mechanism of the negative forms;

- variation series C → O → P would correspond to a significant change in the evolution of the hydrothermal system, marked by adiabatic extension phenomena, by breccifications, boiling processes, with the deposition of sulphides under conditions of thermodynamic and composition instability and the deposition of carbonates. The development of COP forms would suggest, according to diagram in Figure 6, the delimitation of the mostly zinciferous zone in the vein;

- variation series C → P could signify either the transition towards other zone with different thermodynamic parameters or slight fluctuations of the system parameters. This hypothesis seems more plausible considering that the forms CP are associated with the plumbiferous field in Figure 6, which shows transition characteristics towards the zinciferous and cupriferous fields.

The association of the pyrite negative forms with the cupriferous zone, situated at the lower western part of the deposit, points to their typomorphic character for the cupriferous mineralization proper. The implications are obvious: sinking of the zone with pyrite negative forms (C → O → {hkl}) eastwards (Fig. 4) would indicate in fact the sinking of the cupriferous zone in this direction and, implicitly, a larger economic prospect at depth.

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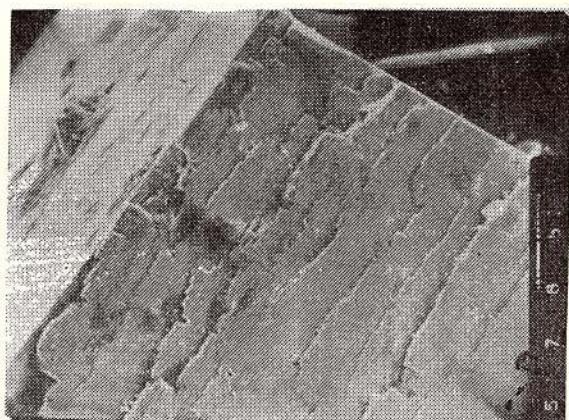
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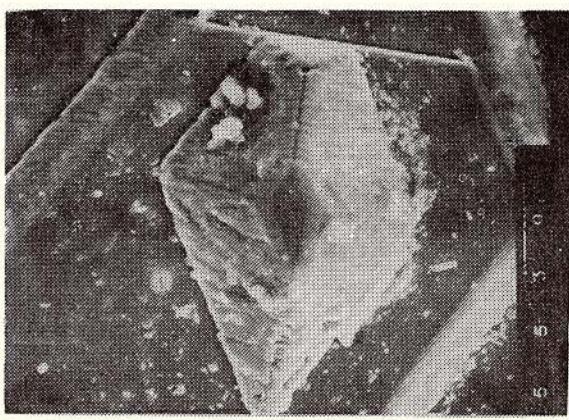
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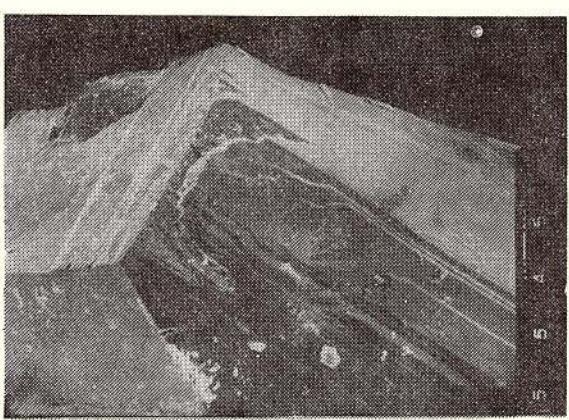
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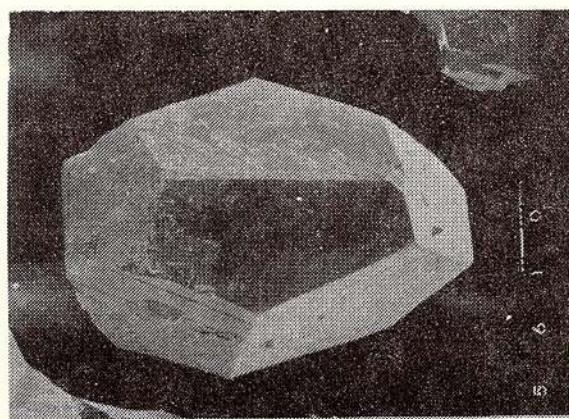
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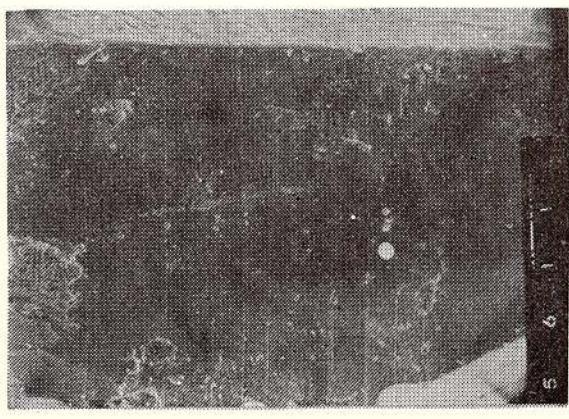
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Plate I

Fig. 1 – Dissolution structure pointing out thin growth beds on face {100}. Scanning. 1500 x.

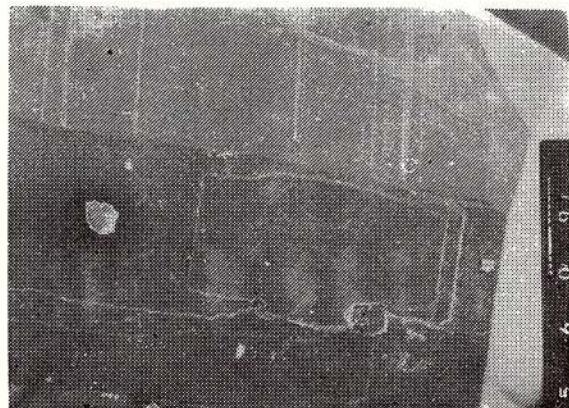
Fig. 2 – Growth beds on face {100} with formation of octahedron faces {100}. Scanning. 600 x.

Fig. 3 – Growth beds on face {100} with formation of pentagonal dodecahedron faces {210}. Scanning. 250 x.

Fig. 4 – Edges of growth beds after face {100} lead to the formation of face {210}. Scanning. 150 x.

Fig. 5 – Negative form of pentagonal dodecahedron. Striae perpendicular to the edge common to the pentagon bases. Scanning. 45 x.

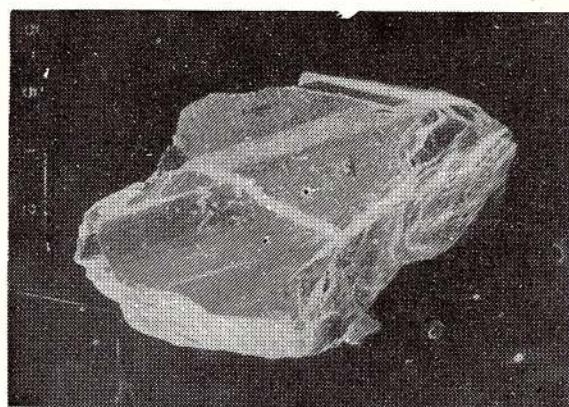
Fig. 6 – Detail to Figure 1 pointing out striae on face {210}. Scanning. 150 x.



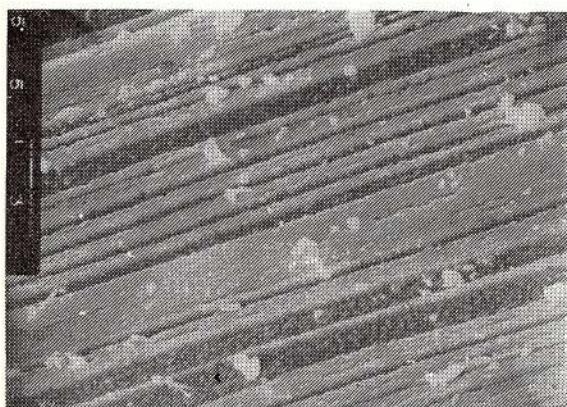
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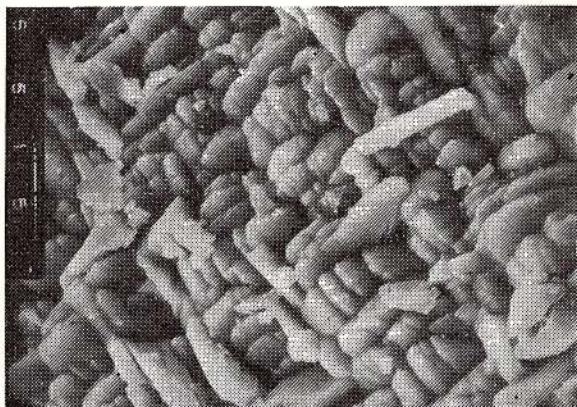
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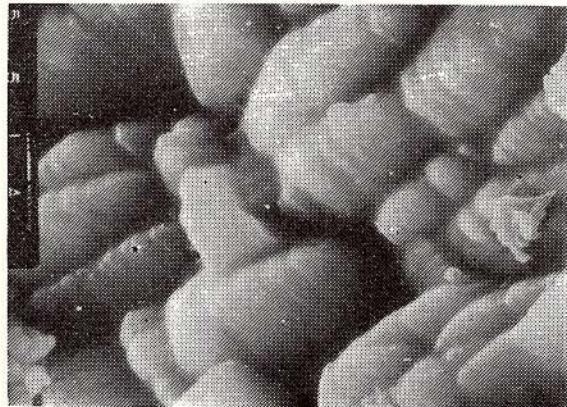
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5



6

Plate II

- Fig. 1 – Emphasizing of the growth mechanism after {210} at a negative form of pentagonal dodecahedron. The very thin growth beds are rendered evident by fine striae. Scanning, 100 x.
- Fig. 2 – Emphasizing of the growth mechanism with thick beds after face {210} at a negative form of pentagonal dodecahedron. Scanning, 75 x.
- Fig. 3 – Marcasite pseudomorphs after pyrite on pentagonal dodecahedron + cube faces. Scanning, 30 x.
- Fig. 4 – Detail face {210} (Fig. 3). Marcasitization process is developed along positive striae of the pyrite. Scanning, 150 x.
- Fig. 5 – Detail positive striae (Fig. 4). Marcasite displays an oriented structure of the "growth pyramids" after two orthogonal trends, which would point to the simultaneous existence of positive and negative striae of pyrite. Scanning, 1500 x.
- Fig. 6 – Detail Fig. 5. Scanning, 5000 x.

A NEW TELLURIDE MINERAL FROM STĂNIJA AREA, METALIFERI MOUNTAINS

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Key words: Tellurides. New minerals. Microhardness. Electron probe data. X-ray data. Apuseni Mountains – Southern Apuseni Mountains - Metaliferi Mountains.

Abstract: A new telluride with composition of $SbTe_2$ was found in the ores of the telluride-bearing gold veins at Stănija, Metaliferi Mountains, which have formed in relation with volcanic structures of Neogene ages. The $SbTe_2$ mineral is closely associated with altaite and sylvanite and exhibits a low bireflectance with white-rose to white yellowish colours. The anisotropy is weaker than that of sylvanite with light brown-yellowish to grey-light green tints. The spectral reflectance was measured at 486,551,589 and 656 nm and differs from that of tellurantimony. The microhardness is low ranging from 14 to 18 kg/mm^2 , much lower than that of tellurantimony. Electron probe microanalyses gave composition close to $SbTe_2$. Although the X-ray analysis was not possible due to the small grain size, the telluride from Stănija seems to represent a new mineral species near to, but different of tellurantimony.

Introduction

A telluride mineral of composition close to $SbTe_2$ was found in the gold deposits in the Stănija area, Zlatna district (Southern Apuseni Mts), which are associated with the Neogene volcanic activity. Here the telluride-bearing gold veins occur in the Ungurului and Fericelii hills.

The vein complex in the Ungurului Hill is located within a Pannonian andesite crater. This volcanic structure consists of several veins trending $N\ 10^{\circ}E-N\ 10^{\circ}W$ crossed by main Vilanela vein ($N70^{\circ}E$), containing tellurides associated with native gold and base metal sulfides (Ghițulescu, Socolescu, 1941). Among the tellurides of the Vilanela vein, altaite, petzite and tetradyomite are cited (Helke, 1933; Giușcă, 1936; Ghițulescu, Socolescu, 1941; Ianovici et al., 1969).

Although it is located in Cretaceous sedimentary formations, the vein complex in the Fericelii Hill is related to a Pannonian andesite subvolcanic body seated at depth (Ianovici et al., 1969); some of these telluride-bearing gold mineralizations seem to constitute the upper part of the base metal ore veins investigated by the West Muncăeasca gallery (Cioflica et al., 1962; Ianovici et al., 1969). The tellurides are associated with native gold and sulfides and occur in Iolanda and Roșia veins (Roșia gallery) as well as in Spoiala, Haber, Scara and Robotin veins (Baia Acra gallery)(Helke, 1933; Ghițulescu, Socolescu, 1941). The tellurides of this association are: sylvanite, calaverite, hessite, petzite, tetradyomite and stützite; native tellurium is also known (Helke, 1933; Giușcă, 1936; Ghițulescu, Socolescu, 1941; Ianovici et al., 1969).

The samples containing the new telluride were collected from the mentioned vein complexes and also found in the collection of polished sections of the Department of Mineralogy, University of Bucharest.

Optical and Vickers microhardness (VHN) investigations as well as electron microprobe analysis were performed; because of insufficient material, no X-ray diffraction analyses were possible.



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Main features

The Stănița telluride is associated with altaite and sylvanite (Pl. I, Figs. 1, 2); the coarse-grained mineral aggregate contains also pyrrhotite, chalcopyrite and sphalerite. The grains are 0.1-0.3 mm in size, hypidiomorphic and xenomorphic, and fill the spaces between the altaite grains or between altaite and sylvanite; it also replaces partly the altaite grains.

Physical properties

The Stănița telluride is usually relatively easily polished; however, triangles reminiscent of galena and altaite are locally present.

In reflected light, the mineral is white with a slight rose tint, by direct comparison to altaite; or white with a slight yellowish tint, when associated with sylvanite; the rose or yellowish tints are intensified in immersion. The bireflexion is low and the pleochroism is weak. The reflexion spectrum of Stănița telluride is slightly different from that of tellurantimony from Quebec and Hokkaido, mainly with respect to 486 nm and 470 nm wave lengths (Tab. 1), the R_{max} reflexion coefficient exceeding 70 % (Fig. 1). The anisotropy is slightly weaker than that of sylvanite one with, the colours ranging from light brown yellowish to grey with light green tint. Simple twins are noticed in places.

Table 1
Reflectance data*

Wavelength nm		Stănița	Quebec	Hokkaido
470	R_{max}		71.1	
	R_{min}		60.4	
486	R_{max}	66.1		71.0
	R_{min}	61.3		60.5
546	R_{max}		67.9	
	R_{min}		59.8	
551	R_{max}	66.5		68
	R_{min}	61.5		60
589	R_{max}	67.5	67.9	68
	R_{min}	62.5	61.5	61.5
650	R_{Max}		68.7	
	R_{min}		61.5	
656	R_{max}	67		69
	R_{min}	62		61.5
References		Present study	Thorpe, Harris (1973)	Feklichev (1977)

* Zeiss microphotospectrometer

Vickers microhardness determination was made by using a Zeiss Durimet microscope with different loads and it was found to range from 14 to 18 kg/mm² (Tab. 2). VHN values reported for Stănița Sb₂Te₃ are much lower than those characteristic of Quebec and Hokkaido Sb₂Te₃.

Chemical characteristics

The chemical composition has been determined by N. Farkaș (ISIM-Timișoara) by means of Jeol JCXA-SOA electron microprobe. The X-ray diffraction image account for the sample homogeneity and gave Sb and Te in substantial amounts as major elements. Quantitative analytical data show: Sb=33.30%, Te=64.55%. Recalculated values are presented in the Table 3. The calculated formula Sb₁Te_{1.88} corresponds to an ideal SbTe₂ stoichiometric formula.



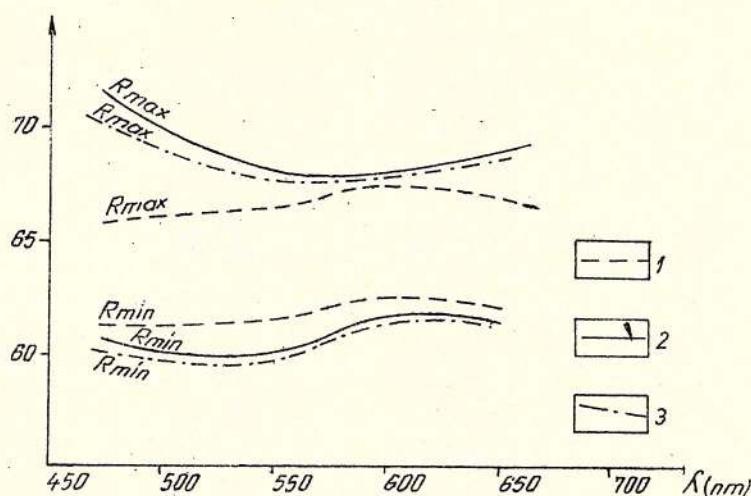


Fig. 1 - Reflectance value in the visible light range for SbTe_2 from Stănija (1) and for Sb_2Te_3 from Quebec (2) and Hokkaido (3).

Table 2
Micro-indentation hardness

Location	Range of measurements	Average	References
Stănija	14 - 18	16.125*	Present study
Quebec	40.2 - 73.9	54.9**	Thorpe, Harris (1973)
Hokkaido	39.6 - 61.3	49.8***	Feklichev (1977)
	40 - 80		

* 5 g load; ** 15 g load; *** 25 g load

Table 3
Compositional data

Location		Stănija	Quebec	Hokkaido
Sb	Average Range	34.03	37.5 35.8-38.2	36.8-40.0
Bi	Average Range		0.3 0.2-0.3	
Pb	Average Range			1.0-1.3
Te	Average Range	67.97	61.8 61.0-62.6	58.2-61.5
Formula		$\text{Sb}_1\text{Te}_{1.88}$	$\text{Sb}_{1.91}\text{Te}_{3.0}$	$\text{Sb}_{1.92}\text{Te}_{3.0}$
References		Present study	Thorpe, Harris (1973)	Nakata et al. (1956)

Conclusions

By studying the classical telluride occurrences in the Stănija gold deposits a new telluride of SbTe_2 composition was found. It differs from the Quebec and Hokkaido tellurantimony (Sb_2Te_3) by optical and particularly compositional data. Although the small grain size precluded the X-ray analysis, the Stănija new telluride SbTe_2 can be regarded as a new mineral species.

The relationships between the mineral components of a paragenesis account for the late deposition of Stănija telluride. The crystallisation sequence might be: pyrrhotite, chalcopyrite, sphalerite, altaite, sylvanite, SbTe_2 .



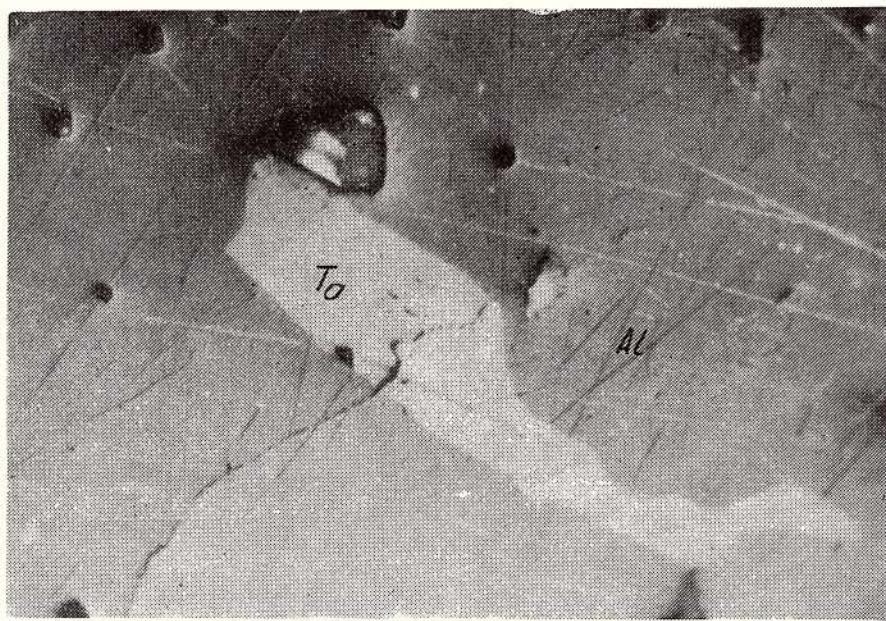
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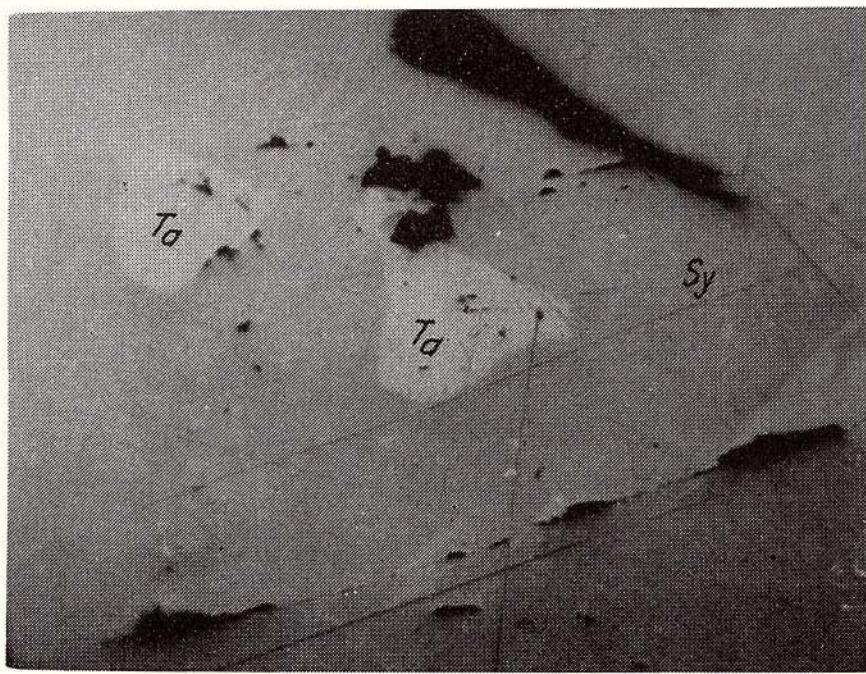
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2

Fig. 1 – The new telluride $SbTe_2$ (Ta) associated with altaite (Al). Oil immersion, N+, 120 x.
Fig. 2 – $SbTe_2$ (Ta) included in sylvanite (Sy). Oil immersion, N+, 120 x.

NEW DATA CONCERNING SZAIBELYITE FROM ROMANIA: THE GRUIULUI HILL OCCURRENCE (ALEULUI VALLEY, BIHOR MOUNTAINS)

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Key words: Borates. Szaibelyite. Metasomatism. Paragenesis. Optical mineralogy. Major elements. DTA data. TGA data. X-ray data. Electron probe data. Infrared spectra. P-T conditions. Apuseni Mountains – North Apuseni – Central Bihor Massif.

Résumé: Nouvelles données sur la szaibelyite de Roumanie : occurrence de la colline de Gruiului (monts de Bihor). Dans le bassin médian de la vallée d'Aleu (monts de Bihor, au confluent de celle-ci avec la vallée de Sebișel, dans la zone de la colline de Gruiului, on a identifié une importante minéralisation de borates endogènes, y comprises la ludwigite et la szaibelyite, dans un contexte qui indique la préexistence de la kotoïte. La minéralisation représente le produit de la métasomatose fluoro-borique de quelques roches carbonatées (dolomies) étant superposée dans l'espace à un fond de cornéennes magnésiennes développées au contact du pluton banatique de Pietroasa avec des dolomies anisiennes de l'unité de Ferice. À la paragenèse initiale du type forstérite-talc-clinochllore-clinohumite-ludwigite-calcite (\pm kotoïte, fluorite, suanite) se superposent des néoformations hydrométasomatiques, ci-incluses la brucite, la serpentine (lisardite), la szaibelyite et des minéraux associés à celles-ci (magnétite). Le caractère extrêmement magnésien de la szaibelyite de la colline de Gruiului (à contenu en moles sussexitives de seulement 0,37 à 0,42 %) a été confirmé par l'étude optique en lamelles minces, analyse par diffraction des rayons X, spectrométrie d'absorption en infrarouge et étude thermique. La genèse du minéral a été favorisée par les suivantes conditions physico-chimiques: températures de 275 à 350° C, pressions inférieures à 500 bars, fractions molaires limitées du dioxyde de carbone et grandes, variables, pour l'eau; pH basique; Eh négatif. Les facteurs de contrôle de la disposition des minéraux de bore sont de nature tectonique et lithologique, en permettant une intense métasomatose de diffusion dans des zones "d'excédent" magnésien des phases carbonatées.

