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MINERAL OCCURRENCES IN THE METALIFERI MTS., ROMANIA

G. Udubaşa, R. O. Strusievicz, E. Dafin, Gr. Verdeş

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Excursion Guide

to

The First National Symposium on Mineralogy in Romania

MINERAL OCCURRENCES IN THE METALIFERI MOUNTAINS

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MINERAL OCCURRENCES IN THE METALIFERI MOUNTAINS

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Part 1 – General Data *(G. Udubaşa)*

1. Introduction

The Metaliferi Mountains ("Siebenbürgisches Erzgebirge") represent one of the most interesting geological unit in Romania, exhibiting both a very complicated geological structure and abundant mineral occurrences with rich, partly unique mineral associations. Due to its richness, the area is known since centuries as being an important centre of mining activity. Mining workings going back to the Roman times can be still seen (e.g. at Roşia Montană). The most important metal obtained here was gold (Fig. 1). Old and new stories show that the Romans have transported to Rome thousands and thousands of Kg of gold.

Samuel Köleseri gave perhaps the first record on gold in the Metaliferi Mountains. His book "Auraria Romano-Dacica" appeared as early as 1717 in Cibini/Hermannstadt (the Latin and the German name, respectively of the city of Sibiu). The Governer General of Transylvania, Samuel Brukenthal set up in 1780 in the same town a mineral collection containing more than 2000 samples from the mines in the Metaliferi Mountains, out of which over 250 are with native tellurium and gold-silver tellurides. The collection still exists as a special section of the Brukenthal.Museum in Sibiu.

The "Gold Quadrangle" in the Metaliferi Mountains was regarded at the beginning of the XX Century as the European Eldorado. Maclaren (1908) showed that the "Twelve Apostles Mine" near Brad was at that time " the richest and most productive gold mine in Europe" (p. 184). The mine was repeatedly presented in various journals, e.g. by J. Bauer (1905) in "Berg. n. hüttenm. Jb.", by P. Krusch (1910) and F. Schumacher (1912) in "Z. prakt. Geologie", by J. Prem (1926) in "Revista Miniera de Bolivia" by W Hoffman (1931) in "Kohle u. Erz" etc. A comprehensive review of the gold industry in Romania is given by Haiduc (1940). As a matter of fact there was the second fame peak of the Transylvanian gold, the first one being related to much earlier years; Scapoli (1783) in Italy and Hacquet (1785) in Paris reported on the rich ores of Nagyag/Săcărîmb; further on many data were given to the scientific community by Buchoway (1831) in Paris, von Cotta (1862) in Freiberg, Tschermack (1868) in Vienna ("Das siebenbürgische Goldfield"), Liveing (1886) in England ("Transylvanian Gold Mining") etc.

During the time new gold mines have been discovered and beside gold many other metals successively became interesting for the mining activity, i.e. silver, zinc, lead, mercury etc. The most peculiar feature of the area is its recent becoming the main producer of copper in Romania. In the last time a lot of porphyry copper deposits have been discovered, some of them being already under exploitation, e.g. Roşia Poieni, near Roşia Montană.