1. Introduction

In the middle basin of the Aleului Valley (Bihor Mountains), at its confluence with the Sebișel Valley, at the Gruiului Hill, an important endogene borate deposit, including ludwigite and szaibelyite, pointing to the kotoite presence, was identified. The mineralized site is situated at about 4 km NE of the locality of Pietroasa (Bihor District). The occurrence, investigated by mine workings, had also been pointed out (Stoicovici, Stoici, 1969; Stoici, 1974) but it did not constitute the study object of a thorough mineralogical study.

The ore deposit is hosted in a zone with magnesian hornfels (sensu Turner, Verhoogen, 1960), at the contact of the Pietroasa banatitic pluton with Anisian dolomitic limestones of the Ferice Unit (Nappe) (see Bordea, Bordea, 1973, for details).

2. Paleosome

The metasomatic genesis of the endogene borate deposits is unanimously admitted (Tilley, 1951; Barsukov and Egorov, 1957; Watanabe, 1958; Aleksandrov, 1982 and reports); it is obvious in case of the Gruiului Hill occurrence, too.

The identity of the paleosome with magnesian hornfels nearby the study occurrence (Aleului Valley, Sebișel Valley), unaffected by boron metasomatism, is very likely. Their study rendered evident the presence of a



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mineral association including forsterite, diopside, talc, tremolite, phlogopite, clinochlore, magnetite, brucite, serpentine, pyrite, dolomite, calcite (see also Rafalet, 1963), the carbonatic phases clearly predominating.

The capacity of the trigonal carbonates to form solid solutions raises a significant question when estimating the composition of the carbonatic background. One can estimate the mostly dolomitic origin of the initial assemblage, taking into account the "protodolomitic" character of the premetamorphic rock.

The optical study revealed the coexistence of two carbonatic phases, differentiated by relief, in the cavities of the studied samples. A thermal analysis effectuated on a marble sampled in the proximity of the banatite-dolomitic limestone contact on the Sebișel Valley emphasized the presence of the calcite-dolomite association. The thermal curves are rendered in Figure 1. The endothermic effects along the DTA and DTG curves can be referred to the following phase transformations:

755° C: $MgCO_3$ decomposition from dolomite;

880° C: $CaCO_3$ decomposition from dolomite;

940° C: $CaCO_3$ decomposition from calcite.

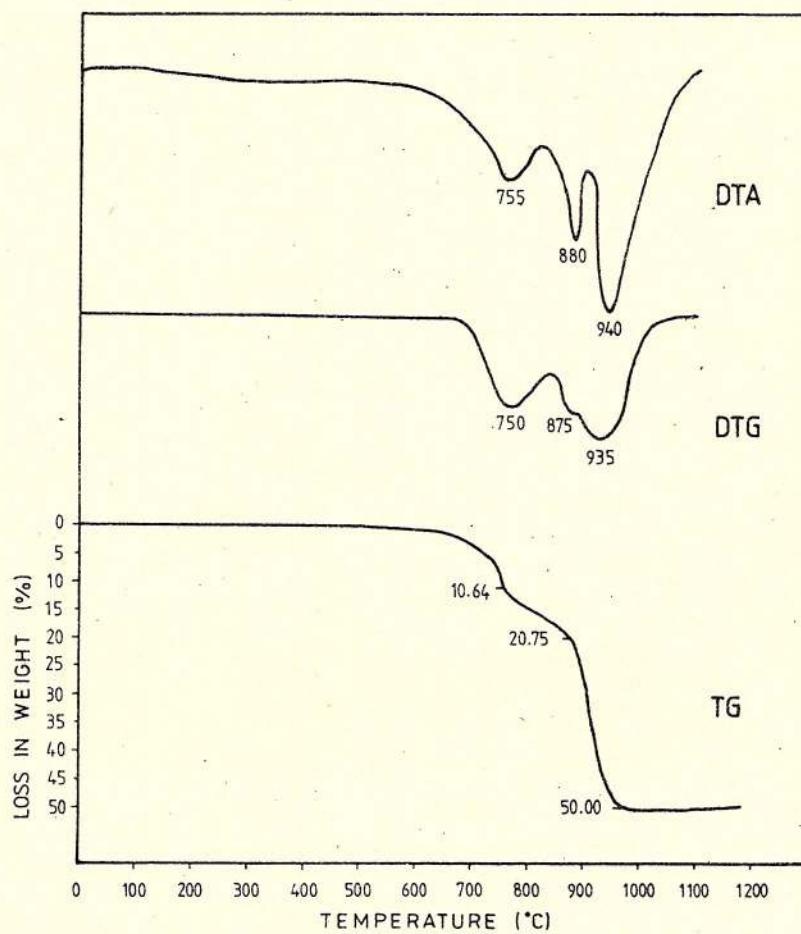


Fig. 1 - Thermal curves of the calcite-dolomite mixture representing the potential paleosome (10^0 °C/minute, analyst T. Drăghici, I.G.G.)

Calcite prevalence is, however, obvious in most of the studied samples, both in those affected and in those unaffected by the boron-fluorine metasomatism. This prevalence is regarded as the result of the initial calcite-dolomite marble evolution, that is the outlining of zones of "magnesium free marbles" after the thermal contact metamorphism. The appearance of calcite-dolomite intergrowths similar to those yielded by thermal exsolution (Carpenter, 1967) points to considerable contents of $MgCO_3$ found as solid solution in calcite. The estimation of these contents in the hypothesis of the reverse linear correlation between the roentgenographically determined value of the interplanar distances $d(10\bar{1}4)$ and the $MgCO_3$ content (Goldsmith et al., 1955) made possible the establishing of unsignificant variations of the magnesitic moles contents in calcites from zones affected or

unaffected by the boron metasomatism (Tab. 1). The low contents of Fe^{2+} and Mn^{2+} from the studied marbles (about 0.02 per cent MnO and 0 per cent FeO)¹ can be neglected as an error source when using this method.

3. Mineralogical Aspects of the Gruului Hill Association

The mineral association identified strictly within the occurrence comprises, beside szaibelyite: calcite, dolomite, forsterite, clinohumite, talc, clinochlore, brucite, serpentine, ludwigite, magnetite, pyrite, goethite and lepidocrocite.

Calcite maintains its role of dominant phase in the Gruului Hill association; it occurs as large beds, practically monominerals, jointing silicates and borates. The local occurrence of lenticular dolomitic segregations, differentiated by a higher refringence, is in concordance with the magnesian character previously mentioned (Tab. 1). These segregations frequently display a linear disposition, very likely along the perfect cleavage after (1011) of calcite, in an angular unconformity with the polysynthetic twin planes, probably (0221).

Dolomite occurs subordinately in the carbonatic association, its relatively low frequency being generally correlatable with the abundance of the associated silicates and magnesian borates. Its presence has already been pointed out in aggregates similar in morphologic respect to the "fine-grained dolomite" described by Carpenter (1967) at Crestmore and regarded as exsolution products from magnesian calcites. The parallel occurrence of largely crystallized dolomitic masses with a limited extension can be interpreted rather as a remobilization of the dolomite exsolved or yielded by reactions like those of brucite calcification - carbonatation (Turner, 1965, in Carpenter, 1967) than as a result of a reaction of partial dissolution of the preexistent dolomite, according to reaction (1) in Figure 2, unaffected dolomitic "relics" being maintained.

Olivine is sporadically found in the boron-carbonatic mass, as isolated crystals, with anhedral, rarely subhedral, contours, frequently bordered by alpha-serpentinic reaction rims. The optical study made possible to diagnose as forsterite the olivinic term from the Gruului Hill association, after establishing the extreme values of the (+)2V ($86\text{--}88^{\circ}$) angle and the second order birefringence. All this does point to a term with less than 10 per cent fayalite, whose presence is perfectly compatible with the Fe^{2+} deficiency observed in the system.

Clinohumite is found in similar conditions as forsterite; it is also characterized by anhedral contours and the frequency of alpha-serpentinic borders. Diagnosis was made on the basis of the optical features. This mineral is biaxial positive with $2V=74\text{--}76^{\circ}$ and displays a poor pleochroism (light yellow after n_p - colourless after n_g and n_m). Most of the crystals are polysynthetically twinned after (001). Extinction $c:n_p=13^{\circ}$, measured at one of the crystals, accepting as crystallographic marker the poor cleavage after (100), indicates the presence of clinohumite; not of chondrodite previously mentioned in the area (Rafalet, 1963). The relatively low birefringence (this mineral polarizes at the middle of the second order) indicates an extreme magnesian term (Tröger, 1959).

Talc occurs frequently in the Gruului Hill association, as xenoblastic crystals, which seem to be centripetally substituted by subsequent phases. Locally, szaibelyite advances along the perfect cleavage after (001), generating mixed aggregates, similar to talc-szaibelyite intergrowths, in which minerals can be differentiated by refringence. All the other optical characteristics are classical. The practically uniaxial (negative) character of the mineral indicates very small 2V angles ($-2V \approx 0^{\circ}$). The positive elongation and the straight extinction versus the cleavage direction after (001) are obvious. The polarization shades are intense, characteristic of a high birefringence (third order).

Chlorite is found in the Gruului Hill association as an early product, possibly generated during reactions as that illustrated in Figure 2 (3). Optical characters (poor pleochroism in light green shades after n_p and n_m - yellowish-green after n_g ; low birefringence, in colours belonging to the first half of the first order; positive biaxial character with small 2V (cca 20°); extinction $n_p: c \approx 0^{\circ}$) point to a pennine-clinochlore type orthochlorite. The significance of the species identification resides in the impossibility to separate szaibelyite from chlorite, with which it frequently forms intergrowths similar to those of talc-szaibelyite. The powder X-ray diffraction pattern of a chlorite-szaibelyite sample pointed out reflections with values d/n (\AA) and intensities I/I_0 rendered in Table 2. They were indexed by comparison with similar reflections of monoclinic chlorite samples presented by Brindley (1961). The average and high intensities of the first five orders of basal reflection indicate a magnesian chlorite (in which the percentage of the positions occupied by Fe in octahedral coordination is less than 30 per cent : Brindley, 1961). The low intensity of the (001), (003) and (005) reflections versus that of (002) and (004) reflections is typical of high-Fe chlorites (Brindley, 1961), indicating a high amount of ($\text{Fe}^{2+} + \text{Fe}^{3+}$) in the Gruului Hill chlorite formula.

¹Analyst : E. Colios.



Table 1. Magnesium Content of Carbonate Phases from Sebișelului and Aleului Valleys, Based on Variation of $(10\bar{1}4)$ Spacing

Sample	Location	d $(10\bar{1}4)$ (Å)	(1) ad standard (Å)	(2) Ad $(10\bar{1}4)$ (Å)	Other associated minerals	(3) $MgCO_3$ (%)
153	Sebișel V.	2,889	0,293	0,146	ta, cl	49,8
179	Gruiului Hill	3,021	0,293	0,014	fo, ch, ta, br, se, cl, sz	4,8
210	Aleului V.	3,025	0,293	0,010	sp, fo, se, br	3,4
133	Gruiului Hill	3,027	0,293	0,008	fo, cl, ta, se, br, sz, lw, ch	2,7
160	Aleului V.	3,023	0,293	0,012	ph, br, se	4,1

(1) Cu k_{α} radiation, $\lambda=1,5418 \text{ \AA}$; analyst Corina Cristea (IG.G.)

(2) standards after Brown (1961) : $d(10\bar{1}4) = 3,035 \text{ \AA}$ for calcite;
 $d(10\bar{1}4) = 2,742 \text{ \AA}$ for magnesite

(3) abbreviations in fig. 2; lw = ludwigite; ch = clinohumite; ph = phlogopite

Table 2. X-ray Powder Data for Gruiului Hill Chlorite: Basal Reflections

d/n (Å)	14,24	7,16	4,77	3,561	2,833	2,357	2,026
I/I_0	30	100	50	60	25	40	25
(0 0 1)	(0 0 1)	(0 0 2)	(0 0 3)	(0 0 4)	(0 0 5)	(0 0 6)	(0 0 7)

• Cu k_{α} radiation, $\lambda=1,5418 \text{ \AA}$; analyst Corina Cristea (IG.G.)

Table 3. X-ray Powder Data for Gruiului Hill Serpentine

1	2	3	4	5	6	7	8
d/n (Å)	7,27	4,62	3,64	2,87	2,66	2,499	2,43
I/I_0	100	20	60	14	15	45	12
(h k l)	(0 0 2)	(0 2 0)	(0 0 4)	(0 2 4)	(1 3 0)	(2 0 2)	(0 0 6)
1	9	10	11	12	13		
d/n (Å)	2,205	2,148	1,732	1,536	1,507		
I/I_0	10	11	4	25	11		
(h k l)	(2 0 4)	(2 0 4)	(3 1 0)	(0 6 0)	(2 0 8)		

• Cu k_{α} radiation, $\lambda=1,5418 \text{ \AA}$; analyst Corina Cristea (IG.G.)



Taking into account the value of the reticular distance $d(001)$ and using the relation proposed by Brindley (1961) in order to determine the diagnostic value x :

$$d(001) = 14.55 - 0.29 x, \quad x = 1.07 \text{ result.}$$

The correlation of this value with the value (zero) of the ferro-magnesian ratio $R = Fe^{2+} : (Fe^{2+} + Mg^{2+})$ (Hey, 1954), given by the absence of the ferrous oxide from the global analysis of the same sample (Tab. 4), points to a chlorite where $R=0$ and $x = 1.07$, assigned by Hey (1954) and Brindley (1961) to the clinochlore field ($0 \leq R \leq 0.2$ and $0.9 \leq x \leq 1.2$).

Even after the total transformation of the ferric oxide into ferrous oxide (on the basis of the relation $Fe_2O_3 = 1.11 FeO$) and considering as work hypothesis the presence of the whole amount of Fe^{3+} in the chlorite formula, the ferro-magnesian ratio R is not more than 0.2 (see the chemical-structural formula established at point 4.2).

Brucite occurs constantly in the Gruiului Hill association, both within brucite-serpentine intergrowths (in reaction rims bordering nesosilicates) or within brucite-szaibelyite intergrowths, and as isolated lamellas in the boron-carbonatic mass. All this, as well as the absence of characteristic aspects, e. g. "onion skin textures", indicating pseudomorphs after periclase (Carpenter, 1967), are in favour of its genesis in reactions of type (6) or (a) rendered in Figure 2, not as a result of the periclase hydration reaction (4). Diagnosis was made on the basis of the optical features: the mineral is uniaxial positive, displays a straight extinction versus the direction of the perfect cleavage after (0001) and a relatively low birefringence (end of the first order).

Serpentine minerals define, within the Gruiului Hill association, crystalline aggregates similar with the "alpha-serpentinic mesh textures" (sensu Wicks et al., 1977), displaying serpophitic nuclei or relics of forsterite or clinohumite bordered by alpha-serpentine (thus defined on the basis of the negative elongation and of the negative optical sign). Isolatedly, aspects defining hourglass textures were observed as pseudomorphs after olivine, both aspects indicating, as a matter of fact, the genesis of the Gruiului Hill serpentine as a result of the 6th reaction in Figure 2. The optical characters (low birefringence, in shades belonging to the first half of the first order; hardly perceptible pleochroism: colourless after n_p - slightly greenish after n_g ; negative biaxial character) make impossible the discrimination of the mineral species. Considering the identity serpophite=lizardite and the fact that alpha-serpentine has usually the same origin (Wicks, Zussman, 1975), the presence of lizardite in the Gruiului Hill paragenesis is, however, presumed.

This conclusion is in agreement with the powder X-ray diffraction data. The reticular distances d/n (Å) and the intensities I/I_0 of the main reflections for the mineral are rendered in Table 3. Their index was achieved by comparison with similar reflections of lizarditic or lizardite-chrysotilic samples presented by Whittaker and Zussman (1956). In agreement with the above-mentioned authors we consider the following aspects discriminatory: the absence of the marked line from $d=1.563$ Å (typical of antigorite); the presence of a line with a high intensity at 2.499 Å; the presence of a line doublet at 1.536 Å and 1.507 Å, the latter being specific to lizardite).

Ludwigite represents a subordinate component of the boron-carbonatic mass of the Gruiului Hill association, its percentage participation being clearly lower than that of szaibelyite. Ludwigite crystals, with millimetric lengths and a long prismatic (fibrous) habit are generally disseminated in the carbonatic mass, being grouped as fan-like aggregates or nodular aggregates consisting of crystals with a radial disposition.

The transmitted light study revealed: 1) the practically opaque behaviour of the mineral, with the local delimitation of marginal translucent zones, visualising ludwigite-szaibelyite intergrowths (within which the green-dark olive up to brown pleochroism of the mineral can be emphasized, without specifying the vibrational directions), and 2) the markedly positive relief, superior to that of calcite and of szaibelyite. The practically opaque character points out the presence of a ferriferous ludwigite at Gruiului Hill (Winchell, 1959). The optical characters determined by the chalcographic study also indicate a ferriferous term. The grey-coloured mineral is strongly bireflectant (light grey after the elongation direction - grey-bluish after the other direction), a phenomenon rendered evident especially in immersion; it is anisotropic (in brown-grey hues) and its reflection capacity is inferior to that of magnetite, beside which it often occurs.

The X-ray powder diffraction pattern of nodular-like ludwigite aggregates revealed the ludwigite-szaibelyite-calcite association, ludwigite reflections, from 5-12 Å ($I/I_0=100$), 2.547 Å ($I/I_0=95$), 2.163 Å ($I/I_0=35$) and 1.995 Å ($I/I_0=30$), being noticeable (the others being generally superposed with reflections of the associated minerals).

Magnetite occurs generally in association with ludwigite and szaibelyite, as fan-like crystalline aggregates suggesting pseudomorphs after a preexistent ludwigite (in which case magnetite and szaibelyite would be newly



formed at its expense). Within these aggregates magnetite is characterized by the hipidiomorphism of the contours and by the tendency of a linear disposition, locally generating elongated grains. In places, magnetite crystals include zones in which saibelyite is accompanied by superposed goethite aggregates, displaying strong internal reflections, in red-brownish hues.

Goethite and *lepidocrocite* were generally identified within compound aggregates of limonitic type, in which the two minerals are intimately intergrown, differing by the optical characters that can be noticed in reflectant light (grey-whitish colour with a marked bireflectance in bluish-white hues, great reflection capacity and strong anisotropy for lepidocrocite, and grey-bluish colour, weak bireflectance, low reflection capacity and hardly observable anisotropy for goethite). The disposition of these aggregates nearby ludwigite crystals or magnetite-ludwigite intergrowths, as discontinuous borders, with an atoll-like aspect point to leaching processes subsequent to the supergene alteration.

Pyrite occurs sporadically in the Gruiului Hill association, being characterized by a marked idiomorphic tendency, outlining cubic shapes. Its disposition in the boron-carbonatic mass seems to be controlled by a system of microfissures, its spatial relationships with the other minerals pointing to a mere superposition.

On the basis of the mutual relationships between the noncarbonatic phases, described previously in the Gruiului Hill association, the following crystallization succession can be established : forsterite-clinochlore-talc-ludwigite-serpentine-brucite-magnetite-szaibelyite-pyrite-goethite+lepidocrocite. This order is broadly in concordance with an "ideal" petrogenetic scheme, drawn up for a system with a deficit of FeO and Fe₂O₃, whose main reactions are rendered in Figure 2.

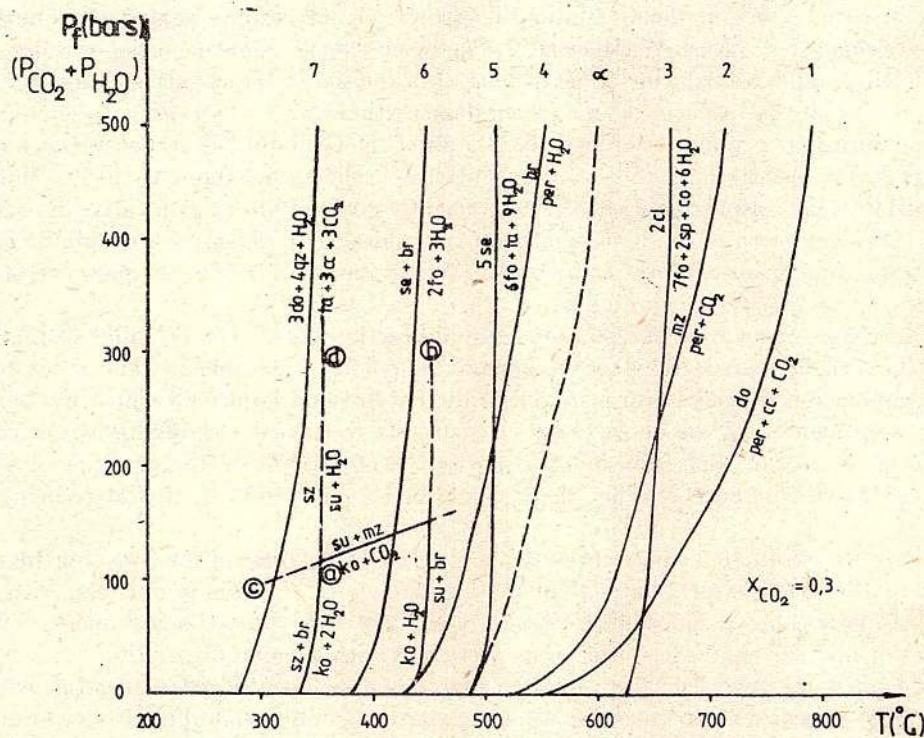


Fig. 2 - Petrogenetic sketch of the main mineral equilibrium of the system $CaO - MgO - SiO_2 - Al_2O_3 - B_2O_3 - CO_2 - H_2O$, for $X_{CO_2}=0.3$, particularized for the Gruiului Hill association.

1, 2 - after Harker & Tuttle (1955), $P_{fluid} = P_{CO_2}$; 3 - after Yoder (1952), $P_{fluid} = P_{CO_2}$; 4 - after Kennedy (1956), $P_{fluid} = P_{CO_2}$; 5, 6 - after data presented by Johanes (1969) for the reaction $3mz + 4qz + H_2O = ta + 3CO_2$, $P_{fluid} = P_{H_2O} + P_{CO_2}$; 1-7 - correlated with data presented by Kerrick (1974), Zharikov et al. (1977), Skippen (1974); a, b, c, d - hypothetical curves for the reactions: $ko + 2H_2O = sz + br$: (a); $su + br = ko + H_2O$: (b); $ko + CO_2 = su + mz$ or $ko + cc + CO_2 = su + do$: (c); $su + H_2O = sz$: (d) according to the thermobaric stability fields of sanidine, kotoite, szaibelyite established by Aleksandrov (1982), $P_{fluid} = P_{CO_2} + P_{H_2O}$; α - hypothetical separation limit of the thermobaric conditions defining the hornblende facies (after Turner, Verhoogen, 1960). br = brucite, cc = calcite, cl = clinochlore, co = corundum, do = dolomite, fo = forsterite, ko = kotoite, mz = magnesite, per = periclase, qz = quartz, se = serpentine, sp = spinel, su = suanite, sz = szaibelyite, ta = talc.

4. Szaibelyite

4.1 Optical characters

Szaibelyite abundance in the Gruiului Hill association is remarkable, locally the mineral representing about 60–70 per cent from the boron-carbonatic mass.

The macroscopic study made possible to emphasize the local presence of szaibelyite aggregates with a fibro-radial development and nodular aspect (nodules diameters varying between 5 and 15 mm). The white colour and silky lustre of the mineral are noticeable.

The very small dimensions of the crystals make difficult the transmitted light study of the mineral; observations can be made only on pluricrystalline aggregates.

Two characteristics point to the presence in the Gruiului Hill association of a term with a low content of sussexitic moles (after Winchell, 1969) :

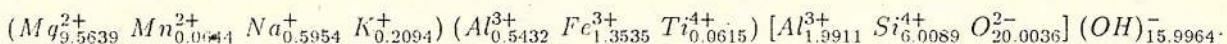
- high birefringence (the mineral polarizes in colours of the second half or the fourth order);
- relatively low refringence (refraction index determined in immersion using Schröder's method is $n=1.65$, probably corresponding to n_m or to n_g).

A negative biaxial character with a small (-2V) of the mineral can be presumed considering the normal optical behaviour of talc within the talc-szaibelyite intergrowths, practically not influenced by the szaibelyite presence.

4.2 Chemistry

The difficulty to separate monomineral samples raises problems when establishing the major chemistry of the mineral. The geochemical features clearly different from those of associated minerals (carbonatic and silicate phases) made possible the derivation of the Gruiului Hill szaibelyite formula.

Table 4 presents the chemistry of the concentrate obtained by handpicking and magnetic separation, followed by cold etching with acetic acid and washing with a view to removing brucite and diminishing the carbonatic phases. Normative composition calculated on the basis of the presented analyses was established by correlation with optical and X-ray data which made possible the identification of the mineral association. For simplification, the stoichiometry of the carbonatic phases and of serpentine ne formulas was estimated, considering the oxidic contents of Na_2O , K_2O , TiO_2 , Al_2O_3 and Fe_2O_3 entirely integrated in the chemistry of a hypothetical clinochlore whose formula is $\text{X}_{10}\text{Y}_2(\text{Al}_2\text{Si}_6\text{O}_{20})(\text{OH})_{16}$ where $\text{X}=\text{Mg}^{2+}$, Na^+ , K^+ and $\text{Y}=\text{Al}^{3+}$, Fe^{3+} , Ti^{4+} . Its chemical-structural formula established by recalculation at cent per cent and referring it to the base 36 (O, OH), admitting the proportionality of $\text{Mn}^{2+} : \text{Mg}^{2+}$ participation in all the minerals of the association (see further on) is :



The establishing of the percentage of Mn^{2+} included in the Gruiului Hill szaibelyite network plays an important part in the definition of the percentage of the sussexitic moles in its composition. The low amount of Mn^{2+} rendered evident in the concentrate (Tab. 4) points to a reduced participation of sussexite, indicating a term close to the extreme szaibelyite (only 0.42 per cent sussexite) even when admitting that Mn^{2+} is totally included in the borate network.

Szaibelyite chemical-structural formula established in this case (by recalculation at one hundred per cent and referring it to base 6 (O, OH)) is : $(\text{Mg}_{2.0276}^{2+} \text{Mn}_{0.0086}^{2+}) (\text{OH})_{0.8195} [\text{B}_{2.0361}^{3+} \text{O}_{4.1806}^{2-} (\text{OH})^-]$ (Takeuchi, Kudoh's, for the structural formula, 1975).

The qualitative study with the electron microprobe of samples from the Gruiului Hill rendered evident the similar trend of the variation curves of the Mn^{2+} and Mg^{2+} contents in studied profiles (Pl. I) when Mn^{2+} occurs in all the minerals containing Mg^{2+} . All this made possible the hypothesis of the Mn^{2+} appearance exclusively as an isovalent substitute of Mg^{2+} and implicitly the admittance of the constancy of the $\text{Mn}^{2+}:\text{Mg}^{2+}$ ratio.

The recalculation, considering this hypothesis, of the chemical-structural formula of the Gruiului Hill szaibelyite led to the formula: $(\text{Mg}_{2.0293}^{2+} \text{Mn}_{0.0075}^{2+}) (\text{OH})_{0.8192} [\text{B}_{2.0358}^{3+} \text{O}_{4.1809} (\text{OH})^-]$.

The chemistry of the mineral determined in this hypothesis is rendered in Table 5, in comparison with the chemistry established for the Băița Bihorului (Rézbánya) szaibelyite, where the mineral was first mentioned (Peters, 1861) and the chemistry of the synthetic compound.



Table 4. Major-element Analyses⁽¹⁾ and Norms Calculated for a Szaibelyite Concentrate from Gruialui Hill

Oxides	wt %	Normative minerals	wt %
SiO ₂	4,23	szaibelyite	81,17
TiO ₂	0,04	clinochlore	9,44
Al ₂ O ₃	1,05	serpentine	2,98
Fe ₂ O ₃	0,88	calcite	1,98
MnO	0,29	dolomite	4,34
MgO	44,24	water (H ₂ O ⁻)	0,07
CaO	2,43	TOTAL	99,98
K ₂ O	0,08		
Na ₂ O	0,15		
H ₂ O ⁺	9,41		
H ₂ O ⁻	0,07		
CO ₂	2,95		
B ₂ O ₃	34,16		
TOTAL	99,98		

(1) analyst Elena Colios, I.P.G.G.

Table 5. Comparative Chemical Analyses for Romanian Szaibelyite

Oxides	Synthetic Mg ₂ (OH)[B ₂ O ₄ (OH)]	Szaibelyite from Gruialui Hill	Szaibelyite from Băița Bihor (Rézbánya) ⁽¹⁾
MgO	47,92	47,94	51,28
MnO	—	0,31	—
B ₂ O ₃	41,38	42,08	35,89
H ₂ O ⁺	10,70	9,67	12,83

(1) after Peters, 1961; recalculated to 100% after deduction of 3,4% insoluble (Fe₂O₃=3,2% Cl =0,2%)

Table 6 Comparative X-ray Powder Diffraction Data for Szaibelyite

Crt. nr.	Szaibelyite Dealul Gruiului : present work*		Szaibelyite Bâița Bihor : Săbău, 1988 – unpublished data		Szaibelyite Douglas Lake (f=0,12) Takeuchi , 1957		Synthetic $Mg_2B_2O_5 \cdot H_2O$: Grigoriev et al , 1966		(h k l)	
	d/n (Å)	I/I₀	d/n (Å)	I/I₀	d/n (Å)	I/I₀	d/n (Å)	I/I₀	indexed as orthorombic (Takeuchi, 1957)	indexed as monoclinic (Grigoriev et al, 1966)
1	6,23	100	6,22	100	6,20	100	6,24	90	(0 2 0)	(2 0 0)
2	5,19	50	5,19	35	5,17	50	5,21	20	(2 0 0)	(0 2 0)
3	3,98	6	3,98	10	3,97	8	-	-	(2 2 0)	(2 2 0)*
4	3,865	15	3,86	15	3,85	20	3,87	10	(1 3 0)	(3 1 0)
5	3,34	15	3,34	12	3,32	18	3,342	30	(3 1 0)	(1 3 0)
6	3,25	50	3,246	45	3,24	45	3,254	50	(2 3 0)	(3 2 0)
7	3,03	40	3,028	35	3,02	40	3,027	50	(3 2 0)	(2 3 0)
8	2,665	55	2,665	100	2,657	75	2,664	100	(2 4 0)	(0 2 1)
9	2,595	10	2,59	10	2,586	30	2,591	30	(4 0 0)	(0 4 0) (2 1 1)
10	2,54	8	2,54	20	2,533	40	2,538	80	(4 1 0)	(2 2 T) (1 4 0)*
11	2,432	60	2,43	60	2,424	75	2,427	100	(1 5 0)	(5 1 0)
12	2,316	10	2,315	40	2,313	30	2,311	80	(3 4 0)	(0 3 1) (4 3 0)*
13	2,207	75	2,205	65	2,202	80	2,201	100	(3 2 1)	(3 4 0)
14	2,084	60	2,084	60	2,079	60	2,078	90	(0 6 0)	(6 0 0)
15	1,999	25	1,995	25	1,992	25	1,991	80	(4 4 0) (4 1 1)	(4 4 0) (1 4 T)*
16	1,971	11	1,970	10	1,967	12	1,972	10	(0 5 1) (5 2 0)	(2 5 0) (5 0 1)*
17	1,934	10	1,934	8	1,932	12	1,935	20	(1 5 1)	(2 4 T)
18	1,790	10	1,790	8	1,779	12	1,790	50	(3 6 0)	(6 1 T) (6 3 0)*
19	1,727	5	1,726	25	1,726	20	-	-	(6 0 0)	(0 6 0)*
20	1,515	6	1,514	35	1,510	14	-	-	(6 4 0)	(4 6 0)*
21	1,494	10	1,494	9	1,493	12	-	-	(2 8 0)	(8 2 0)*
22	1,475	14	1,475	8	1,474	14	-	-	(6 2 1)	(2 6 T)*

* Cu K_{α} radiation, $\lambda=1,5418 \text{ \AA}$; analyst Corina Cristea

(h k l)*: indexed by Zachariasen method

4.3 X-ray diffraction analysis

The X-ray diffractometric study using the powder method of the Gruiului Hill szaibelyite emphasized reflections characteristic of a term with a reduced number of sussexitic moles ($f = Mn^{2+} : (Mn^{2+} + Mg^{2+}) \approx 0$). This conclusion was inferred from the trend to displace towards higher values distances corresponding to the main reflections, as a result of the progression of the isomorphic substitution $Mn^{2+} \rightarrow Mg^{2+}$ (Takeuchi, 1957). It is of note the closeness of these reflections with those recorded for a szaibelyite sample from Băia Bihor (Rézbánya). The X-ray powder data are presented in Table 6 versus corresponding data recorded for a szaibelyite from Douglas Lake (Canada), with 12 per cent sussexitic moles (Takeuchi, 1957), and for a synthetic "hydroxyl-szaibelyite" with $f=0$ (Grigoriev et al., 1966). The index of the planes (hkl) was made both in the hypothesis of an orthorhombic symmetry of the mineral (acc. to Takeuchi, 1957) and in the hypothesis of a monoclinic symmetry (acc. to Grigoriev et al., 1966), in the latter case being completed, for further reflections, with values established by reciprocity with the index for the orthorhombic cell, verified by Zachariasen's analytical method.

The extremely small dimensions of the Gruiului Hill szaibelyite crystals make difficult the attempts to establish with certainty the mineral symmetry. However, the still existing incertitudes as regards the polymorphism of the mineral (Takeuchi, Kudoh, 1975) make us deal with this aspect with care. For this reason the calculation of the cell parameters on the basis of the diffraction data rendered in Table 6 was achieved in three variants (Tab. 7) : "normal" monoclinic cell variant, orthorhombic cell variant and twinned monoclinic cell variant (with pseudo-orthorhombic structure, in which the orthorhombic cells can be described as polysynthetic twins of szaibelyite, extended to the scale of the elementary cell half: Takeuchi, Kudoh, 1975).

The results were obtained by the least squares refinement of the data presented in Table 6, starting from Bjurström's equation

$$\frac{1}{d^2} = \frac{h^2}{a_0^2} + \frac{k^2}{b_0^2} + \frac{l^2}{c_0^2}$$

for the orthorhombic symmetry and

$$\frac{l}{d^2} = \frac{h^2/a_0^2 + l^2/c_0^2 + 2hl\cos\beta/a_0c_0}{\sin^2\beta} + \frac{k^2}{b_0^2}$$

for the monoclinic symmetry.

The obtained values are close to those mentioned in the relevant literature for terms with a small number of sussexitic moles : $a_0=10.34 \text{ \AA}$; $b_0=12.45 \text{ \AA}$; $c_0=3.21 \text{ \AA}$ for szaibelyite with $f=0.12$, assuming an orthorhombic symmetry (Takeuchi, 1957) and $a_0=12.56 \text{ \AA}$; $b_0=10.37 \text{ \AA}$; $c_0=3.125 \text{ \AA}$; $\beta=5.7^\circ$ for a synthetic "hydroxyl-szaibelyite", with $f=0$, assuming a monoclinic symmetry (Grigoriev et al., 1966). The recorded diffractometric data are presented in Table 6.

4.4 Infrared absorption spectrometry study

The infrared absorption spectrum obtained for a szaibelyite sample from the Gruiului Hill, ranging between 400 and 3600 cm^{-1} in the frequency domain, shows characteristics similar with those obtained for borates with a "calcite"-type structure (Gadsden, 1975). This statement is supported by the position of the large complex of absorption bands with high intensities ranging between 1250 and 1500 cm^{-1} , correlated with the absence of the absorption band materializing symmetric stretching (Gadsden, 1975), within the interval of frequency specific to the "aragonite"-type structures, varying from 850 to 900 cm^{-1} . The position and characteristics of the main absorption bands are presented in Table 8 and Figure 3, versus similar data synthetized by Gadsden (1975) and Moenke (1962).

The peculiarities observed for absorption bands recorded between 600 and 800 cm^{-1} , representing the boron-oxygen (ν_3) and metal-borate bands stretching vibrations (ν_2 acc. to Gadsden, 1975) are minor. All this makes us presume the low content of sussexitic moles of the Gruiului Hill szaibelyite, close to those of the magnesian terms considered by Moenke (1962) and Gadsden (1975). The magnesian character of the studied szaibelyite is also stated by the narrowness of the absorption band around the value of 930^{-1} (924 cm^{-1}) whose width varies clearly within the szaibelyite-sussexite series, displaying maximum values at the extreme magniferous term (Nekrasov et al., 1970).



Table 7. A Base for Gruiului Hill Szaibelyite Polymorphism

Symmetry	Cell dimensions (Å)			$\beta = 95,72$	Space group
	a	b	c		
1 monoclinic	12,55	10,359	3,215	$\beta = 95,72$	P 2 ₁ /a
2 orthorhombic	10,359	12,488	3,215	—	P 2 ₁ 2 ₁ 2 ₁
3 monoclinic (twinned cell)	24,976	10,359	3,215	$\gamma = 90,00$	P 2 ₁ /a

Table 8. IR-absorption Band Frequencies of Gruiului Hill Szaibelyite⁽¹⁾ as Compared with Gadsden (1975) and Moenke (1962) Data on Mineral

1	cm ⁻¹	present work	3564	1932	1464 ⁽⁴⁾	1382 ⁽⁴⁾	1272 ⁽⁴⁾
2		Gadsden	3552	1900	1485	1390	1260 – 1270
3		Moenke	3568	—	1482	1385	1280
4	Intensity ⁽²⁾		s	w	vs	vs	s
5	Character ⁽³⁾		sh	b	sh	sh	b
1	1014	980	924	708	688	634	
2	1010 – 1020	979 – 985	921 – 930	710	687 – 690	630	
3	1014	982	928	707	682	626	
4	m	m	m	vs	m	vs	
5	sh	sh	sh	sh	sh –	sh	
1	566	532	520	486	442	406	
2	570	540	—	500	445	410	
3	568	539	512	496	445	408	
4	m	m	w	m	m	m	
5	sh	sh	sh	b	b	sh	

(1) analyst Gabriela Stelea, I.G.G.

(2) s - strong; m - medium; w - weak; vs - very strong

(3) sh - sharp; b - broad

(4) series of spaced peaks on a broad background



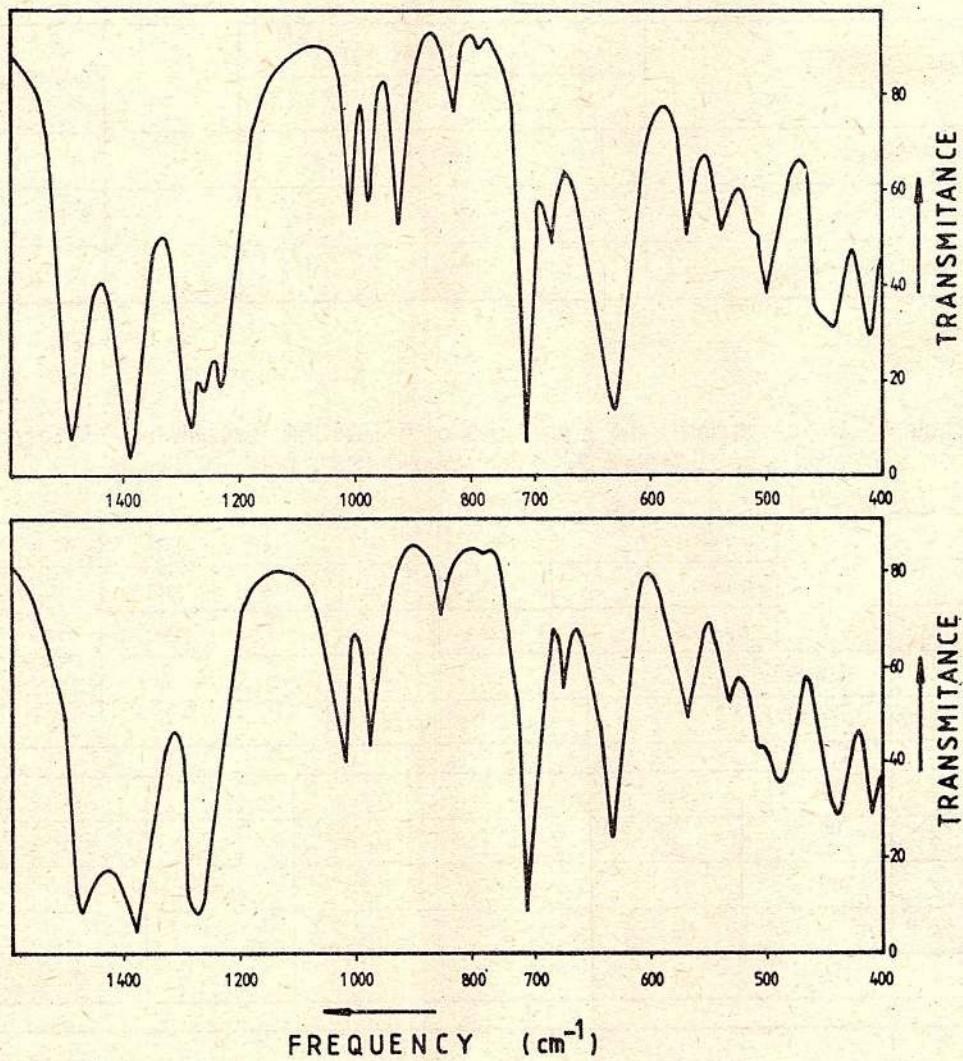


Fig. 3 - Infrared absorption spectrum of the Gruiului Hill szaibelyite (bottom) versus the standard spectrum given by Moenke (1962) for a Stassfurt "ascharite" (top).

4.5 Thermal study

The thermal curves recorded for a szaibelyite sample from the Gruiului Hill obtained by handpicking and etching with hydrochloric acid, in order to eliminate the carbonatic phases, emphasized the "normal" behaviour of the mineral (Fig. 4). The only effect traced is the endothermic one recorded on DTG and DTA curves at temperatures of 690 and 695°C, respectively, pointing out the mineral dehydration. Subsequent analyses emphasized that the position of the peak marking this effect changes little in case of the calcite presence in the sample (700-710°C for samples with 25-50 % calcite in mechanic mixture). The effect corresponds to a mass loss of about 11 per cent (inferred on the basis of the TGA curve), very close to that calculated for szaibelyite conversion into suanite, by losing one water molecule (10.71 per cent).

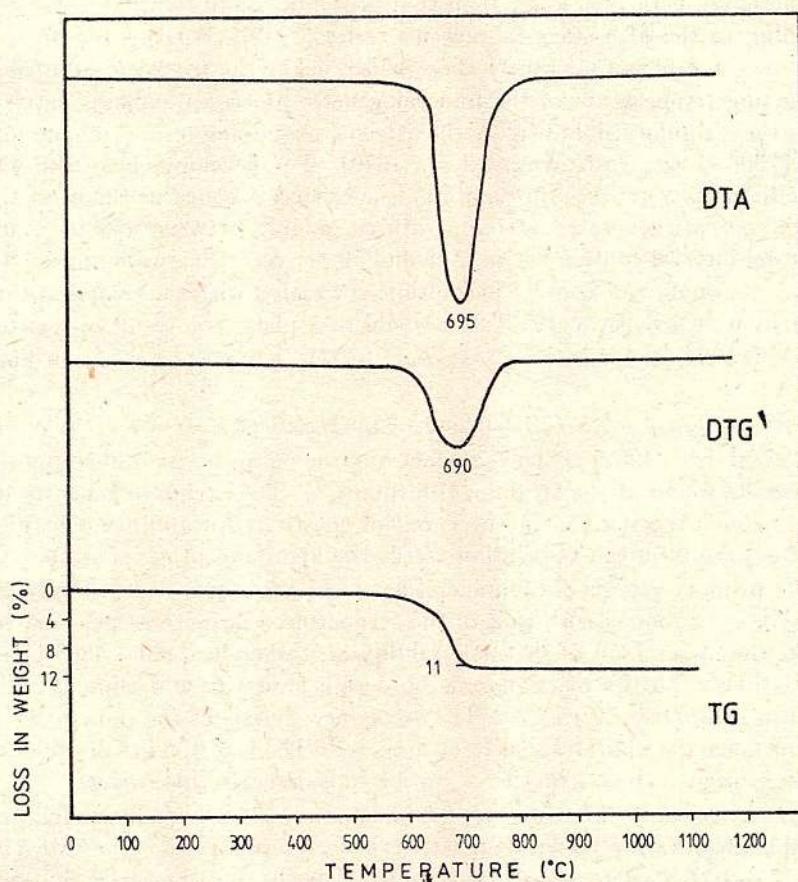


Fig. 4 - Thermal curve of Gruiului Hill szaibelyite (10^0 C/min, analyst T. Drăghici, I.G.G.)

A characteristic of the Gruiului Hill szaibelyite is the absence of the exothermic effect figured by Grigoriev et al.(1966) on the DTA curves of "hydroxyl-szaibelyite" samples, subsequent to their dehydration, without any mass loss. All this indicates undoubtedly the absence of a structural reorganization of the analysed mineral after the elimination of a water molecule, defining, in case of the Gruiului Hill szaibelyite, a szaibelyite sensu strictu.

5. Genetical Data

The mineralogical study of the Gruiului Hill association pointed out the spatial superposition of the boron minerals over magnesian hornfels, similar to those in adjacent zones, where there are no traces of a boron-fluorine metasomatism.

The derivation of these hornfels from Anisian dolomites of the Ferice Unit is possible under conditions of an isochemical thermal metasomatism, the silica deficit being maintained. The initial paragenesis is considered to be of the forsterite-talc-clinochlore-calcite type. The acceptance, in these circumstances, of the presence of boron and fluorine as mobile components of the fluid phase (Turner, Verhoogen, 1960) would lead to the outlining of an initial paragenesis similar to that described at the Gruiului Hill (forsterite-talc-clinochlore-clinohumite-ludwigite-calcite) changing the isochemistry conditions. Allochemistry is, however, resumed to the introduction in the system of boron and fluorine, without changing the equilibrium as regards the other elements. This fact, obvious for major elements, was confirmed by the spectral analyses also as regards the minor elements. They revealed that the remarkable low-contents of minor elements of the magnesian hornfels in the area (less than 2 ppm Pb, Sn, Ga, Mo, Ni, Co, V, Sc; less than 3 ppm Cu; less than 10 ppm Ba, Sr, Y, Nb)² is also common to the Gruiului Hill boron mineralization.

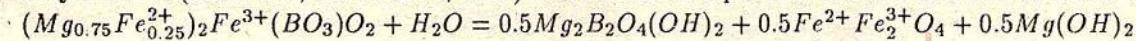
The above-mentioned paragenesis defines thermo-baric conditions that can be referred to the hornblende hornfels facies (Turner, Verhoogen, 1960). The absence of aspects pointing to the periclase preexistence (see

²Analyst: A. Ţerbănescu.

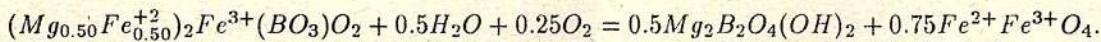
point 3) indicates genetic temperatures lower than that of the dolomite thermal decomposition (reaction 1 in Figure 2), corresponding to the fifth stage in Bowen's series (1940). For this reason we consider the initial conditions of thermal metamorphism inferior to those which define the pyroxene hornfels facies.

The intimated starting temperature of the mineralogic processes explains satisfactorily the iron-rich character recorded for the Gruiului Hill ludwigite, the extreme magnesian term ("magnesioludwigite") requiring higher temperatures (700° C acc. to Nekrasov et al., 1970). The development of the reactions to the left of the periclase out-brucite in curve (curve 4 in Figure 2) is admitted as concerns the presence of ludwigitic terms with a high vonsenite content, generated at temperatures ranging between 450° C and 500° C. Ludwigites generated in this thermal interval contain between 25 and 50 per cent vonsenitic moles (Nekrasov et al., 1970).

The increase of the carbon dioxide content in solution, correlated with the temperature decrease cause their szaibelyitization (Barsukov, Kurilcikova, 1957) that would take place as a result of reactions of the type:



or



Such reactions (Aleksandrov, 1982) explain satisfactorily the parageneses szaibelyite + magnetite \pm brucite at the expense of ludwigite found at the Gruiului Hill (point 3). The exclusive generation of the Gruiului Hill szaibelyite as a result of such reactions is, however, out of question. An argument in this respect is the small percentage of magnetite present in the association versus the high percentage of szaibelyite.