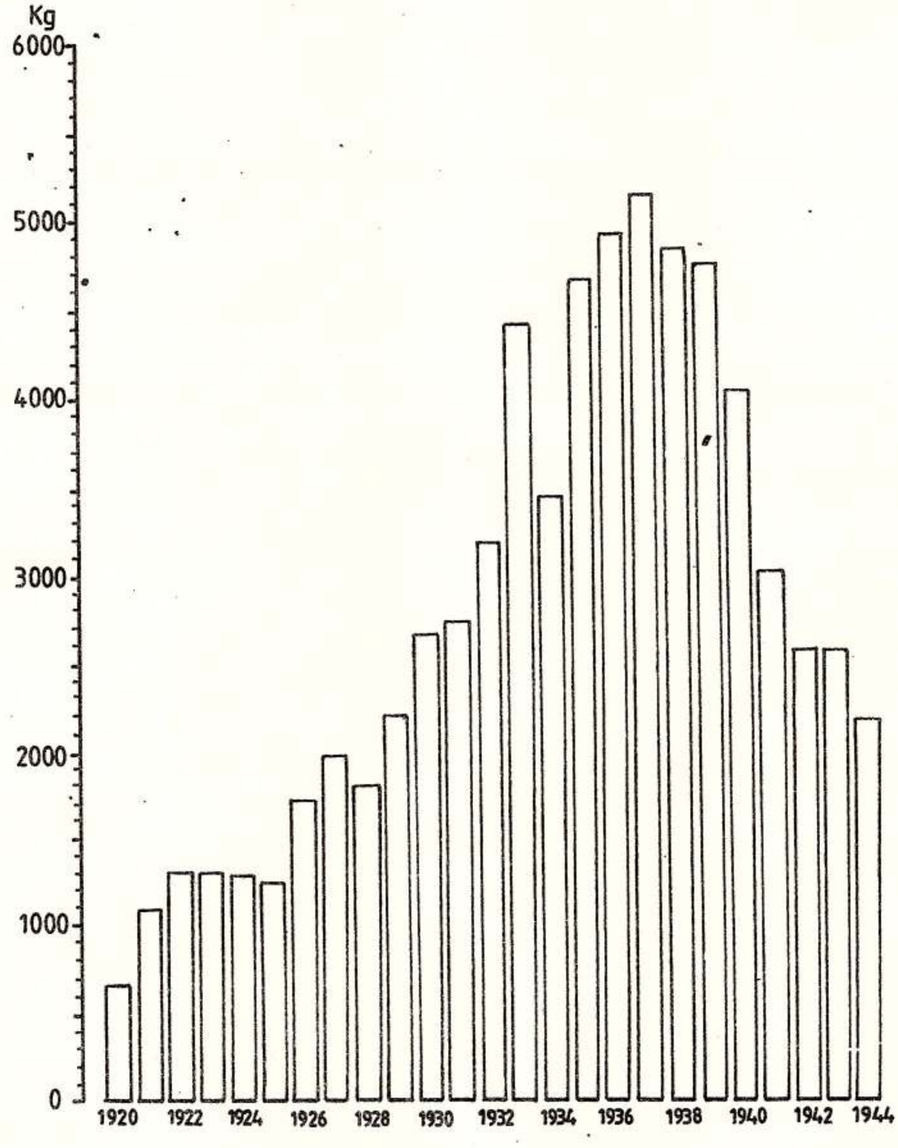


Fig. 1 – Gold production of Romania (1924–1944)
(acc. to Haiduc, 1940; Lăzărescu and Brana, 1972)

The older gold mines are mostly closed as being exhausted; however, the deeper parts exhibited still interesting base metal contents (e.g. Săcărîmb mine); in the nearest vicinity of such rich mines new targets have been found,for example the lead-zinc open pit at Coranda-Hondol near the old veins with native gold; or zones between the older mining workings which contain still interesting gold-silver ores, e.g. the zone of the Săcărîmb mine to be visited.

2. Geological outlook

The Metaliferi Mountains display a very complex geological structure due to the presence of both very different geological formations and to a long geologic evolution. Metamorphic rocks of Precambrian or even Paleozoic age, magmatic rocks ranging in composition from ultrabasite to rhyolites and in age from Jurassic to Upper Neogene, as well as sedimentary rocks covering both the Mesozoic and Cainizoic time interval are exposed in different parts of the Metaliferi Mountains. During the Alpine time the area display features marking the "through type" character evolved from the presence of an important Mesozoic ophiolitic mass and by the flysch and molasse consisting of Cretaceous and Neocretaceous sedimentary formations (Rădulescu et al., 1981).