The hypothesis of a primary genesis of the mineral has to be taken into account only as far as its formation would be approximately synchronous with that of the serpentine + brucite association (acc. to reaction 2 in Figure 2), therefore at the upper limit of thermal stability of szaibelyite ($400 - 430^{\circ}$ C acc. to Aleksandrov's data). Szaibelyite relations with the reaction rims bordering forsterite and clinohumite clearly indicate the late borate formation in comparison with these. The secondary genesis of the mineral, as a result of hydration processes of preexistent magnesian borates, has to be accepted. The lack of relics of such borates makes difficult the specification of their origin. Three hypotheses can be considered in this respect:

1. Fluoborate preexistence. Metastability of the term with a high hydroxylic content belonging to fluoborate series is well known. Szaibelyitization reactions of such terms, of the type: $Mg_3(BO_3)(OH)_3 + H_2O = 0.5Mg_2B_2O_4(OH)_2 + 2Mg(OH)_2$, were described in similar deposits, e.g. Fresno and Crestmore (Aleksandrov, 1982). Generally, fluoborate formation is admitted simultaneously with minerals from the humite group, as a result of the boron-fluorine metasomatism of preexistent dolomite and forsterite (Aleksandrov, 1982). In this case the fluorine supply would affect both newly-formed minerals, the preexistence of an extreme hydroxyl-fluoborate implying the parallel existence of a low-fluorine clinohumite. The determination of the fluorine content in the Gruiului Hill clinohumite might, therefore, confirm or weaken the mentioned hypothesis.

2. Suanite preexistence. The restrictive stability conditions of this mineral, highly susceptible to hydration, make difficult its occurrence in an association like that at the Gruiului Hill. As regards the temperature these conditions are fulfilled as the mineral crystallizes at temperatures ranging between 450 and 500° C (Nekrasov et al., 1970); its subsequent stability is disputable, requiring fluids with very high contents of carbon dioxide, with limited mole fractions of water. The presence in the Gruiului Hill association of hydroxylic minerals such as talc, serpentine and brucite points out the active role of water in supercritical state in the system, implying its prevalence as a volatile phase. In these circumstances the reaction of suanite conversion into szaibelyite: $Mg_2B_2O_5 + H_2O = Mg_2B_2O_4(OH)_2$ is inevitable. The possibility to identify pseudomorphic aspects materializing reactions of this type is, however, limited by the recrystallization trend of szaibelyite (initially prismatic), yielding fascicular fibrous aggregates (szaibelyite II conversion into szaibelyite III according to Aleksandrov, 1982). Moreover, brucite presence in this association (whose upper stability limit is given by reaction 4 in Figure 2) makes possible the development of the reaction of suanite conversion into kotoite (b in Figure 2), stable at lower temperatures and pressures of the carbon dioxide. In this case the reaction sequence would be of the suanite-kotoite-szaibelyite type.

3. Kotoite preexistence. Although previously mentioned in the Gruiului Hill association (Stoicovici, Stoici, 1969; Stoici, 1974), kotoite has not been found. Arguments in favour of its preexistence are given by the frequency of szaibelyite + brucite intergrowths, with a fibro-radial development, suggesting a centripetal szaibelyitization of kotoite, which generated structural aspects similar to those reported from Băița Bihorului (Stoici, 1974). The hypothesis of the mineral integral pseudomorph as a result of reactions of type (a) in Figure 2 is compatible with the water abundance in the fluid phase, as already suggested, and with the moderate pressure of the carbon dioxide. These conditions are obviously maintained at temperatures lower than that of kotoite crystallization ($350 - 400^{\circ}$ C according to Nekrasov et al., 1970).



The relationships between minerals within the Gruiului Hill association undoubtedly indicate the crystallization of the Gruiului Hill szaibelyite at a temperature lower than that of forsterite serpentinization (acc. to reaction 6 in Figure 2). Concomitantly, the presence of szaibelyite intergrowth with talc unaffected by serpentinization processes (reaction: 1 serpentine + 2 quartz = 1 talc + 1 H₂O which according to Johannes (1969) marks the lower limit of the talc stability) suggests borate formation at temperatures higher than the talc out - serpentine in curve. Even admitting that the mineralizing fluids had appreciable contents of carbon dioxide, talc instability would have been inevitable after a carbonatation reaction (7) (Fig. 2).

The thermo-baric domain of the Gruiului Hill szaibelyite generation is satisfactorily superposed over the field delimited by curves (6) and (7) in Figure 2. The temperatures determined in this way are close to those mentioned in the relevant literature concerning the stability of this mineral (160 – 430° C; Aleksandrov, 1982). Admitting the preexistence of kotoite or of suanite, the crystallization domain of the newly-formed szaibelyite is reduced to the space delimited by the curves (a+d) and (7) in Figure 2, defining temperatures ranging between 275 and 350° C.

The mineralogenesis of the Gruiului Hill association under thermal contact conditions, with a poor metasomatic supply, makes possible the approximation of the total pressure within the system through the pressure of the fluid phases. Mineralogical aspects broadly justify the consideration of a bicomponent system as concerns the fluid phases (CO₂ + H₂O) and the neglect of other volatiles supply (that is the fluorine), considered as subordinate. Therefore, the Gruiului Hill szaibelyite formation was achieved at pressures lower than 3 kilobars, considered by Turner and Verhoogen as limit pressure within the contact metamorphism. The evolution of the association within an open fractural system (see point 6) would reduce this limit, and the estimation of the Gruiului Hill szaibelyite crystallization at pressures lower than 500 bars would be reasonable.

Admitting the bicomponent fluid system there is, however, another problem: mole fractions of CO₂ and H₂O. For carbon dioxide we accepted the opinion of Zharikov et al. (1977) according to which "the contact metamorphism in the Earth's crust is realized when the mole fraction of the carbon dioxide does not exceed X=0.3 and depends very little on depth"; for water the paragenesis of the hydroxylic minerals points to high mole fractions, probably variable, difficult to be established in our case.

The reconstitution of the chemical evolution of the system is facilitated by the outlining of parageneses with a diagnostic character. The presence of szaibelyite beside a whole range of hydroxylic minerals points to a basic pH. The pH decrease after ludwigite crystallization, as a premise of its szaibelyitization (Barsukov, Kurilcikova, 1957) would outline a pH evolution similar to that presented in Figure 5 (dotted line) as well as the crystallization succession of ludwigite±suanite-kotoite-szaibelyite type.

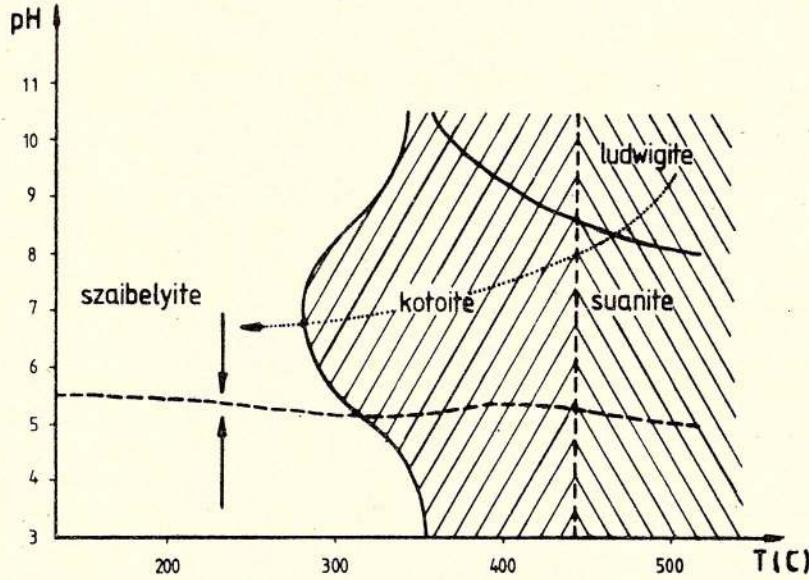


Fig. 5 - Stability domains of the main endogene magnesian borates according to temperature and pH of the generating solutions (after Aleksandrov, 1982). dashed line = equilibrium curve between the pH of the solutions and that of the borates; dotted line with arrow = probable direction of the T-pH evolution of the Gruiului Hill association.

The establishing of ludwigite-magnetite association and the recent pyrite deposition on microfissures affecting the boron-carbonatic mass are arguments in favour of the persistence of negative Eh conditions within a wide thermal interval, mostly superposed over that estimated for the genesis of the Gruiului Hill szaibelyite.

6. Conclusions

The data pointed out by the mineralogical and physico-chemical study of szaibelyite and associated minerals in the Gruiului Hill occurrence, correlated with general geological aspects led us to the following conclusions:

1. The formation of the borates from the contact aureole of the Pietroasa granitoid body is the result of an infiltration metasomatic process. This process explains the frequency of the occurrence of ludwigite disseminations in other parts of the contact aureole of the body (Rafalet, 1963). In case of the Gruiului Hill occurrence the significant boron-fluorine supply implies large metasomatic processes compatible only with an intense diffusion metasomatism.

2. The hypothesis of a diffusion metasomatism implies the tectonic control of the boron minerals disposition in case of the Gruiului Hill occurrence. This hypothesis, also supported by Stoicovici and Stoici (1969), is based on the location of the mineralized zone nearby a major fault of the Galbenii fracture system (with a NW-SE disposition): Tirău-Măgura Guranilor Fault, at its intersection with a network of conjugated fractures.

3. The presence of minerals with potential fluorine contents (clinohumite can contain up to 4 per cent F according to Aleksandrov, 1982) makes plausible the hypothesis of the boron transport as fluoro-boric compounds with alkaline solutions as an agent (Barsukov, Egorov, 1957). The interaction with the dolomitic background makes possible the decrease of the alkalinity of such solutions, necessary for borate precipitation.

4. Iron seems to be the primary precipitant of boron, as indicated by ludwigite formation before the pure magnesian borates. The iron deficit in the system would make possible the synchronous crystallization of such borates (that is of suanite or fluoborite) as well as the later crystallization of kotoite (Barsukov, Egorov, 1957).

5. Boron-(fluorine) metasomatic supply is unique, influencing the preservation of the pure magnesian character of the primary borates, imprinted by the paleosome origin. The character of these borates, highly susceptible to the acceptance into the network of cations like Mn^{2+} , Sn^{4+} , Ti^{4+} , induces the extreme magnesian character of the Gruiului Hill szaibelyite, for which the secondary genesis has been admitted.

6. The constancy of the magnesian contents in calcites occurring in areas with hornfels affected or unaffected by the boron metasomatism (see point 2) leads to the conclusion of the extension of this metasomatism in zones where the limited development of the silicate minerals made possible the formation of an "excess" of magnesium available in the carbonatic phases. The reverse correlation between the abundance of the silicates and the abundance of the boron minerals implies the active role of the lithologic control in the location of the Gruiului Hill mineralization.

Acknowledgements

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CHRONICLE

FIRST NATIONAL SYMPOSIUM ON GEMMOLOGY

A Symposium on gemmology took place in Cluj-Napoca from 11 to 13 October 1991, as a first scientific meeting of the recently founded "Association of friends of mineralogy, paleontology and gemmology" (President Prof. V. Ghiurcă, University of Cluj-Napoca, Str. Kogălniceanu 1).

Over 30 papers have been presented covering many aspects of gemmological activity in Romania. They included description of some mineral occurrences of gemmological interest in our country such as the amber of Colți, the "Maramureș diamonds", the blue chalcedony of Trestia, many occurrences of chalcedony in the Baia Mare mining district and in the Apuseni Mts, the rhodochrosite from Cavnic, the silicified woods from the Metaliferi Mts etc.

A nice exhibition of polished stones was organized during the symposium including a large variety of achates from the Metaliferi Mts, cut and polished samples of blue chalcedony from Trestia and skarn mineral assemblages from Băița Bihor, self-polished stones from a cave in the East Carpathians etc.

An one-day field trip was organized after the symposium for collecting purposes. The celestite occurrence at Copăceni near Turda and the chalcedony (red and green) occurrences at Rimetea/Buru (related to the Mesozoic ophiolites) have been thus visited.

G. U.

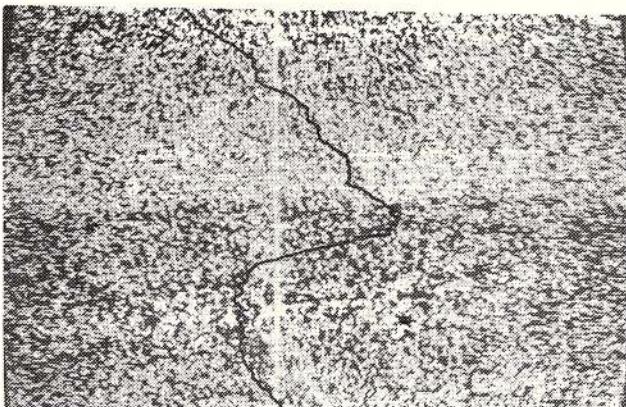


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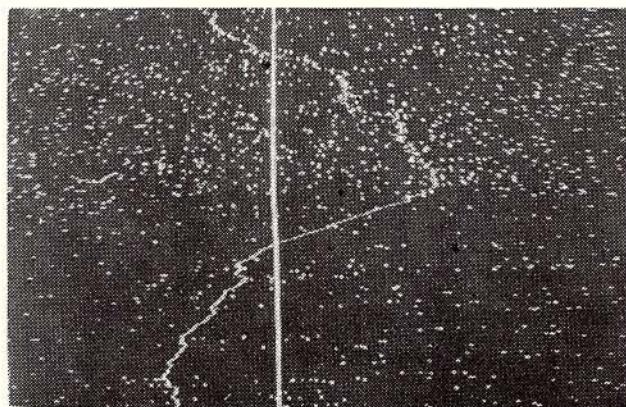
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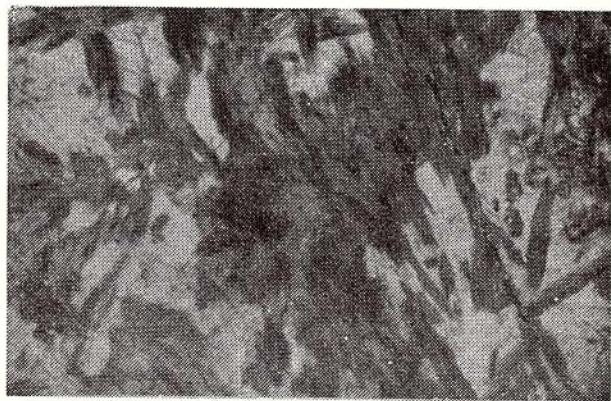
Plate I

Fig. 1 – Szaibelyite (black) in association with calcite (white) in the field investigated with the electron microprobe. Image in secondary electrons; 700 x (white line represents the study profile).

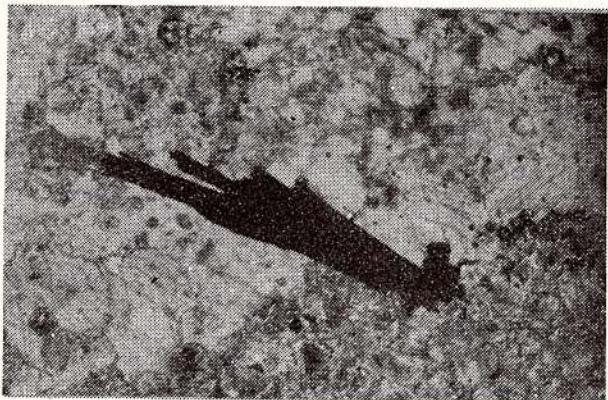
Fig. 2 – X-ray scanning image showing magnesium distribution and variation curve of its content; 700 x.

Fig. 3 – X-ray scanning image showing manganese distribution and variation curve of its content; 700 x.

ȘT. MARINCEA – SZAIBELYITE FROM GRUIULUI HILL (BIHOR MTS)



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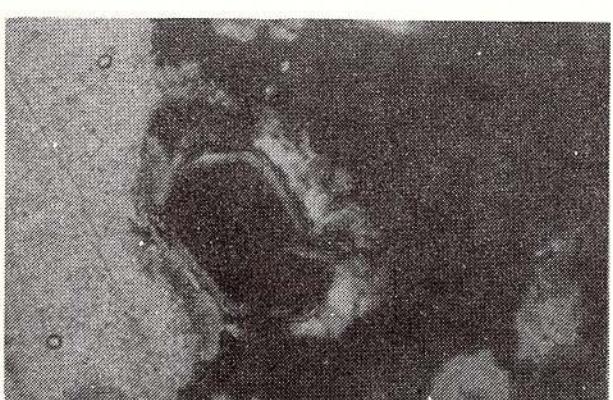
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Plate II

Fig. 1 – Incomplete pseudomorphs of szaibelyite after ludwigite; N+, 10 x.

Fig. 2 – Ludwigite aggregate in the boron-carbonatic mass; N+, 10 x.

Fig. 3 – Talc-szaibelyite pseudointergrowth. Mineral phases cannot be distinguished. N+, 20 x.

Fig. 4 – Clinohumite (polysynthetically twinned) in the boron-carbonatic mass; sz=szaibelyite; cc=calcite; N+, 20 x.

Fig. 5 – Brucite (br) beside a szaibelyite-brucite (sz-br) intergrowth; N+, 20 x.

Fig. 6 – Serpophite with alpha-serpentinic border pseudomorphs after olivine; N+, 20 x.

SUR LA PRÉSENCE DE LA LILLIANITE DANS LES MINÉRALISATIONS DE JOLOTCA – DITRĂU

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Key words: Lillianite. Mineral data. X-ray data. Optical mineralogy. Microhardness. Electron probe data. East Carpathians – Crystalline-Mesozoic Zone – Giurgeu Mountains.

Abstract: *On the Presence of Lillianite in the Jolotca-Ditrău Occurrence.* The presence of lillianite was first pointed out in Romania in the molybdenum, REE and common sulfide-bearing occurrence at Jolotca. The optical characteristics and the microhardness determinations are similar with those from the relevant literature. The electrono-optical evidence pointed out lead, bismuth and sulfur as major elements, the X-ray images indicating the homogeneity of the material. The empirical formula computed on the basis of the quantitative analysis at the electron microprobe is $Pb_{2.73}$, $Bi_{1.97}$, $Cu_{0.048}$, $Ag_{0.06}$, $Te_{0.012}$, S_6 . The experimental data and the mineralogical assemblage within which lillianite occurs point to high temperatures corresponding to the transition domain from pneumatolitic to hydrothermal.

1. Introduction. Les premières observations sur les minéralisations associées du massif alcalin de Ditrău sont présentées dans les travaux de Ianovici (1933 - 1938). Ultérieurement Stanciu (1955), Codarcea (1958), Jakab et Garbașevschi (1977), Pop (1980) ont apporté de nouvelles données concernant la minéralogie de ce massif.

Constantinescu et al. (1983) décrit dans son travail sur les associations paragénétiques des minéralisations du massif, dix associations à position minéralogique différente, comportant 56 minéraux. Y apparaissent, en association avec les sulfures communes (pyrite, sphalérite, pyrrhotite, galène, chalcopyrite) et carbonates, des minéraux de bismuth: bismuthine, joseïte et tétradymite. De nouvelles investigations sur quelques échantillons par des méthodes plus complexes (microdureté Vickers, capacité de réflexion et microscopie électronique) ont mis en évidence la présence de la lillianite ($Pb_3Bi_2S_6$) et d'un nouveau minéral, un sulfotellurure de plomb et de bismuth avec la formule $PbBi_3Te_4S_3$ (Damian et al., 1986).

2. La lillianite : minéral ou mélange de minéraux ? L'existence de la lillianite a suscité beaucoup de discussions. Le matériel originaire de Lillian (Leadville, Colorado), décrit par Keller (1889) (fide Dana, 1955) comme une nouvelle espèce minérale, la lillianite, a été considéré ultérieurement par Emmons (fide Dana, 1955) comme un mélange de galène, bismuthine et argentite. Berry (1940) (fide Dana, 1955), analysant une lillianite de Gladhammar (Suède) par diffraction de rayons X et en sections polies, conclut qu'il s'agit d'un mélange de galéno-bismuthine et galène. Ramdohr (1969) décrit une lillianite homogène dans des échantillons provenant de Jilijärvi (Finlande).

Le matériel décrit par Kupcik et al. (1961) (fide Uytenbogaardt, 1971) comme une lillianite homogène a été déterminé ultérieurement tel un mélange où un des composants serait une variété de jamésonite riche en bismuth.

Otto et Strunz (1968) fide Uytenbogaardt (1971) ont obtenu un composé synthétique avec la formule $Pb_3Bi_2S_6$, ayant les mêmes propriétés optiques que celles présentées par Ontoev (1959) et Syritso et Lenderova

(1964), confirmées aussi par les données de Malakhov et al. (1968) et Klyaklin et Dmitriyeva (1968) (fide Uytenbogaardt, 1971).

Ramdohr soutient l'idée de Vaasjoki selon lequel ce minéral appartient à une catégorie de minéraux qui deviennent instables et se conservent seulement en des conditions exceptionnelles.

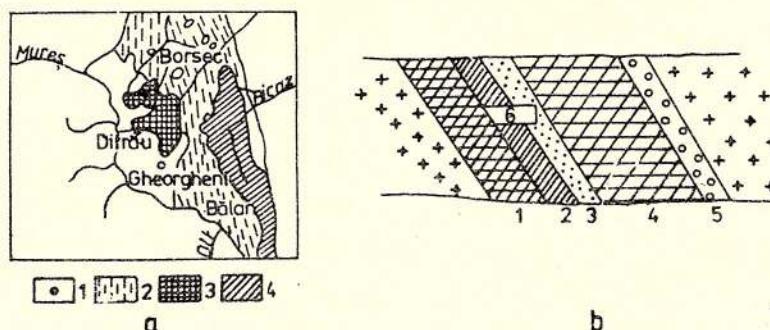


Fig.1 a - Schéma de la partie méridionale de la zone cristallino-mésozoïque (Carpathes Orientales) et du massif de Ditrău. 1, localisation de l'occurrence à lillianite dans le massif de Ditrău ; 2, schistes cristallins; 3, dépôts mésozoïques; 4, massif de Ditrău (selon la carte géologique de la Roumanie à 1:1.000.000). b - Détail structural avec l'emplacement de l'association à lillianite. 1, minerai pyriteux surtout; 2, bande riche en orthite et monazite à veines et impregnations de sulfures; 3, minerai pyriteux à ilménite, galène et blende; 4, zone prédominamment pyriteuse; 5, zone de mylonitisation à éléments de monazite et feldspath; 6, origine des échantillons à lillianite.

Cette opinion est confirmée aussi par le nombre réduit d'occurrences où a été identifié ce minéral. L'uniformité de la composition, déterminée par les analyses présentées dans la littérature, proche de la formule $A_3X_2S_6$, infirme l'interprétation de la lillianite comme mélange minéral et nous détermine de l'accepter comme minéral individuel.

3. Mode de présentation. À Jolotca la lillianite a été mise en évidence sous forme de granules minces ou plages xénomorphes de 1 à 2 mm, en association avec la pyrite, constituant de petits filons qui traversent des agrégats compacts de monazite et carbonates (pl. I, fig. 1, 2). Les échantillons ont été prélevés des minéralisations affleurées à l'horizon 25 (fig. 1 ab). Des grains fins inférieurs à 0,2 mm) associés avec la pyrite et une sulfotellurure de plomb et bismuth (pl. I, fig. 3) ont été décrits par Damian et al.(1986).

4. Données optiques. La lillianite est moins dure que la pyrite et semblable à la galène. Elle présente une couleur blanche-grisâtre à des faibles teintes jaunâtres. L'extinction est incliné et la biréflexion est faible mais visible dans l'aire.

L'anisotropie est fort, similaire, un peu plus réduite que celle du bismuth. Les couleurs d'anisotropie varient de blanc-jaunâtre, blanc-grisâtre à grisâtre-brun. En immersion la couleur devient blanche-grisâtre et la biréflexion et l'anisotropie s'accentuent.

Les déterminations de la capacité de réflexion¹ sont présentées dans le tableau 1 en comparaison avec les données de la littérature pour la lillianite, la cosalite et la galénobismuthine (selon Feklicev, 1977).

La galénobismuthine présente une diminution linéaire et de petites différences entre les valeurs maximums (Rg) et minimums (Rp); quant à la cosalite elle présente des valeurs beaucoup plus basses. Le spectre de réflexion est similaire à celui présenté pour la lillianite, les valeurs déterminées pour la réflectance étant un peu plus réduites (fig. 2).

5. Microdureté. On remarque une bonne correspondance entre les déterminations de microdureté Vickers² présentées dans le tableau 2 et les données de la littérature de spécialité pour la lillianite (Feklicev, 1977; Uytenbogaardt, 1971).

6. Données électro-optiques et chimiques. Les déterminations effectuées à la microsonde électronique³ ont mis en évidence le plomb, le bismuth et le soufre (pl. II) comme éléments majeurs (par électro-

¹Microspectrophotomètre Zeiss, au microscope Amplival Pal U.

²Microduremetre Zeiss, au microscope Amplival, chargement 50 g.

³Type JCA-5A - commandé par le ordinateur PDP 8/m - analyste: N. Farkaş - Institutul de Sudură și Încercări de Materiale, Timișoara.

phie); le cuivre, l'argent et le tellure sont présents aussi mais en quantités réduites.

La formule brute calculée de l'analyse microchimique est $Pb_{2,73} Bi_{1,97} Cu_{0,048} Ag_{0,06} Te_{0,012} S_6$ qui correspond à la formule théorique de la lillianite $Pb_3Bi_2S_6$.

TABLEAU 1
Capacité de réflexion de la lillianite de Jolotca par rapport aux données de la littérature

No	MINÉRAL	λ, NH				ΔR	
		486	551	589	656		
1	Lillianite - Jolotca	Rg	50	46	45	44	9
		Rp	39,5	36,2	36	35	9
2	Lillianite - Feklicev $Pb_3 Bi_2 S_6$	Rg	55	52,5	51	51	14
		Rp	40	38,5	37	37	14
3	Galeo-bismuthine-Feklicev	Rg	51	50,5	48	47,5	3,5
		Rp	46,5	46	44,5	43,5	3,5
4	Cosalite - Feklicev $Pb_2 Bi_2 S_5$	Rg	49	46,5	45	45	6,5
		Rp	41	39,5	38,5	38	6,5

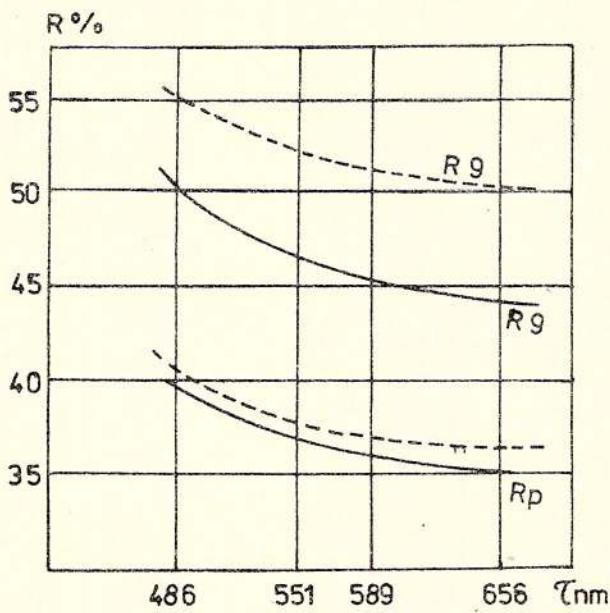


Fig. 2 - Spectre de la capacité de réflexion de la lillianite. 1, lillianite Jolotca; 2, lillianite Feklicev.

— 1 — 2

7. Conclusions. Les propriétés optiques, les valeurs de la capacité de réflexion et de la microdureté corroborées avec les résultats des analyses du chimisme effectuées à la microsonde électronique, prouvent l'existence de la lillianite dans les minéralisations de Jolotca, elle constituant la première occurrence de ce minéral, mise en évidence dans notre pays. Les images électrono-optiques indiquent l'homogénéité du matériel analysé chimiquement. Les seules impuretés présentes sont le tellure, le cuivre et l'argent, la première bien évidencée dans la planche II, figure 4.

En ce qui concerne la genèse de ces minéralisations, Pop (1980) associe les minéraux de bismuth au stade pneumatolitique et Constantinescu et al. (1981) au stade méso-hypothermal.

La lillianite a été décrite par Ramdohr (1969) comme minéral de température élevée dans les minéralisations de Jilijärvi (Finlande). Craig (1967) (fide Ciuhrov, 1974), dans son étude expérimentale sur le système Bi-Pb-S, démontre la formation de ce minéral à une température supérieure à 400° C.

TABLEAU 2

Valeurs de la microdureté Vickers (Vnh) pour la lillianite de Jolotca, par rapport aux données de la littérature

No	MINÉRAL	Microdureté Vickers kg/mm ²			Poids de percement
		Max.	Med.	Min.	
1	Lillianite - Jolotca	228	199	171	50
2	Lillianite - Feklicev	195	-	120	
3	Lillianite - Uytenbogaardt	195	-	120	
4	Cosalite - Uytenbogaardt	161	-	83	50

Tenant compte des données expérimentales et des observations des divers auteurs concernant l'instabilité de ce minéral en des conditions de température réduite, on admet pour la lillianite de Jolotca sa formation en des conditions de température élevée, probablement dans le domaine de transition de pneumatolitique à hydrothermal.

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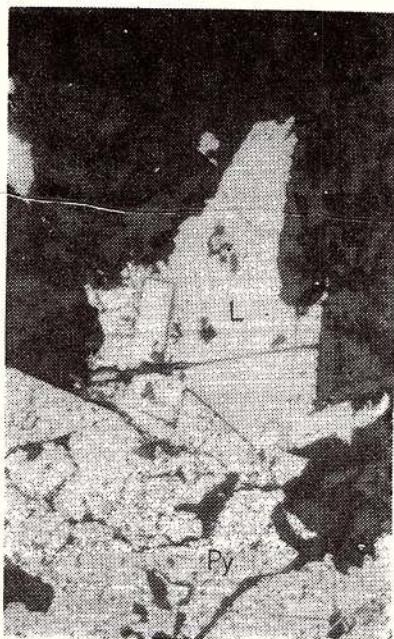
Presented at the scientific session of the Institute of Geology and Geophysics:

May 27, 1988

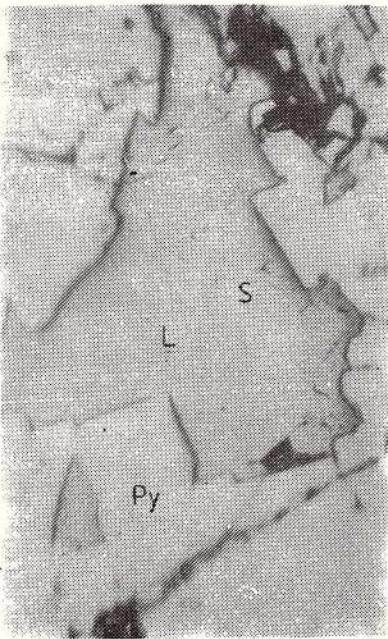




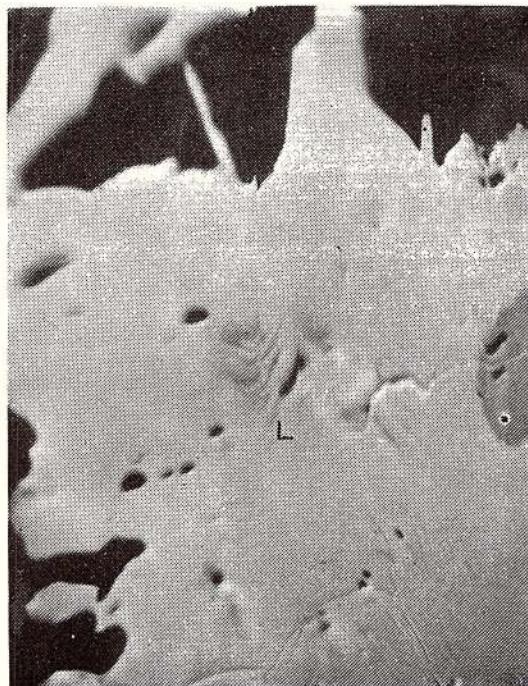
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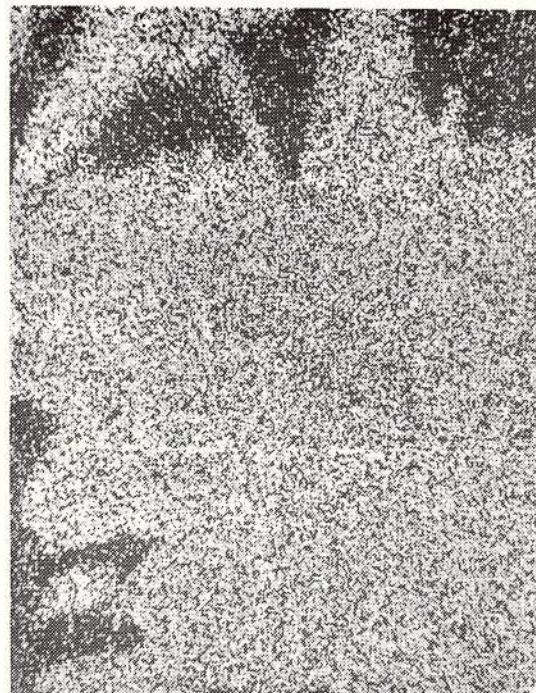
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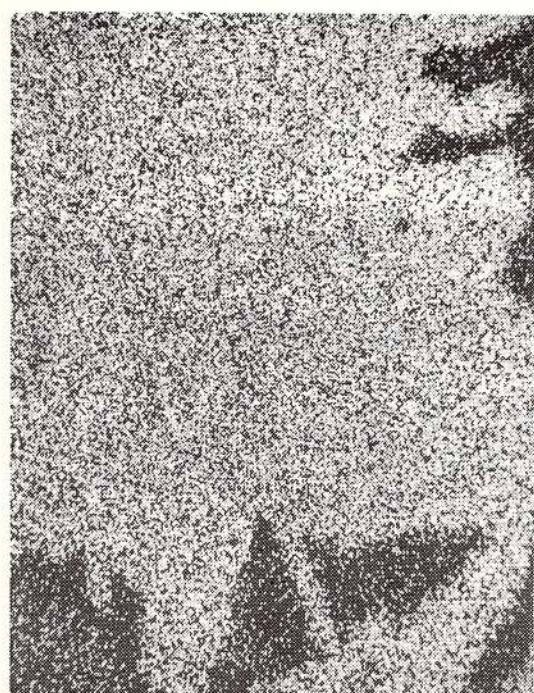
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Planche I

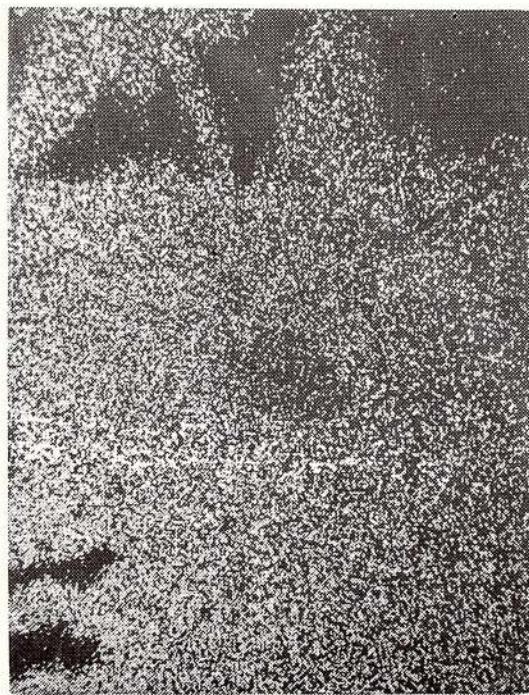
- Fig. 1 – Filon petit en agrégats compacts de monazite et carbonates à pyrite (Py) et lillianite (L). 65 x, Nic. II.
Fig. 2 – Lillianite (L), grains submillimétriques xénomorphes associés à la pyrite. On observe à la lillianite (L) une empreinte restée des déterminations de microdureté Vickers (Vnh). 126 x, Nic. II.
Fig. 3 – Lillianite (L) associée avec sulfotellurure de plomb et bismuth (S) englobés dans la pyrite (Py) massive. 250 x, Nic. II.
Fig. 4 – Détail de la microsonde. Grain xénomorphe de lillianite (L). Image de composition. 500 x.



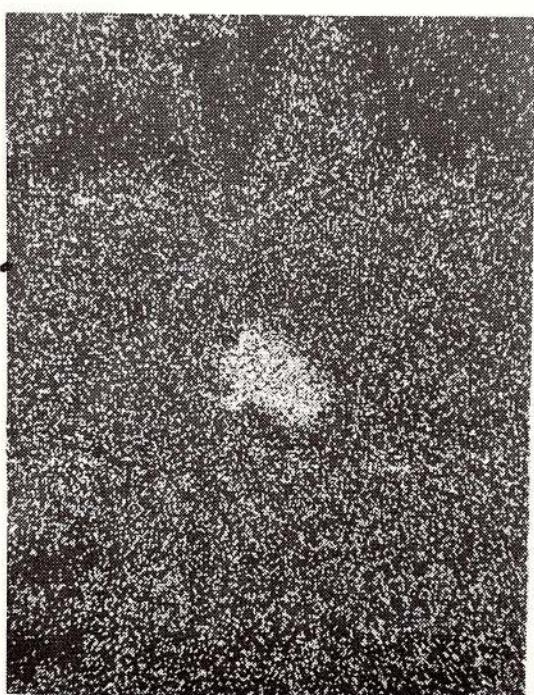
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Planche II

Fig. 1 – Image des rayons X avec la distribution du plomb. La lillianite s'individualise par l'agglomération des points blancs. 500 x.

Fig. 2 – Image des rayons X avec la distribution du bismuth. La lillianite est individualisée dans l'agglomération de points blancs. 500 x.

Fig. 3 – Image des rayons X avec la distribution du soufre. 500 x.

Fig. 4 – Image des rayons X avec la distribution du tellure qui forme une agglomération dans la zone centrale correspondant à l'inclusion de sulfotellurure de plomb et bismuth. 500 x.

ÉTUDE DES CRISTAUX DE ZIRCON DE QUELQUES GRANITOÏDES DE BANAT (OGRADENA, CHERBELEZU, SFÎRDIN, CERNA)

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Keywords: Granitoid. Zircon. Crystals. Habit. Mineral data. South Carpathians – Crystalline Danubian Realm – Almăj Mountains.

Abstract: *Study on the Zircon Crystals in Some Granitoids in Banat (Ogradena, Cherbelezu, Sfîrdin, Cerna).* The study on the zircon populations in the Banat granitoids pointed out similar characteristics and evolutions for all the samples taken into account. Most of the crystals display a long, prismatic bipyramidal habit, (110), (101) faces, colours varying from pink to brown, few inclusions and small sizes. Zoned crystals occur in a small number and those with a nucleus are found only in the Cerna granite. The crystal formation temperature varies from 600 to 700° C for most of the study crystals. Magma from which zircon crystallized had a mixed origin (crust+mantle) for the Cherbelezu, Sfîrdin and Cerna granitoids and it comes from the mantle or mainly from the mantle for the Ogradena granitoids.

Le zircon contenu par les roches granitoides comme minéral accessoire peut fournir des informations concernant le milieu de cristallisation. Les nouvelles investigations ont relevé la nécessité des données sur la forme des cristaux, la couleur, les dimensions, l'elongation, les phénomènes de surcroissance, les zonations et inclusions pour la détermination des conditions physico-chimiques du milieu de cristallisation.

De nombreux auteurs ont élaboré des études en ce sens: Pupin, Turco (1969, 1972, 1975, 1980), Brodscăia et al. (1986), Birlea (in Iancu, 1972, rapport nonpublié, 1976, rapport nonpublié), Robu, Robu (1986, 1987).

Cadre géologique. Les massifs granitoides investigués – Ogradena, Cherbelezu, Sfîrdin, Cerna – se trouvent situés en des roches cristallophylliennes appartenant à la série de Ielova, à la formation de Poiana Mraconia, à la série de Corbu et à la série de Neamțu, séries qui forment le cristallin danubien (fig. 1).

La série de Ielova (Stan, 1985) comporte des amphibolites et gneiss amphiboliques avec ou sans biotite et subordonnément paragneiss.

La formation de Poiana Mraconia (Stan, 1985) comporte principalement des roches amphiboliques semblables à celles de la série de Ielova et qui renferment des intercalations de gneiss à hornblende, avec ou sans biotite. Les quartzites et les quartzites feldspathiques sont rares et les micaschistes sporadiques.

La série de Corbu (Stan, 1985) est rétromorphosée, représentée principalement par des schistes séricito-chloriteux.

La série de Neamțu (Stan, 1985) renferme des roches quartzo-feldspathiques, amphibolites, micaschistes et phyllites, parfois partiellement rétromorphosées, tout comme des calcaires cristallins.

Le massif granitoid d'Ogradena, situé dans la partie sud-est de Banat représente un corps disposé en concordance avec le cristallin de la série de Neamțu, étant partiellement recouvert par des formations plus récentes, de couverture, dans la partie orientale.

La structure de ce massif, en général simple, présente des aspects massifs ou orientés (du type gneissique); elle devient plus complexe dans les parties marginales du corps (Anastasiu, 1976) étant données les nombreuses intercalations des schistes cristallins (paragneiss, micaschistes, amphibolites).

Pétrographiquement les granitoides d'Ogradena correspondent à quelques granites-granodiorites et présentent la suivante composition minéralogique: feldspath plagioclase, feldspath potassique, quartz, biotite, muscovite, grenat.

Le massif granitoid de Cherbelezu, situé au nord-ouest du granitode d'Ogradena, est un corps disposé en concordance avec la formation de Poiana Mraconia au nord et ouest et la formation de Corbu à l'est.



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Pétrographiquement et minéralogiquement les roches ne présentent pas de grandes variations. Les études microscopiques ont relevé la suivante composition minéralogique: quartz, feldspath plagioclase, feldspath potassique, biotite±muscovite et minéraux accessoires (zircon, apatite, sphène, orthite±grenat) (Stan et al., 1985).

Le granitoïde de Cherbelezu présente une grande variété d'images structurales: massif macrogranuleux au sud et à l'est, faciès pegmatoides dans la partie centrale et septentrionale, structures gneissiques à l'est et cataclastiques le long du bord oriental, au contact avec les schistes cristallins (Stan et al., 1985).

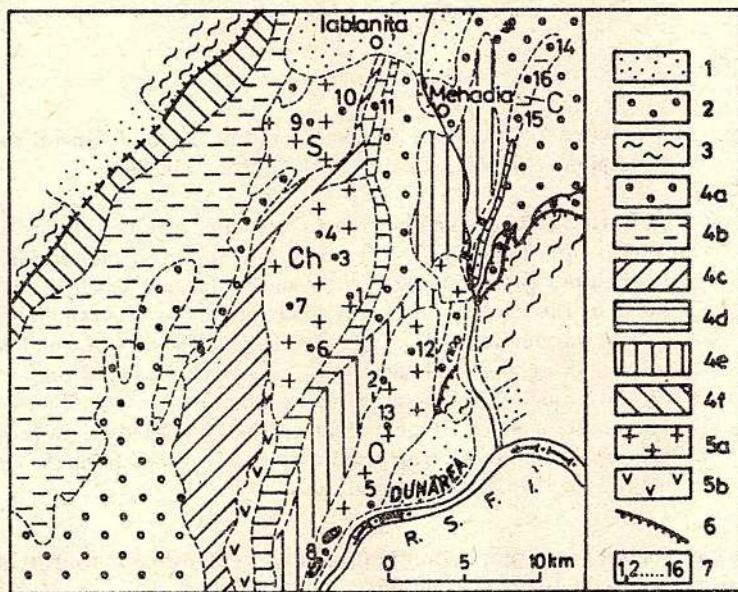


Fig. 1 Schéma géologique des massifs granitoides de Banat (selon le Guide du V-ème Congrès de l'Association Carpato-Balcanique).

1, Bassins situés entre les montagnes-Miocène; 2, Para-autochtone de Severin-Créacé inférieur; 3, Domaine Géétique-Série de Sebes; 4, Domaine Danubien; 4a, Couverture sédimentaire; 4b, Série de Ielova; 4c, Formation de Poiana Mraconia; 4d, Série de Corbu; 4e, Série de Neamțu; 4f, Série de Toronița; 5, Roches magmatiques; 5a, Granites, granodiorites (O-Ogradena; Ch-Cherbelezu; S-Sfîrdin; C-Cerna); 5b, Gabbros, serpentinites; 6, Nappe de charriage; 7, Echantillons prélevés pour le zircon.

Le massif granitoides de Sfîrdin affleure au nord du granitoïde de Cherbelezu, étant délimité à l'ouest par la série de Ielova, au sud par la formation de Poiana Mraconia, à l'est par la série de Corbu et au nord par la couverture sédimentaire. Ces granitoïdes présentent des structures massives, laminées ou cataclastiques (Stan, 1985). Les études microscopiques ont mis en évidence la suivante composition minéralogique: quartz, feldspath plagioclase, feldspath potassique, biotite±muscovite; les cristaux de hornblende ont été identifiés seulement dans quelques sections minces. Parmi les minéraux accessoires on a identifié: sphène, apatite, zircon, epidote, orthite, monazite (Stan et al., 1985).

Le granite de Cerna qui affleure le long de la vallée de Cerna, au nord de la localité de Băile Herculane, est partiellement recouvert par des formations de couverture. Du point de vue minéralogique il comporte principalement du quartz, feldspath plagioclase, feldspath potassique et biotite±muscovite et zircon, apatite et sphène comme minéraux accessoires.

Méthodologie de préparation des échantillons. Les cristaux de zircon ont été obtenus d'approximativement 5 kg de roche broyée jusqu'à la granulation de 0,5 mm, en employant les méthodes ordinaires pour obtenir les minéraux lourds. Pour l'étude de la variation morphologique des cristaux de zircon on a trié à la loupe binoculaire 100 cristaux représentatifs pour chaque échantillon.

L'étude de la morphologie des cristaux de zircon est fondée sur la méthode typologique (Pupin, Turco, 1972). La méthode consiste dans la détermination d'une corrélation entre la face pyramidale (211), (101) ou (301) et celle prismatique (110) ou (100) tenant compte des conditions physico-chimiques du milieu de cristallisation.

Les propriétés optiques des cristaux ont été déterminées au microscope et à la loupe binoculaire.

On a prélevé 16 échantillons de tous les quatre corps de roches granitoïdes (Ogradena-5, Cherbelezu-5, Sfirdin-3, Cerna-3) de manière que la répartition de ceux-ci dans les massifs soit la plus uniforme possible. La localisation des échantillons est indiquée dans la figure 1.

Caractéristiques des cristaux de zircon. Les cristaux des populations de zircon séparées pour le massif granitoïde d'Ogradena ont un habitus long prismatique (rarement court prismatique), bipyramidal. Par l'assimilation des formes rencontrées avec celles présentées par Pupin et Turco (1972) on a pu indexer des faces de prisme du type (100) et (110) et de pyramide du type (211) et (101). L'interprétation statistique de ces données a relevé une prédominance des faces (110) et (101).

La couleur varie de rose pâle jusqu'à brun; les cristaux incolores sont très rares.

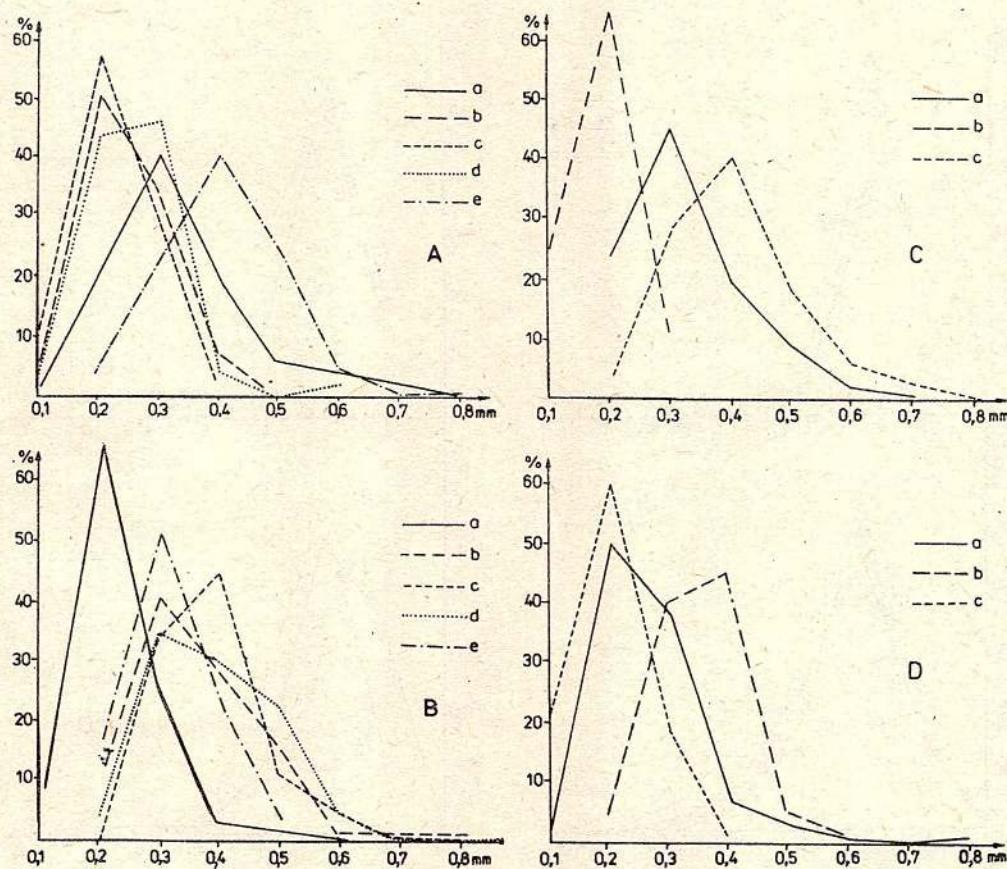


Fig.2 – Diagrammes de variation de la longueur des cristaux de zircon des granitoïdes: A-Ogradena; B-Cherbelezu; C-Sfirdin; D-Cerna. Mode de variation de la longueur des cristaux de zircon des échantillons: a, 1, 2, 9, 14; b, 3, 5, 10, 15; c, 4, 11, 12, 16; d, 6, 13; e, 7, 8.

On a observé, en des sections minces, des cristaux à habitus long prismatique, transparents, translucides jusqu'à opaques, incolores, à relief fort. La plupart des cristaux ont un aspect métamict, très peu d'entre eux étant limpides. Les cristaux sont renfermés dans la biotite, feldspath potassique et quartz. La disposition du minéral dans les paquets de biotite ou dans le feldspath potassique est chaotique, sans aucune direction préférentielle (planes de clivage, bords de cristaux etc.).

Les cristaux de zircon sont limpides ou zonés; ceux zonés sont peu nombreux. Les zones sont disposées en rapport avec la face de prisme ou de pyramide et rarement selon les deux faces en même temps. L'épaisseur et le nombre des zones varient d'un cristal à l'autre.

On a observé à l'intérieur des cristaux de zircon des inclusions de minéraux transparents (zircon, apatite), opaques et plus rare des inclusions fluides. Les dimensions très réduites des inclusions rendent très difficile leur détermination.

On n'a pas rencontré des cristaux à noyau.

Le zircon du granitoïde de Cherbelezu a été étudié par cinq échantillons. Les cristaux observés ont un habitus long prismatique, bipyramidal. Prédominent les faces de prisme du type (110) et celles de pyramide du type (101).

En sections minces on a observé la présence du zircon dans tous les minéraux components, étant plus concentré dans le quartz. Les cristaux sont incolores ou roses jusqu'à bruns. Ils peuvent être transparents, translucides ou opaques, selon l'état métamictite.

Les cristaux zonés sont peu nombreux. Les zones sont épaisses et étroites. On observe une certaine variation de l'épaisseur de celles-ci, du centre vers les bords du cristal.

Les inclusions présentent une distribution chaotique, surtout dans la zone de développement de la prisme. Les dimensions réduites des inclusions rendent impossible leur identification.

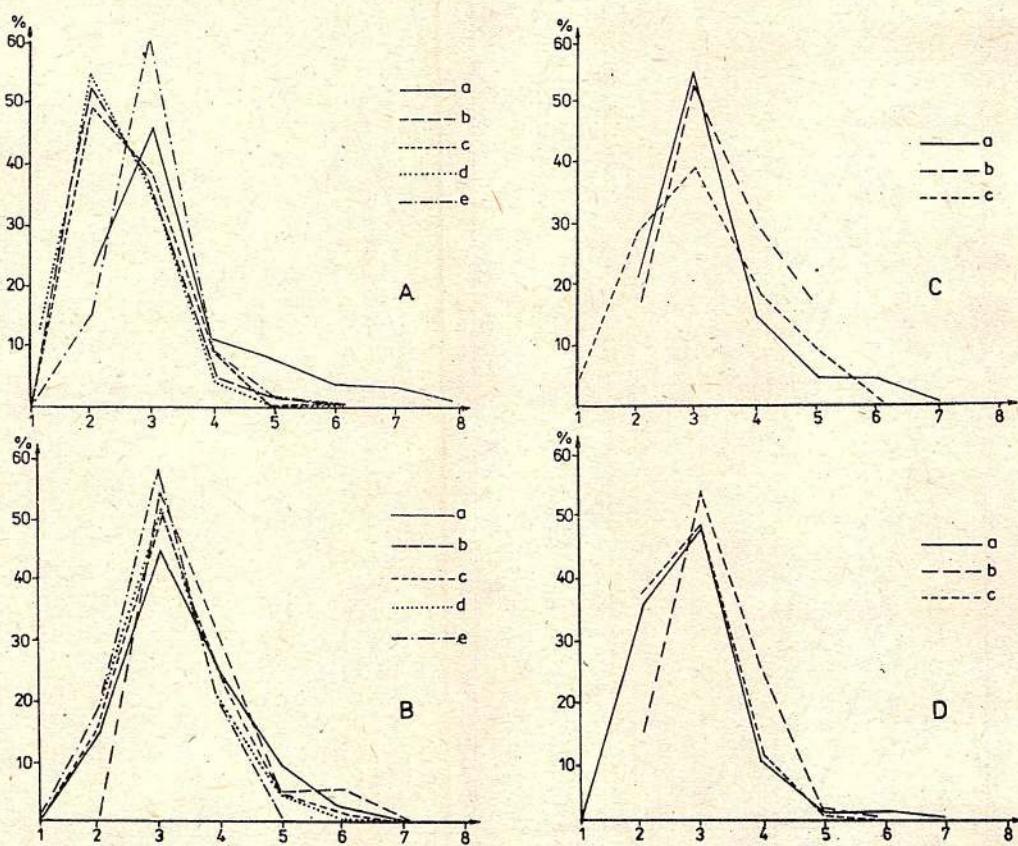


Fig. 3 - Diagrammes de variation de l'élargissement des cristaux de zircon des granitoïdes: A, Ogradena; B, Cherbelezu; C, Sfîrdin; D, Cerna. Mode de variation de l'élargissement des cristaux de zircon des échantillons: a, 1, 2, 9, 14; b, 3, 5, 10, 15; c, 4, 11, 12, 16; d, 6, 13; e, 7, 8.

Le granitoïde de Sfîrdin comporte généralement des cristaux de zircon long prismatiques, ceux court prismatiques étant très rares. On observe à la loupe binoculaire la présence des faces de prisme du type (110) et (100) et de pyramide du type (211) et (101). On constate une fréquence plus élevée des faces du type (101) et (110). Le zircon de ces granitoïdes est incolore, rose ou brun, à des différentes nuances.

En des sections minces on observe la présence du zircon dans tous les minéraux components, surtout dans le quartz. Son habitus est long prismatique sans être traversé qu'accidentellement par des fissures transversales sur la face de prisme. La plupart des cristaux de zircon sont incolores et transparents; ceux bruns sont rares et translucides ou opaques en général.

Les cristaux zonés sont rares et ceux à noyau manquent en totalité. La zonalité présente une grande variation d'un cristal à un autre ou même à l'intérieur du même cristal. On observe une fréquence plus élevée des zones dans les parties marginales des cristaux.

Les inclusions se trouvent en nombre réduit et comportent des minéraux transparents (zircon) ou opaques et plus rare des inclusions fluides. Les dimensions sont très réduites, leur détermination étant dans la plupart des cas impossible.

Le zircon du granitoïde de Cerna a été étudié en trois échantillons et on a observé une grande ressemblance de celui-ci avec celui décrit du granitoïde d'Ogradena, de Cherbelezu et de Sfirdin.

Les cristaux présentent des faces du type (101), (211), (110) et plus rare (100). On observe aussi une prédominance des faces (101) et (110).

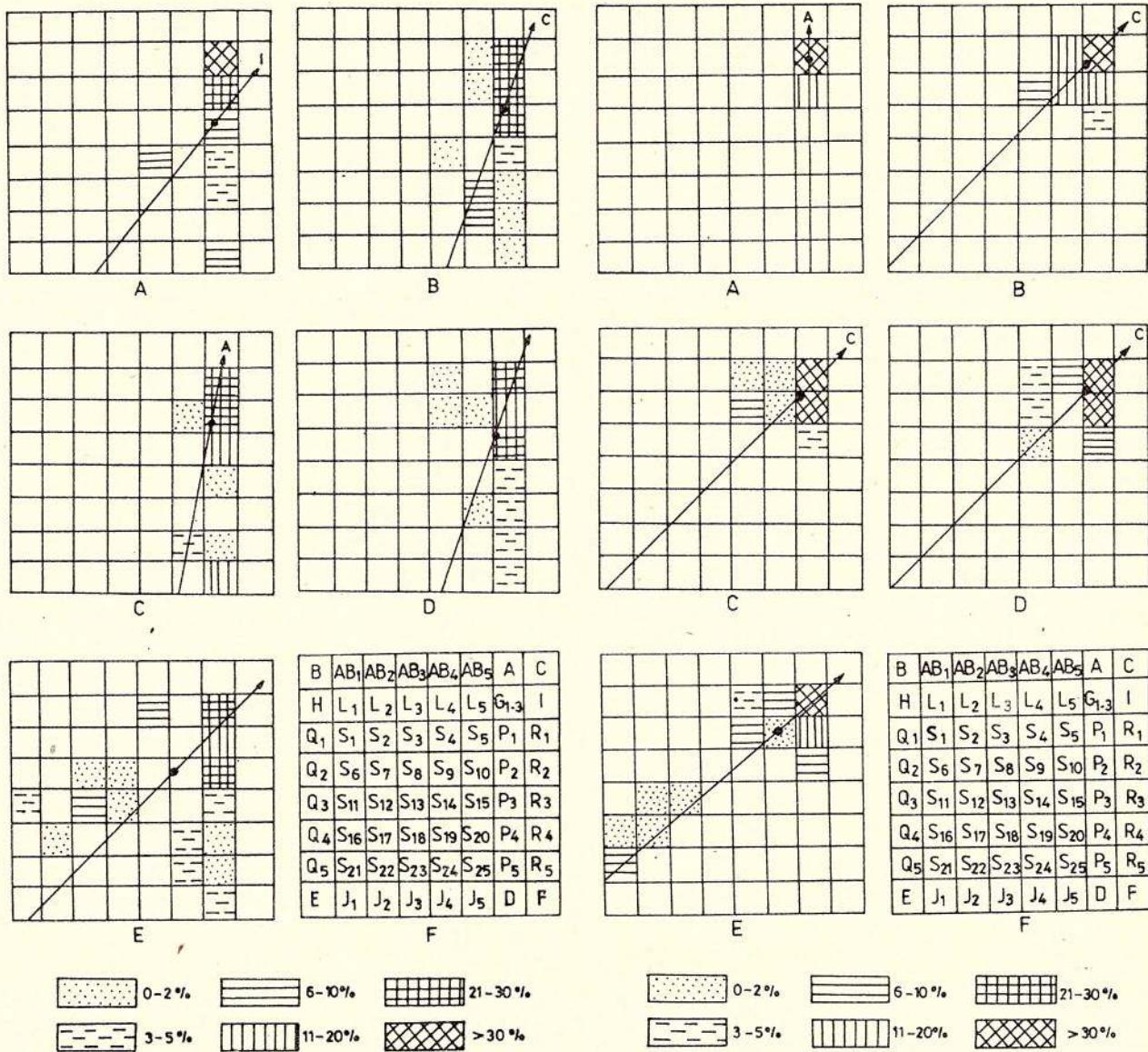


Fig. 4 - Diagramme de fréquence des cristaux de zircon dans le granitoïde d'Ogradena: A, échantillon 2; B, échantillon 5; C, échantillon 8; D, échantillon 12; E, échantillon 13; F, les principaux types et sous-types de la classification typologique (Pupin, Turco, 1972).

Fig. 5 - Diagramme de fréquence des cristaux de zircon du granitoïde de Cherbelezu: A, échantillon 1; B, échantillon 3; C, échantillon 4; D, échantillon 6; E, échantillon 7; F, les principaux types et sous-types de la classification typologique (Pupin, Turco, 1972).

Les cristaux sont incolores, présentant des différentes nuances de rose, transparents, translucides ou opaques à des différentes nuances de brun. Les inclusions sont rares et comportent généralement des cristaux très petits, indéterminables. Les cristaux zonés et/ou à noyau sont très peu nombreux. Les zones sont étroites et nombreuses disposées parallèlement avec les faces de prisme. Le noyau est ovalé, allongé selon la face de prisme et disposé dans la partie centrale du cristal.

Variation des dimensions des cristaux de zircon. Les trois dimensions réciproquement perpendiculaires des cristaux de zircon a:b:c ont été mesurées par l'oculaire micrométrique. Celles-ci varient entre 0,1/0,05/0,05 mm et 0,8/0,2/0,2 mm pour les granitoïdes de Cerna, Ogradena et Sfirdin et entre 0,2/0,1/0,1 mm et 0,9/0,2/0,2 mm pour le granitoïde de Cherbelezu.

Dans les diagrammes de variation de la longueur des cristaux de zircon (fig. 2) on observe que la plupart des cristaux ont des longueurs proches de la valeur de 0,2 mm (échantillons 5 et 8 - Ogradena - 50-55 %, échantillon 1 - Cherbelezu - 65 %, échantillon 10 - Sfîrdin - 65% et échantillons 14 et 16 - Cerna - 50-60 %), 0,3 mm (échantillons 2 et 12 - Ogradena - 40-45 %, 3, 6 et 7 - Cherbelezu - 40-50 % et 9 - Sfîrdin - 42 %) et 0,4 mm (13 - Ogradena - 40 %, 4 - Cherbelezu - 45 %, 11 - Sfîrdin - 40 % et 15 - Cerna - 45 %).

Quant à l'élongation des cristaux de zircon on constate une grande constance pour les granitoïdes de Sfîrdin, Cherbelezu et Cerna qui ont les maximums de fréquence proche de la valeur 3 pour tous les échantillons (fig. 3). Les granitoïdes d'Ogradena présentent deux maximums de fréquence le premier autour de la valeur 3 pour les échantillons 2 et 13 et l'autre proche de la valeur 2 pour les échantillons 5, 8 et 12 (fig. 3).

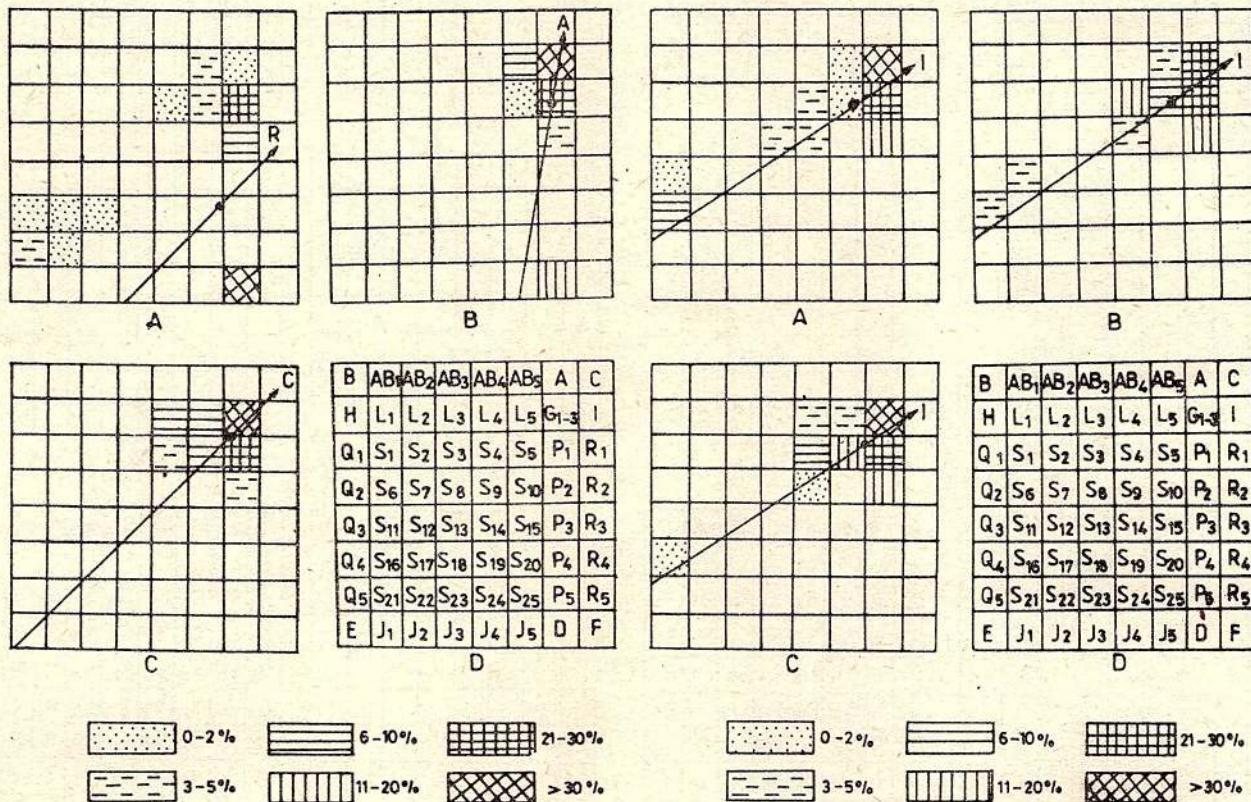


Fig. 6 - Diagramme de fréquence des cristaux de zircon du massif granitoid de Sfîrdin: A, échantillon 9; B, échantillon 10; C, échantillon 11; D, les principaux types et sous-types de la classification typologique (Pupin, Turco, 1972).

Fig. 7 - Diagramme de fréquence des cristaux de zircon du granitoid de Cerna: A, échantillon 14; B, échantillon 15; C, échantillon 16; D, les principaux types et sous-types de la classification typologique (Pupin, Turco, 1972).

Signification pétrogénétique du zircon. La détermination pétrogénétique de ce minéral est fondée sur les caractères morphologiques des cristaux interprétés du point de vue statistique conformément à la méthode typologique (Pupin, Turco, 1972).

La méthode et les bases de celle-ci ont été présentées dans les travaux antérieurs (Robu, Robu, 1987).

Pour le granitoid d'Ogradena on a décrit des cristaux du type G, P, L, S où les types G, P₁ et P₂ présentent la fréquence la plus élevée (fig. 4).

Le développement avec prédominance de la face de pyramide (101) le long de l'échelle géothermométrique, relève une évolution relativement constante pendant l'alcalinité du magma.

Du diagramme de l'évolution typologique (T.E.T.) (fig. 8) résulte le mode relativement semblable d'évolution des échantillons en discussion; la tendance de ceux-ci est vers des formes du type A, C, I où prédomine la face pyramidale (301).

La température de formation du zircon, déterminée par Pupin (1972) sur base des caractères morphologiques de celui-ci se situe entre 900° C et 650° C. On doit mentionner que la majorité des cristaux se sont formés

dans l'intervalle de température de 700°C à 600°C , quand ont existé probablement dans le magma des concentrations plus importantes de zirconium.

Dans le granitoïde de Cherbelezu on a mis en évidence des cristaux du type G, P, L, S, Q, dont le type G est prédominant (fig. 5).

Le diagramme de tendance de l'évolution typologique (fig. 8) indique l'évolution unitaire des populations de zircon des échantillons no. 3, 4, 6, et 7 vers le type C ayant la face pyramidale (301) et vers le type A pour l'échantillon 1.

Les cristaux de zircon se sont formés à des températures entre 700°C et 600°C excepté ceux de l'échantillon 7 où la cristallisation du zircon a commencé à la température de 850°C . La majorité des cristaux se sont formés dans l'intervalle de température de 650°C à 600°C .

Le granitoïde de Sfîrdin comporte des cristaux de zircon du type G, P, S, Q, D, dont les types G et P sont prédominants (fig. 6). La tendance d'évolution diffère d'un échantillon à l'autre (fig. 8). La température de cristallisation déterminée sur base des caractères morphologiques, varie de 900°C (la température de formation des premiers cristaux) jusqu'à 600°C approximativement. La majorité des cristaux se sont formés dans l'intervalle de 700°C à 600°C .

On a évidemment dans le granitoïde de Cerna des cristaux de zircon du type G, P, L, S et Q (fig. 7) qui évoluent vers le même type de cristal I (fig. 8).

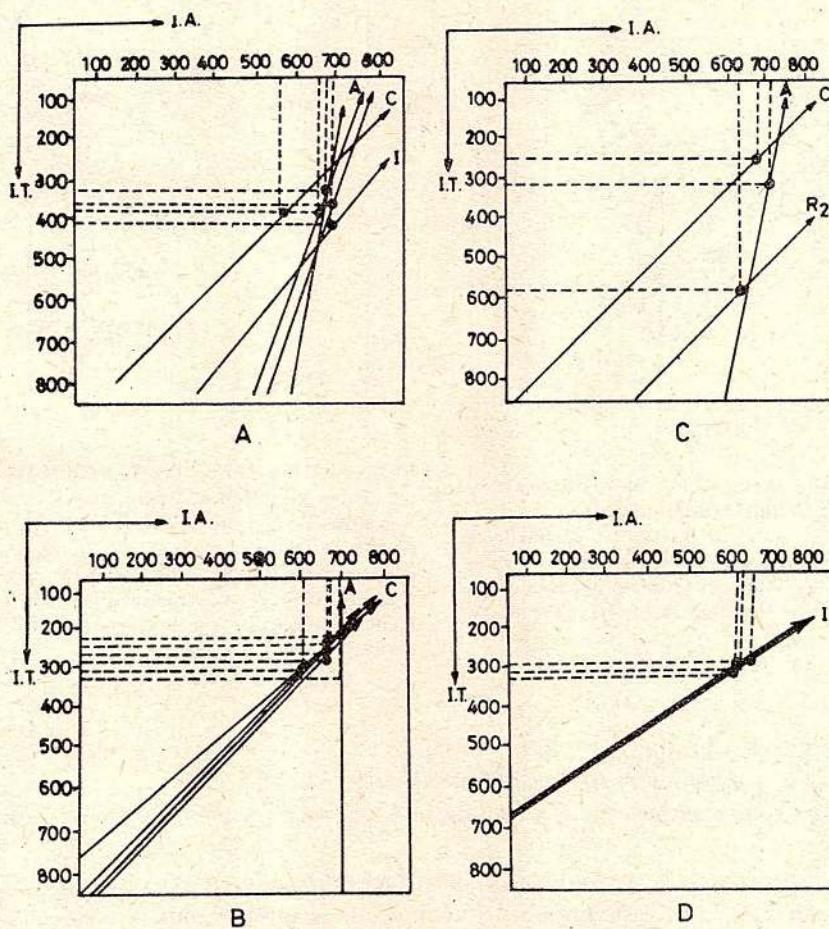


Fig. 8 Diagramme de tendance de l'évolution typologique (T.E.T.) des cristaux de zircon (Pupin, 1980): A, Ogradena; B, Cherbelezu; C, Sfîrdin; D, Cerna.

L'intervalle de température pour la cristallisation se situe entre 800°C et 600°C , la plupart se formant à une température de 650°C ou 600°C .

L'intégration des échantillons étudiés dans le diagramme T.E.T. de distribution des roches plutoniques (fig. 9) indique que celles-ci se projettent dans le champ des syénites et des granites hyperalcalines, ôté l'échantillon 7-Cherbelezu qui se situe dans le champ des monzogranites et monzonites, l'échantillon 9-Sfîrdin et 15-Cerna qui se projettent dans la zone d'interférence du champ des syénites et granites hyperalcalines avec

celui des monzogranites et monzonites et l'échantillon 13-Ogradena projeté dans l'aire d'interférence du champ de granodiorites avec celui des monzogranites et monzonites.

La projection des données dans le diagramme T.E.T. de distribution des roches granitiques (fig. 10) indique que les échantillons prélevés proviennent des roches qui se situent dans le champ des granites à origine mixte (croûte+manteau) (Cherbelezu - tous les échantillons, Cerna - tous les échantillons, Sfirdin - les échantillons 9 et 11, Ogradena - échantillon 13), tout comme dans le champ des granites à origine dans le manteau ou principalement dans le manteau (Ogradena - échantillons 2, 5, 8, 12 et Sfirdin - échantillon 10).

Conclusions. L'étude effectuée sur les populations de zircon des quatre massifs granitoïdes mentionnée relève une série de caractéristiques communes:

- les types de cristaux les plus fréquents sont G et P;
- les faces plus fréquentes sont celles pyramidales du type (101) et celles de prisme du type (110);

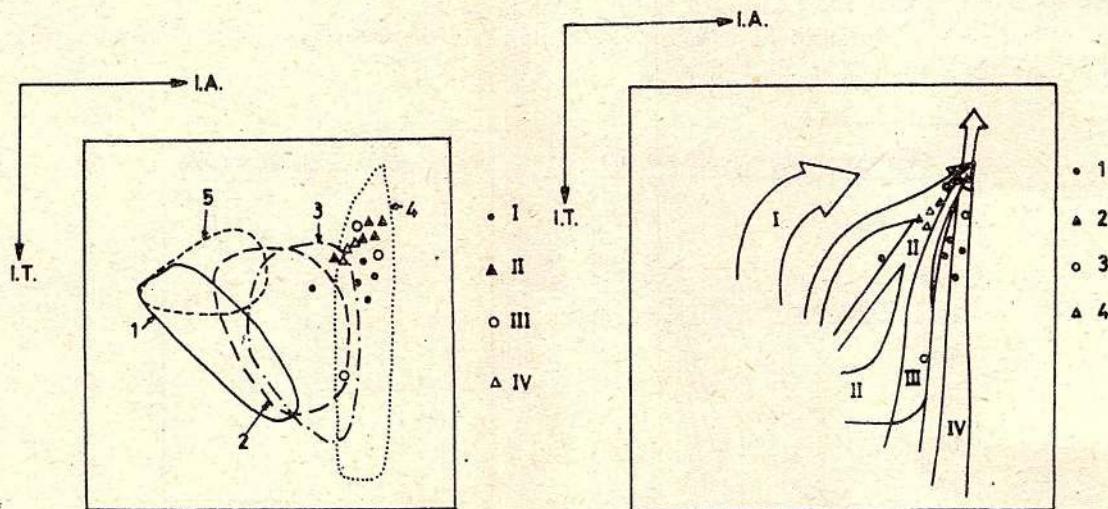


Fig. 9 - Diagramme T.E.T. de distribution des roches plutoniques (Pupin, 1980).
1, diorites, gabbros et diorites quartzifères;
2, granodiorites; 3, monzogranites et monzonites;
4, syénites et granites hyperalcalines.
I, Ogradena; II, Cherbelezu; III, Sfirdin; IV, Cerna.

Fig. 10 - Diagramme T.E.T. de distribution des roches granitiques (Pupin, 1980).
I, granites de la croûte ou ayant l'origine principalement dans la croûte; II+III, granites à origine mixte (croûte+manteau); IV, granites ayant l'origine dans le manteau ou principalement dans le manteau. 1, Ogradena; 2, Cherbelezu; 3, Sfirdin; 4, Cerna.

- la couleur varie de rose à brun;
- les inclusions sont peu nombreuses, à des dimensions très réduites;
- les cristaux zonaux sont rares et ceux à noyau ont été rencontrés seulement dans le granitoïde de Cerna, mais en nombre réduit;
- la variation des dimensions des cristaux de zircon est très proche pour tous les quatre corps granitiques;
- dans le diagramme T.E.T. de distribution des roches plutoniques la plupart des échantillons se situent dans le champ des syénites hyperalcalines, sauf quelques-uns qui se projettent dans la zone d'interférence de ce champ avec celui des monzonites et monzogranitoïdes;
- dans le diagramme T.E.T. de distribution des roches granitiques on observe que les granitoïdes de Cherbelezu, Sfirdin et Cerna se projettent dans le champ des granites à origine mixte (croûte+manteau), pendant que les granitoïdes d'Ogradena se projettent (la plupart) dans le champ des granites à origine mantellique ou principalement dans le manteau.
- la température de cristallisation de la majorité des populations de zircon varie entre 700° C et 600° C, excepté l'échantillon 9-Sfirdin, où la plupart des cristaux de zircon se sont formés à la température d'approximativement 900° C.

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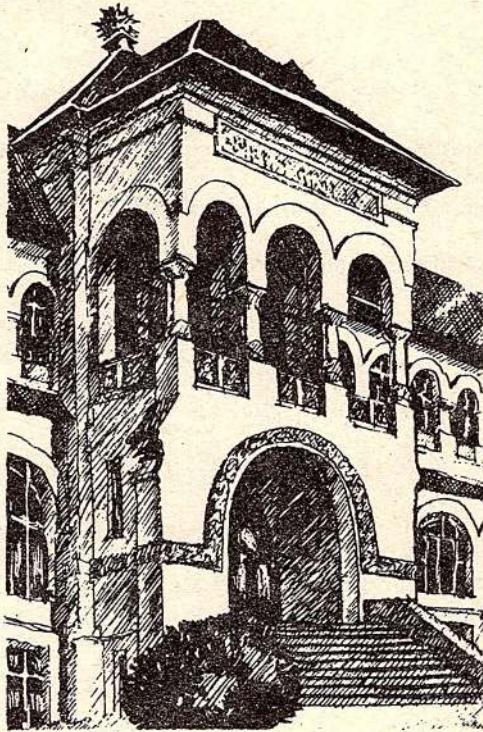
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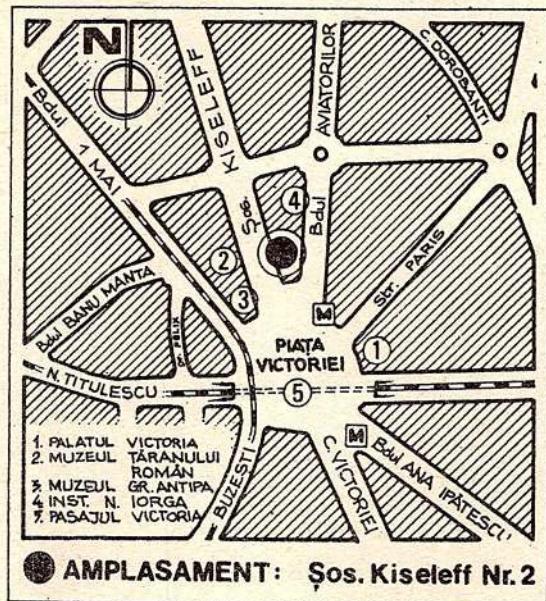


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ASUPRA PREZENȚEI PSEUDORUTILULUI ÎN CRISTALINUL GRUPULUI TULGHEȘ DIN MUNTII PERȘANI

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Key words: Crystalline rocks. Pseudorutile. Pseudomorphism. X-ray data. Electron probe data. East Carpathians – Crystalline-Mesozoic Zone – Perșani Mountains.

Abstract: *On the Pseudorutile Occurrence in the Crystalline Rocks of the Tulgheș Group (Perșani Mountains).* Pseudorutile occurrence is first mentioned in Romania in the Fe-Ti pseudomorphs of the crystalline schists in the Tulgheș Group. Pseudorutile has been determined by means of Rx diffractogram and electron microprobe chemical analyses. The mineralogical and chemical changes of the pseudomorphs are also presented. These alterations are of pseudomorphous and paramorphous type, the occurrence of pseudorutile and rutile₂ being characteristic of the Tulgheș Group.

1. Introducere

Studiul mineralelor de Fe și Ti a constituit obiectul mai multor cercetări datorită, pe de o parte, transformărilor mineralogice frecvent întâlnite și, pe de altă parte, datorită încercărilor făcute privind interpretarea acestor transformări în funcție de condițiile fizico-chimice pe care roca gazdă le-a suferit în timpul diferitelor faze de schimbări ale presiunii, temperaturii, fugacității O₂ și S etc.

In formațiunile cristaline ale grupului Tulgheș din munții Perșani (Vodă, Vodă, 1985; Kräutner et al., 1989, raport nepublicat) mineralele de Fe-Ti apar sub forma unor asociații intime de minerale, cu forme cristalografice bine definite, caracteristice ce sunt descrise de Balintoni, Chițimuș (1973) în munții Bistriței (Carpații Orientali), drept "paramorfoze de rutil după brookit".

2. Prezența pseudorutilului

Apariția pseudorutilului ca specie minerală nouă a pornit de la lucrarea lui Lynd (1960), care studiind procesele de alterare ale ilmenitului, arată că acesta se transformă într-un agregat fin solzos, denumit generic "leucoxen". Temple (1966) arată că de fapt "leucoxenul" reprezintă un amestec fin cristalizat de rutil±anatas±sfen, rezultat în urma levigării Fe²⁺ sub formă de hidroxizi de Fe. Analizele chimice efectuate cu ajutorul microsondei electronice (Teufer, Temple, 1966) au arătat că există o creștere treptată a conținutului de TiO₂ și o scădere a celui de FeO, pentru termenul intermediar propunindu-se denumirea de pseudorutile. Reanalizarea pseudorutilului de către Grey, Reid (1975) a dovedit că de fapt acesta reprezintă o fază stabilă, stoechiometrică, cu formula chimică Fe₂Ti₃O₉.

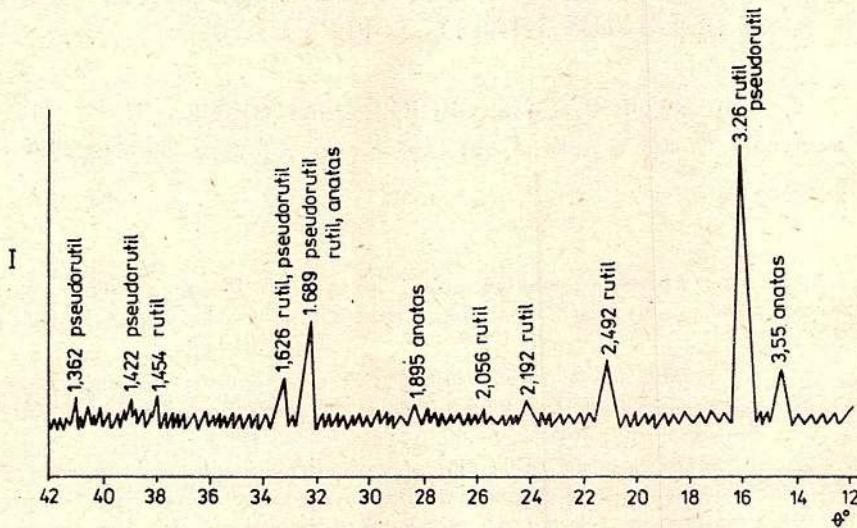
In munții Perșani prezența pseudorutilului a fost presupusă în urma analizei cu ajutorul Rx¹ (vezi figura), datorită peakului de la $d=1,689 \text{ \AA}$, care reprezintă un peak al rutilului (Berry, 1974), dar care ar trebui reinterpretat, conform părerii lui Wort, Jones (1980) ca reprezentând peakul principal al pseudorutilului. Alte peakuri specifice pseudorutilului, dar de intensitate mai mică sunt cele de la $d=1,62 \text{ \AA}$, $d=1,422 \text{ \AA}$ și $d=1,362 \text{ \AA}$.

Prezența pseudorutilului a fost verificată prin analiza chimică cu ajutorul microsondei electronice² (vezi tabelul). Calcularea conținuturilor procentuale ale celor doi oxizi ai Fe s-a făcut împreună, neputindu-se

¹Analist: I. Vanghelie, I.G.G., București.

²Analist: C. Coțofană, Laboratoarele centrale, Uzinele "23 August", București.

analiza cantitativ separat pentru cele două stări de oxidare a Fe. Comparativ au fost date și două analize chimice efectuate pe pseudorutilul din Indonezia și Australia (Grey, Reid, 1975).



Difractogramma Rx a rutilului, pseudorutilului și a anatasului.

Tabel
Analiza chimică cu microsonda electronică a
pseudorutilului din munții Perșani

Oxizi %	1	2	3	4	5
TiO ₂	64,10	60,90	65,40	63,02	58,48
Fe ₂ O ₃	34,80	36,10	32,59	26,00	34,65
FeO				4,51	1,24
Mn ₂ O ₃	0,80	0,40	0,60	2,87	0,60
H ₂ O, OH				2,08	3,24
Total	99,70	97,40	98,59	98,48	98,58

1,2,3, pseudorutile din munții Perșani; 4, pseudorutile din Indonezia; 5, pseudorutile din Australia.

Analiza chimică a pseudorutilului a fost efectuată în trei puncte diferite, situate în aceeași zonă. În altă zonă apare o suprapunere a distribuției Fe și Ti, indicând prezența pseudorutilului și/sau a ilmenitului.

Conținuturile scăzute de Mn₂O₃, asemănătoare cu cele ale pseudorutilului din Australia, semnifică formarea sa dintr-un ilmenit foarte slab manganifer.

3. Transformări chimice și mineralogice

Inainte de a trece la descrierea aspectelor și transformărilor cristalografice, mineralogice și chimice, anticipăm puțin și afirmăm că transformările mineralogice care au loc nu sunt numai de tipul schimbării polimorfice a mineralelor, ci și de schimbări complete (chimice, mineralogice), în care mineralele noi se formează pe seama unor minerale preexistente. Cum acest din urmă aspect predomină, credem că termenul de "pseudomorfoze" este mai apropiat de esența transformărilor decit cel de "paramorfoză", propus de Balintoni, Chițimuș (1973).

Pseudomorfozele apar ca lamele bine individualizate (pl. I, fig. 1), cu dimensiuni variabile, nedepășind însă niciodată 5 mm lungime și 1–2 mm grosime. Au culori diferite, funcție de intensitatea transformărilor mineralogice, variind de la cenusiu închis pînă la alb. Forma este de obicei pseudohexagonală, marginile fiind frecvent franjurate și inconjurate de o bandă, cu grosimi submilimetrice, formată dintr-un amestec de clorit și sericit, foarte fin cristalizat.

In secțiuni subțiri pseudomorfozele apar ca niște lamele alungite (pl. I, fig. 6), opace, orientate după aceeași șistozitate, însă frecvent îndoite și contorsionate după o șistozitate ulterioară. Ele pot apărea fie în masa cuarțo-sericito-cloritoasă a rocilor, fie prinse în "structură armată" în interiorul cristalelor de feldspați sau granat (pl. II, fig. 1).

Din punct de vedere mineralologic, pseudomorfozele sunt alcătuite din parageneza ilmenit±pseudorutil±rutil₁±anatas±hematit±sfen±rutil₂±hidroxizi de fier.

Mineralele citate provin dintr-un singur mineral primar, ilmenitul, care poate apărea atât netransformat (pl. I, fig. 4), cât și alterat, parțial sau total, putându-se astfel deosebi următoarele tipuri de transformări mineralogice:

A) Ilmenit→pseudorutil→rutil₁±anatas±hematit±hidroxizi de Fe

Această parageneză este cel mai frecvent întâlnită, transformarea fiind mai mult sau mai puțin completă. Sensul transformării este clar că decurge de la stînga la dreapta, fapt dovedit de prezența relictelor de ilmenit prinse în masa rutilului (pl. I, fig. 5). Frecvent se întâmplă ca, în aceeași probă, să apară lamele de ilmenit netransformat cât și complet transformat în rutil₁ (pl. I, fig. 6).

Toate aceste faze de transformare a ilmenitului depind de anumite condiții de temperatură, presiune și fugacitate a O₂ (Docka et al., 1986), precum și de fugacitatea S (Force, 1976a) și presiunea CO₂ (Schuiling, Vink, 1967).

In pseudomorfozele din cristalinul munților Perșani, ilmenitul a fost determinat microscopic, el apărind complet, parțial sau deloc transformat. Foarte frecvent, în cadrul același tip petrografic, situat în același areal și la același nivel lithostratigrafic pot coexista lamele ce conțin numai ilmenit cât și lamele ce sunt parțial sau total transformate. Cînd, însă, pseudomorfozele apar în structură "armată" în interiorul feldspatului sau granatului, ilmenitul este întotdeauna netransformat.

In urma determinării pseudorutilului, problema care se pune este legată de modul său de prezentare. Aceasta ar putea exista sub formă de relicte în cristalele de rutil, sau toată masa rutilului ar reprezenta de fapt cristale de pseudorutil. Analiza chimică efectuată într-un alt punct, situat în apropierea celor trei puncte în care s-a determinat pseudorutilul, indică prezența unui rutil. In acest din urmă caz există și posibilitatea, e drept, destul de redusă, să se fi analizat un rutil de a doua generație (ru₂). Cum distincția microscopică între rutil și pseudorutil se poate face cu dificultate, trebuie apelat numai la analizele fizice. Se observă că în difractograma Rx peakurile rutilului sunt evident mai bine individualizate decât cele ale pseudorutilului, ceea ce ne permite să apreciem că transformarea ilmenitului este completă, pînă la rutil, în care se mai păstrează însă relicte din forma intermedieră de trecere între ilmenit și rutil, adică pseudorutilul.

In cadrul pseudomorfozelor hematitul apare prins în ochiurile rețelei de rutil. Dimensiunile foarte mici ale cristalelor de hematit îl fac greu detectabil microscopic, însă prezența sa este bine evidențiată în distribuțiile Fe și Ti. Hematitul este probabil sincron cu formarea rutilului, fiind rezultat în urma eliberării Fe³⁺ din rețeaua pseudorutilului.

B) Rutil₁±anatas→rutil₂

Rutilul₁ apare exclusiv ca produs de substituire a ilmenitului. A fost determinat microscopic (pl. I, fig. 6), cu ajutorul Rx (vezi figura) și analizat chimic cu microsonda electronică. Este constituit numai din TiO₂ (TiO₂=98,5%), celelalte elemente chimice încercate (Fe, Mn, Mg, Ca, Si) lipsind sau reprezentând cîteva sutimi de procent.

Anatasul a fost detectat numai cu ajutorul Rx, unde a apărut peakul specific de la d=3,55 Å. Peakurile de la d=1,82 Å și d=1,689 Å ar putea fi ale anatasului, însă acestea apar și în cazul prezenței rutilului și/sau a pseudorutilului (Berry, 1974). Studiul cu microscopul electronic cu balieaj³ ar putea indica prezența anatasului sub forma unor cristale tabulare dispuse perpendicular pe rețeaua rutilului (pl. II, fig. 1).

La microscop anatasul nu a fost observat, ceea ce indică faptul că apare foarte fin cristalizat, fiind inclus, ca produs al transformării polimorfe, în cristalele mai mari de rutil₁. Anatasul nu a putut fi detectat nici la analiza cu microsonda electronică, datorită faptului că valoarea conținutului în TiO₂ este similară cu cea a rutilului. Prezența anatasului în pseudomorfozele din grupul Tulgheș a fost semnalată și de Nedelcu (1986), fiind determinată tot cu ajutorul difractogramei Rx.

Studiile experimentale făcute de Dachille et al.(1968) pentru sistemul anatas-brookit-rutil-TiO₂-II (acesta din urmă reprezentând un polimorf de presiune foarte ridicată al TiO₂) au stabilit că punctul de inversiune rutil-anatas este situat la 484° C și 9,5 kb, dar, însăși autorii presupun o temperatură mai scăzută. Pe de altă parte, Jamieson, Olinger (1969) susțin că anatasul este peste tot metastabil față de rutil. Ramdohr (1969) arată că, în general, anatasul este mai recent și de temperatură mai scăzută decât rutilul. In schema propusă de Novitzky (1973) privind transformarea mineralelor de Fe-Ti din șisturile cristaline, rezultă de asemenea că anatasul

³Geolog C. Costea, I.G.G., București.

reprezintă ultimul stadiu al acestor schimbări, fiind produsul transformării din rutil, la temperaturi și presiuni foarte scăzute. Udubașa (1982, 1986) arată că, în rocile magmatice, la temperatură foarte scăzută, anatasul se formează în locul rutilului. Totodată apreciază că relația rutil/anatas este dependentă și de fugacitatea S, a cărei creștere favorizează de regulă apariția anatasului.

Pe de altă parte Petruțian et al. (1966, 1971) consideră, pentru zăcăminte de la Bălan și Leșu Ursului, anatasul ca fiind anterior, sau cel mult sincron formării rutilului.

Pentru pseudomorfozele din munții Perșani apreciem o cristalizare anterioară a rutilului, sau cel mult cvasisincronă a rutilului și anatasului, condițiile de temperatură și presiune fiind însă favorabile formării rutilului. Variațiile mici ale acestor parametri, în sensul scăderii lor, au dus la formarea unor mici cantități de anatas, păstrate acolo unde condițiile au fost favorabile stabilității sale. De asemenea, prezența unor sulfuri (bornit, calcopirită) în parageneză ar putea indica o anumită relație între fenomenul de sulfurizare și transformarea rutil-anatas.

Studiul cu ajutorul microscopului electronic cu baleaj a dus la observarea a două generații de rutil: un rutil (ru_1) rezultat prin alterarea marginală și pe discontinuitățile structurale din granulele de ilmenit și un rutil ulterior (ru_2) care apare în interstițiile agregatelor de ru_1 .

Aspectele cristalografice ale ru_1 se observă bine microscopic, pe înglobările făcute perpendicular pe fața (0001) a pseudomorfozelor, unde apare sub forma unor agregate columnare (pl. II, fig. 3), alungite după axul "c", care, frecvent, sunt orientate după două sau chiar trei direcții cristalografice (pl. II, fig. 4, 5), paralele cu planele rombohedrale ale ilmenitului. De aici rezultă o întrepătrundere a cristalelor de rutil, dând aspectul unei rețele regulate, în care ochiurile au formă de romb, sau, respectiv, de triunghi echilateral.

Cea de-a două generație de rutil (ru_2) este întâlnită fie pe marginea cristalelor, fie în interiorul ochiurilor rețelei de ru_1 (pl. II, fig. 4). ru_2 apare cu o structură sogenitică, fiind dispus în rețea la fel ca și ru_1 . Uneori se observă foarte clar transformarea marginală a ru_1 în ru_2 (pl. II, fig. 5). Acest rutil ulterior poate fi diferențiat de rutilul din prima generație prin dimensiunile relative mult mai reduse, cît și prin faptul că apare totdeauna marginal. Celelalte caracteristici ale cristalelor din cele două generații sunt identice.

Distribuția și modul de variație a Fe, Ti și Si din ru_1 arată o neuniformitate a repartiției atomilor de Ti în cadrul cristalelor, cantități foarte scăzute de Fe și faptul că în ochiurile rețelei de rutil apar și silicați (sericit, clorit, quart).

C) Ilmenit-rutil-sfen

Această transformare este destul de rară, fiind întâlnită într-o singură probă, în care ilmenitul, prins în feldspat ("structură armată") este netransformat, pe cind, în celealte lamele transformarea în rutil este completă. Sfenul apare în jurul pseudomorfozelor, formarea sa depinzând probabil de compozitia inițială a ilmenitului și de posibilitatea extragerii Ca din silicați și/sau carbonați.

Apariția sporadică a sfenului poate fi pusă în legătură cu ipoteza că, în caz de sulfurizare, sfenul devine instabil față de rutil (Udubașa, 1982). Prezența în parageneza mineralologică a rocilor găzării a sulfurilor pare să susțină această idee. Pe de altă parte Force (1976b) arată că, frecvent, sfenul apare în cantități importante în metamorfitele de grad scăzut (faciesul șisturilor verzi), sub formă de pseudomorfoze după ilmenit.

4. Concluzii

In urma studiului transformărilor mineralogice și chimice ale oxizilor de Fe-Ti din cristalinul munților Perșani se pot sublinia cîteva aspecte:

- transformările mineralogice sunt de tip pseudomorf și paramorf, mineralul primar fiind ilmenitul;
- apariția pseudorutilului, descris pentru prima dată la noi, ca fază intermediară, stabilă (metastabilă?), în cadrul transformării ilmenit-rutil;
- pseudomorfozele după ilmenit duc la apariția a trei parageneze distincte:
 - A) ilmenit-pseudorutil-rutil₁±anatas±hematit±hidroxizi de Fe
 - B) rutil₁±anatas-rutil₂
 - C) ilmenit-rutil₁-sfen
- transformările oxizilor de Fe-Ti reprezintă încă o dovadă a polimetamorfismului șisturilor cristaline ale grupului Tulgheș, ele depinzând de anumite condiții de temperatură, presiune, fugacitatele O₂ și S, presiunea CO₂, ce vor fi discutate într-o lucrare ulterioară;
- noua parageneză descrisă duce la aprecierea că, pentru grupul Tulgheș, rămîne caracteristică numai apariția rutilului de a doua generație (ru_2). Cum, pentru celelalte serii cristaline din Carpații Orientali și

Meridionali pseudomorfozele oxizilor de Fe-Ti nu au fost analizate chimic punctiform (cu microsonda electronică), este posibilă existența pseudorutilului și în alte zone. De asemenea, celelalte minerale prezente în pseudomorfoze (ilmenit, hematit, sfen) sănt întâlnite în toate seriile cristaline, indiferent că acestea sănt metamorfozate în faciesul șisturilor verzi sau în cel al amfibolitelor. În schimb, prezența rutilului₂, care poate fi observat și microscopic, nu a mai fost semnalată nicăieri. De aceea considerăm, la stadiul actual de cunoaștere, că, pentru grupul Tulgheș, specifice sănt numai pseudomorfozele în care apare rutilul₂.

Autorii mulțumesc în mod deosebit geol. L. Nedelcu, pentru ajutorul dat la întocmirea lucrării, cît și dr. H. Kräutner și geol. G. Bindea pentru discuțiile avute în legătură cu acest studiu.

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COLOCVIUL INTERNATIONAL "F.A. BREITHAUPT"

16-18.09.1991, Freiberg/Germania

După 25 ani, orașul Freiberg a găzduit din nou un colocviu internațional consacrat definirii (și modernizării) noțiunii de parageneză minerală. Colocviul a fost organizat de Academia de mine (Bergakademie) din Freiberg, în colaborare cu Asociația Internațională pentru Geneza Zăcămintelor de Minerale (IAGOD) și Societatea Mineralologică Germană. Au participat specialiști din Africa de Sud, Australia, Austria, Olanda, Polonia, România, Rusia, Ucraina și Germania.

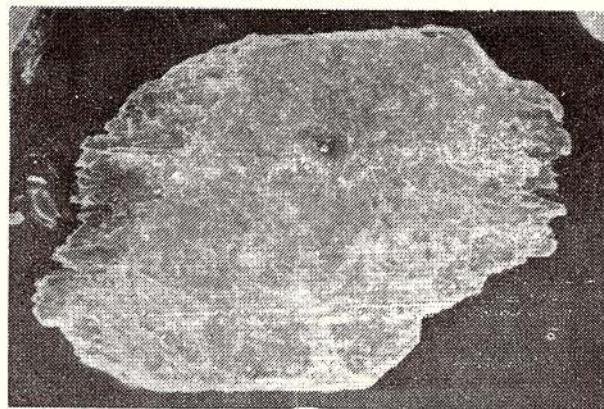
Au fost prezentate cca 40 comunicări (oral și poster), cu un spectru larg de subiecte, desfășurate între mineralogie/petrologie experimentală și "paragenezele minerale" din roci sedimentare, la care s-au adăugat cîteva lucrări dedicate lui Breithaupt – creatorul termenului de parageneză minerală (F.A. Breithaupt – "Paragenesis der Mineralien", 1849). După colocviu, a fost organizată o excursie de o zi în Munții Metaliferi ai Saxoniei, avînd ca obiectiv vizitarea unor ocurențe clasice de greizene cu casiterit, filoane cu fluorină și baritină etc.

În urma discuțiilor din cadrul unei mese rotunde s-a ajuns la următoarea definiție:

"Parageneza minerală este o asociație de minerale formate aproape simultan, în condiții de echilibru, în medii geochimice și izotopice similare, pe cale naturală sau în laborator".

G. U.





1



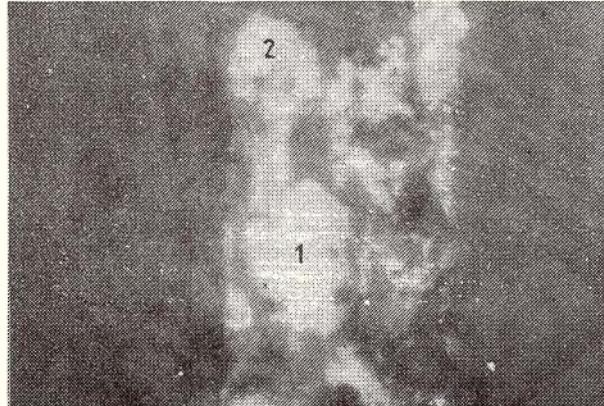
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Planșa I

Fig. 1 - Pseudomorfoză a mineralelor de Fe-Ti. Marginal apar cloritul și sericitul. Microscop electronic cu baleaj, x 62.

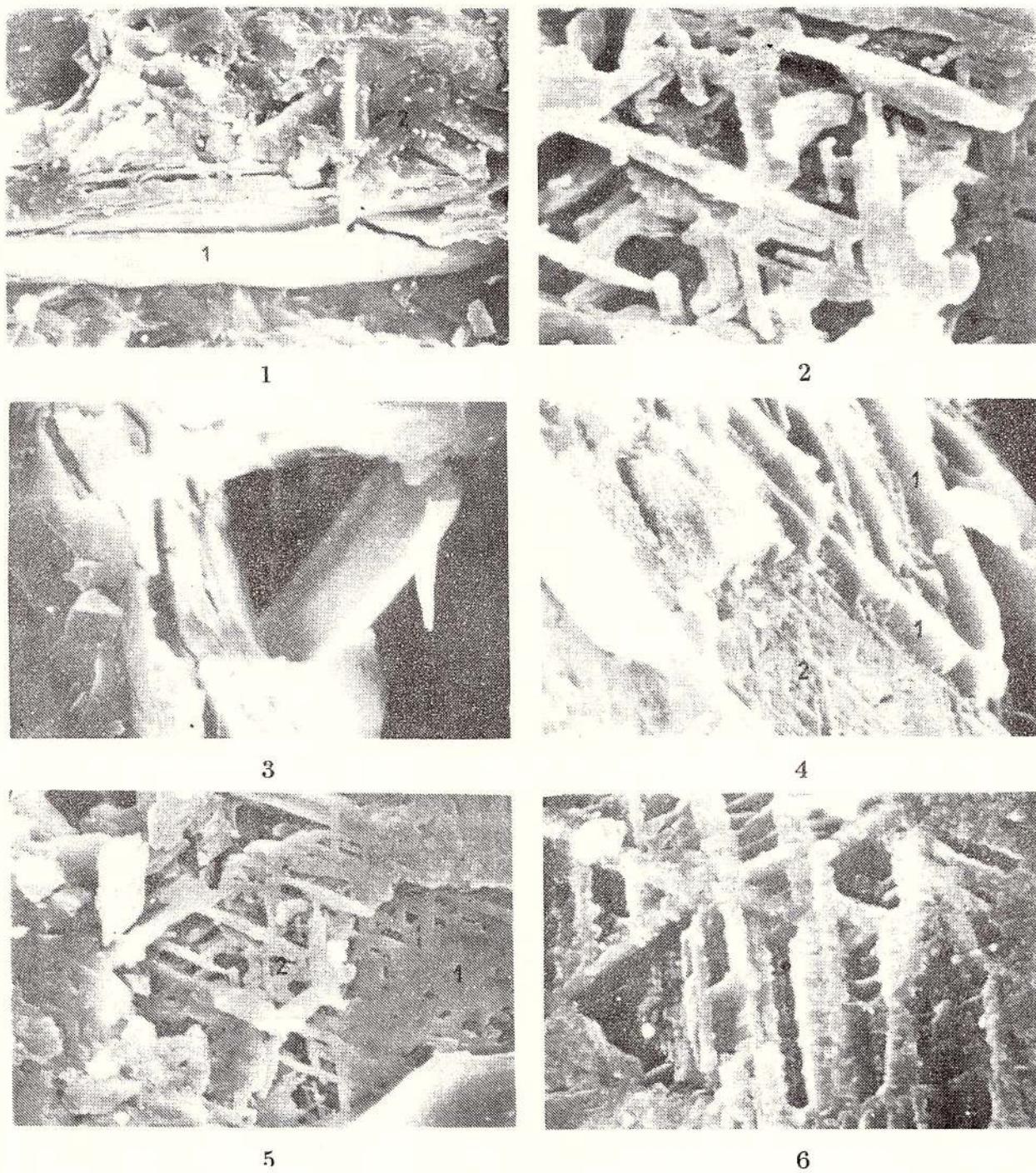
Fig. 2 - Pseudomorfoze (negre) în sisturi sericito-cloritoase. Secțiune subțire, x 30.

Fig. 3 - Pseudomorfoze prinse în "structură armată" în interiorul granulelor de albit. Secțiune subțire, N +, x 30.

Fig. 4 - Ilmenit netransformat. Secțiune lustruită, imersie în ulei, N II, x 1000.

Fig. 5 - Pseudomorfoză de rutil₁ după ilmenit; 1, ilmenit; 2, rutil₁. Secțiune lustruită, N II, x 630.

Fig. 6 - Pseudomorfoze în două stadii de transformare: 1, ilmenit netransformat; 2, rutil format pseudomorf pe seama ilmenitului. Secțiune lustruită, N II, x 250.



Planșa II

- Fig. 1 - Mineral tabular (anatas?) (1) crescut perpendicular pe rețeaua cristalelor de rutil₁ (2). Microscop electronic, x 4100.
Fig. 2 - Rutil₁ orientat după trei direcții cristalografice. Microscop electronic, x 10700.
Fig. 3 - Cristale de rutil₁, ușor indoite, orientate după trei direcții. Microscop electronic, x 4000.
Fig. 4 - Rețea de rutil₁ (1), în interiorul căreia apar cristale orientate după două direcții cristalografice de rutil₂ (2). Microscop electronic, x 9200.
Fig. 5 - Cristal de rutil₁ (1), înlocuit marginal de o rețea de rutil₂ (2). Microscop electronic, x 4100.
Fig. 6 - Rețea de rutil₁ în interstițiile căreia apar cristale de rutil₂. Microscop electronic, x 12300.

CELESTINA DE LA IVĂNCĂUȚI (NORDUL PLATFORMEI MOLDOVENEȘTI)

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Key words: Celestite. Infrared spectra. X-ray data. Mineral data. Fluid inclusions. Moldavian Plateau – Area between Siret and Prut rivers – Northern sector.

Abstract: The Ivăncăuți Celestite Occurrences (Northern Area of the Moldavian Platform). Celestite veinlets associated with calcite are reported, for the first time, from the Badenian limestones overlying the gypsum-bearing formations. Celestite was identified by X-ray diffraction, IR absorption, atomic absorption spectrometry and chemical analyses. According to occurrence and chemical features the Ivăncăuți celestite resembles the one reported from the Cheia (Turda) Badenian formations.

Introducere

Partea nordică a Platformei Moldovenești a constituit obiectul multor lucrări de interes geologic (stratigrafic și paleontologic) și de interes economic. O sinteză asupra istoricului acestor cercetări a fost prezentată recent de Bâgu și Mocanu (1984).

În lucrarea de față se menționează pentru prima dată prezența celestinei în nordul Platformei Moldovenești, legată de formațiunile badeniene de la dealul Grumazu de la Ivăncăuți (fig. 1).



Fig. 1 – Harta cu localizarea ocurenței de celestină de la Ivăncăuți.

2. Cadrul geologic

În zonă se află depozite badeniene, sarmatiene și cuaternare (fig. 2). Badenianul aflorează de-a lungul văii Prutului.

Zona care interesează prezenta lucrare și asupra căreia se dă unele generalități cu caracter litostratigrafic, petrografic și mineralogic, se referă la formațiunile badeniene din Dealul Grumazu.

Formațiunile badeniene sunt reprezentate prin gipsuri, marno-calcare algolitice și marne cu pectinide (fig. 3).



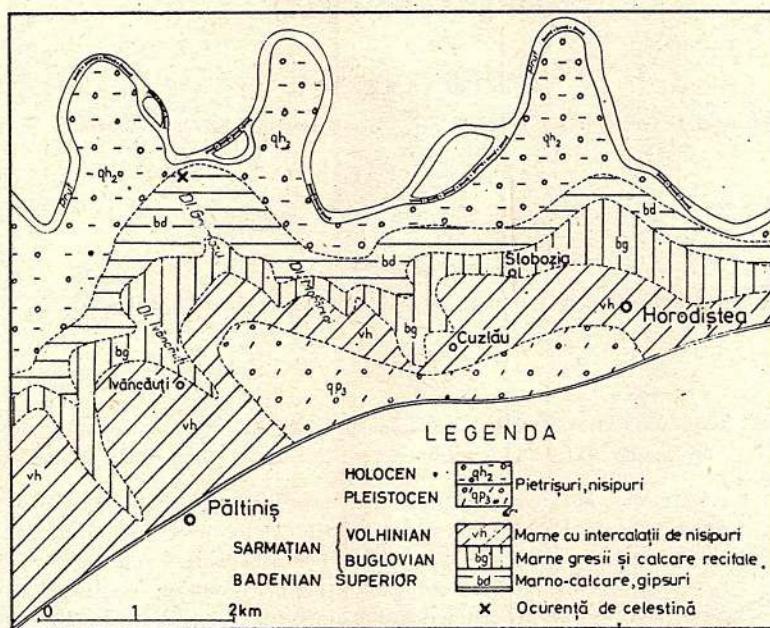


Fig. 2 - Schița geologică a perimetrelui Păltiniș-Horodiștea, după harta geologică a României, sc. 1:200.000, foia Dărăbani (Saulea, Popescu, Bratu, 1966), cu unele completări.

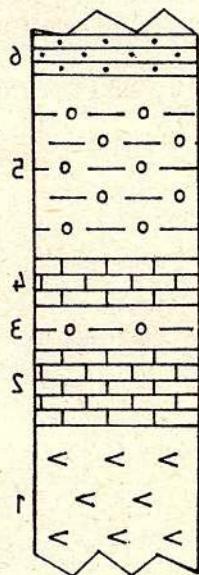


Fig. 3 - Coloana litostratigrafică a formațiunilor badeniene de la dealul Grumazu, Ivăncăuți (după Simionescu, 1902, cu unele completări): 1, gipsuri; 2, calcar (orizontul celestinifer); 3, marme; 4, calcar cu foraminifere; 5, marne cu Lithothamnium; 6, marne cu pectinide.

Formațiunea gipsiferă aflorează pe cîțiva metri înălțime și are, după datele din foraje, o grosime de cca 20 m.

Pe formațiunea gipsiferă repauzează un strat de calcar brun-gălbui cu grosime variabilă între 50 și 90 cm. Este constituit dintr-o masă de granule fine de calcit (2-16 microni) care permite încadrarea lui la tipul de calcare micritice. În secțiuni subțiri arată prezența sporadică a unor teste de miliolide.

Cristalinitatea granulelor din acest calcar, lipsa fragmentelor de material străin și suprapunerea lui direct pe stratul de gips, arată că această rocă a luat naștere prin precipitare directă a carbonatului de calciu din apa mării (Simionescu, 1902).

In succesiunea stratigrafică, conform schiței din figura 3, peste acest calcar urmează o alternanță de calcare și marno-calcare cu *Lithothamnium* și care la partea superioară conține marne cu pectinide.

3. Ocurența de celestină

Aflorimentul în care s-a identificat celestină se află pe versantul nordic al dealului Grumazu, în imediata vecinătate a râului Prut (fig. 2).

Stratul de calcar micritic cu urme fine de miliolide, situat deasupra gipsului, este străbătut de numeroase vinișoare cu grosimi variabile, pînă la 5mm, umplute cu celestină, care este asociată cu calcit.

4. Date cristalografice preliminare

Celestină se află sub formă de agregate cristaline și monocristale. Monocristalele sunt transparente și incolore, prismatice și alungite după axa cristalografică "a". Acest tip de habitus are simbolul $A_a[100] [010]$.

Formele, simbolurile și indicii sunt reprezentate în tabelul 1. Formele de pinacoid (001) și de prismă de sp. II(102) sunt cele mai dezvoltate (fig. 4).

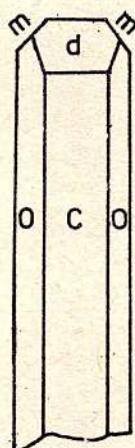


Fig. 4 – Cristal de celestină de la Ivăncăuți.

5. Date structurale

Modelul de difracție al celestinei s-a obținut cu difractometrul DRON-3 folosind radiația $\text{CuK}\alpha(\lambda=1,5418 \text{ \AA})$ și filtru de Ni (tab. 2).

Din datele obținute se poate constata că distanțele interplanare ale celestinei de la Ivăncăuți sunt identice cu cele ale celestinei din fișa etalon a JCPDS, iar intensitățile relative ale liniilor de difracție (I/I_0) sunt apropiate.

6. Spectru de absorbție în infraroșu

Spectrele în infraroșu ale celestinei de la Ivăncăuți s-au înregistrat în domeniul de 4000 cm^{-1} . Porțiunea de spectre luată în discuție, atât în tabelul 3, cât și în figura 5, se află pe intervalul numărului de undă de 2000 cm^{-1} și 400 cm^{-1} .

In tabelul 2 pentru comparație, pe lîngă valorile spectrelor de absorbție în infraroșu ale celestinei de la Ivăncăuți, sunt trecute și valorile pentru celestina din Sicilia (Moenke, 1962), Lake Erie (Omori, 1968) și de la Baciu, de lîngă Cluj.

Tabelul 1
Principalele forme ale cristalelor de celestină
de la Ivăncăuți

Nr.crt.	Forma	Simbol	Indice
1	Pinacoid	c	001
2	Prismă sp. I	o	011
3	Prismă sp. II	d	102
4	Prismă sp. III	m	100

Tabelul 2
Spectre de absorbție în infraroșu ale celestinei
de la Ivăncăuți

Ivăncăuți	Baciu	Lake Erie ¹	Sicilia ²
613	613	610	613
644	644	639	644
993	994	990	993
1095	1095	1095	1092
1133	1133	1130	1132
1197	1197	1195	1197
1242	1242		1242

1, Omori (1968); 2, Moenke (1966).

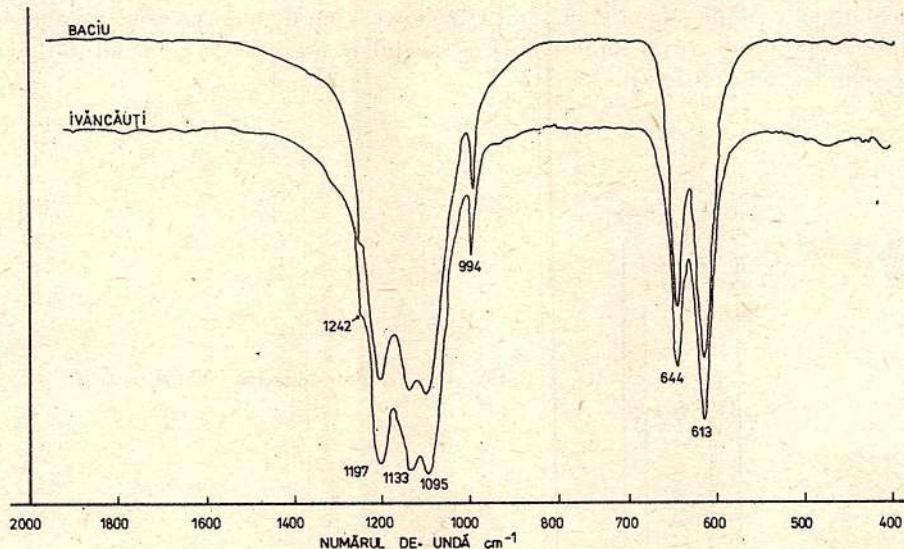


Fig. 5 – Spectrul de absorbție în infraroșu al celestinei de la Ivăncăuți în comparație cu cel al celestinei de la Baciu (Cluj).

Din tabelul 2 se constată că pentru toate ocurențele de celestină spectrele sunt identice sau apropiate cu cele ale celestinei de la Baciu.

După cum se observă în figura 5, toate spectrele, atât pentru celestina de la Ivăncăuți, cât și cele de la Baciu (Transilvania), sunt dominate de două zone unde apar benzi complexe. Principalele benzi de absorbție de la 1095 cm^{-1} , 1133 cm^{-1} și 1197 cm^{-1} sunt cauzate de vibrațiile anionului $(\text{SO}_4)^{2-}$ (Omori, 1968).

7. Date chimice

Pentru determinarea compoziției chimice a celestinei s-au luat două probe brute din vinișoarele din calcarul situat deasupra gipsului. Rezultatele analizelor (media a trei determinări prin spectrofotometria de absorție atomică și metoda colorimetrică) sunt trecute în tabelul 3. În tabel, pentru comparație, se află și analiza chimică a celestinei de la Cheia de lingă Turda (Imreh, Imreh, 1960).

Datele chimice pentru ambele ocurențe de celestină sunt apropiate, cu singura deosebire că, la celestina de la Ivăncăuți se remarcă un conținut mai ridicat în CaO și în Fe_2O_3 . Conținutul ridicat în CaO se datorează asociației intime cu calcit, fapt ce se evidențiază și prin studiul cu razele X.



Tabelul 3 Compoziția chimică a celestinei
de la Ivăncăuți și Cheia (Turda)

Oxizi	Compoziția %	
	Ivăncăuți	Cheia ¹
SrO	54,99	55,24
CaO	1,53	0,41
SiO ₂	0,30	0,53
Fe ₂ O ₃	0,27	0,12
MgO	0,10	
BaO	0,05	
SO ₃	42,70	43,26
H ₂ O		8,29
Total	99,84	99,85

1 Imreh, Imreh (1960)

Concluzii

In lucrare se descrie pentru prima dată prezența celestinelor în Platforma Moldovenească. Ocurența de celestină se află pe versantul nordic al dealului Grumazu de la Ivăncăuți. Se găsește sub formă de vinișoare în calcarele micritice cu urme fine de miliolide și care calcare repauzează pe porțiunea gipsiferă.

Celestina se prezintă sub formă de agregate cristaline și monocristale transparente în asociație cu calcit. Cristalele de celestină sunt lung prismatice și prezintă formele: (001), (102), (011) și (110) cu predominarea primelor două.

Distanțele interplanare ale celestinei de la Ivăncăuți sunt identice cu ale celestinei din fișa etalon a JCPDS.

Compoziția chimică a celestinei de la Ivăncăuți este apropiată cu a celestinei din calcarele badeniene de la Cheia (Turda).

Autorii mulțumesc pe această cale Prof. dr. J. Imreh pentru recomandări de ordin cristalografic precum și dr. Gh. Popescu pentru unele teste micropaleontologice. De asemenea, sunt recunoscători dr. Gh. Udubașa pentru unele sugestii și examinarea manuscrisului.

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SOCIETATEA GEOLOGICĂ A ROMÂNIEI
Secția de mineralogie

CIRCULARA 1

In perioada 15-21 octombrie 1992 va avea loc la Cluj-Napoca "PRIMUL SIMPOZION NATIONAL DE MINERALOGIE", avîndu-se în vedere toate aspectele privind cunoașterea mineralelor de pe teritoriul țării, progresele înregistrate în definirea mai exactă sau redefinirea speciilor minerale descoperite pe teritoriul României, ocurențe noi etc., precum și probleme de mineralogie tehnică și creștere a cristalelor (în special, dar nu exclusiv, de substanțe cu echivalenți naturali).

Dacă numărul de lucrări va fi suficient de mare, problematica simpozionului va fi prezentată pe secțiuni. În mod preliminar, se au în vedere următoarele secțiuni:

1. Minerale și parageneze; ocurențe noi
2. Metode moderne în studiu mineralelor (rezultate)
3. Tipomorfismul mineralelor
4. Geochimia mineralelor (elemente și izotopi)
5. Mineralogie tehnică și/sau aplicată
6. Creșterea cristalelor sintetice

Participarea trebuie să parcurgă următoarele etape:

- I. 15.04.1992 - Anunțarea titlurilor
- II. 1.07.1992 - Trimiterea abstractelor
- III. 25.09.1992 - Confirmarea fermă a participării

Respectarea termenelor este obligatorie, avîndu-se în vedere tipărirea abstractelor și organizarea unei excursii (vizite la muzeu și examinarea unor ocurențe cu minerale mai interesante). Se prevede introducerea unei taxe de participare. Detalii vor fi prezentate în circularele 2 și 3, care vor urma la intervale de 6-8 săptămâni. Aceste circulare vor fi trimise numai celor care răspund la această circulară.

Pentru prima etapă corespondența va fi adresată la:

Dr. G. Udubașa
Institutul de Geologie și Geofizică
78344 Str. Caransebeș nr. 1
București-32

Erratum

	Pagę	Instead of	Should be read
	4, table 2	fineness(%)	fineness (%)
	6, table 4	(=alloclastic?)	(=allocasite?)
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	20, table 20	II Ca	II Ba
	21, 5th line	manganesean	magnesian
	26, table 32, No.21	pyrophyllite	pyrophyllite
	38, 5th line	occurence	occurrence
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	42, No. 20	Werszburg	Weiszburg
	46,	Giușcă(1972) 16(19)	... 16(1)
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