The metamorphic formations occur mostly at the northern and southern border of the Metaliferi Mountains and it seems that they gradually sink towards the inner part of the through along EW trending fractures. However, such formations are known to occur in the axial zone too, either along the fractures or as xenoliths within the Neogene igneous rocks. The Mesozoic ophiolites of the Mureş Ridge were locally intrudes by Upper Cretaceous-Paleocene magmatic rocks but the obvious feature is given by their cutting by NW trending fractures, along which Neogene molase basins have formed as well as at least two important graben-like alignments with Neogene volcanic rocks have developed, i.e. the Brad-Săcărîmb and the Zlatna-Almaşu Mare zones (Fig. 2). The processing of the ophiolites during the subduction processes in the Neogene time may explain both the richness in copper and the obvious relation of gold with manganese within the ore deposits related to the Neogene magmatic activity, i.e. the alabandite-gold tellurides. For the Metaliferi Mountains the geological triad Au-Mn-Te becomes very characteristic as deriving mostly from the genetical link between the ophiolites (with which volcano-sedimentary Mn-ores have formed) and the subduction-related Neogene volcanics.

3. Mineral Occurrences and Main Ore Deposits

The most typical occurrences of mineralogical interest in the Metaliferi Mountains (Tab. 1) are related to the Alpine magmatic events, which developed in several stages, i.e. (A) Mesozoic ophiolites, (B) Upper-Cretaceous-Paleocene magmatites (Banatites) and (C) Subduction related Neogene andesitic volcanics. Less important are the occurrences lying within the metamorphic rocks (e.g. Muncelu Mic – lead-zinc ores), or in relation to the island arc Lower Cretaceous magmatites (granites-granodiorites, e.g. Cerbia quartz-molybdenite-pyrite veins).

(A) In relation to the Jurassic ophiolites the most interesting is the occurrence of agates at Techerău. They form aggregates up to 20–25 cm in diameter, generally of blue color, banded or with concentric structures. Further on, zeolites occurying in the amygdules of "melaphyres" and/or as fissure filling; they are known especially in the Vorţa-Vălişoara area. Other mineral deposits of some importance are: Vorţa – Kuroko-type lead-zinc-copper ores in which pyrite "atolls" have been recognized, enveloping fine intergrowths of base metal sulphides; Căzăneşti-Ciungani – Ti-Fe±V ores in gabbros; magnetite contains fine exsolution bodies of ulvospinel.

(B) Widely distributed in Banat and the Apuseni Mountains, the mineral occurrences and ore deposits (mainly of skarn-type) related to banatites only subordinatelly occur in the Metaliferi Mountains. The most interesting is, however, the high-temperature, low-pressure skarn occurrence with some magnetite at Măgureaua Vaţei. In the Voia area there are interesting occurrences of garnet replacing calcite from the amygdules in "melaphyres", thermically affected by minor intrusions of banatites.

(C) Both mineralogically and economically the most productive event is that related to the Neogene volcanic activity, that is subduction-related prevailingly andesitic magmatism, widely distributed in the southern part of the Metaliferi Mountains. The age of the volcanic rocks are Badenian-Pliocene. Over an area of about 800 sq.km the Neogene volcanic rocks occupy less than one third of the surface. In relation with them, more than 20 major ore deposits are known, among which the most famous and important are: Săcărîmb (formerly Nagyag), Roşia Montană (Verespatak), Baia de Arieş (Offenbanya), Ruda-Barza (Rudaer Zwölf Apostel), Musariu, Stănija, Botes, Căraci etc. In the last years several porphyry copper (±Au, Mo) ores have been discovered within the old mining areas. Some of them are already of industrial value (e.g. Roşia-Poieni, Deva, Bucium-Tarniţa); others are situated at depth, with interesting copper ores (copper tenor over 0.3–0.4 %) lying deeper than 1000 m (e.g. Voia, Tălagiu etc.)

The most typical features of the Neogene ore deposits in the Metaliferi Mountains are the following:

- the prevailing vein form of the ores, mostly located within complex volcanic apparata;
- the prevalence of gold, even if the ores are locally base metal dominated;
- the complex relationships among ores or ore fields; there are both simple, vein-like deposits, containing practically only Au-Ag tellurides (e.g. Săcărîmb) and complex structures carrying both porphyry copper-gold ores and veins with native gold (e.g. Musariu). There are also ore fields displaying a marked regional zoning centered on the porphyry copper systems (e.g. Bolcana-Troiţa, with gold and base metal ore veins zonally disposed around the porphyry copper-gold body). There are also major porphyry copper (+ Mo) systems showing no direct relations with other types, e.g. Deva and Roşia Poieni.

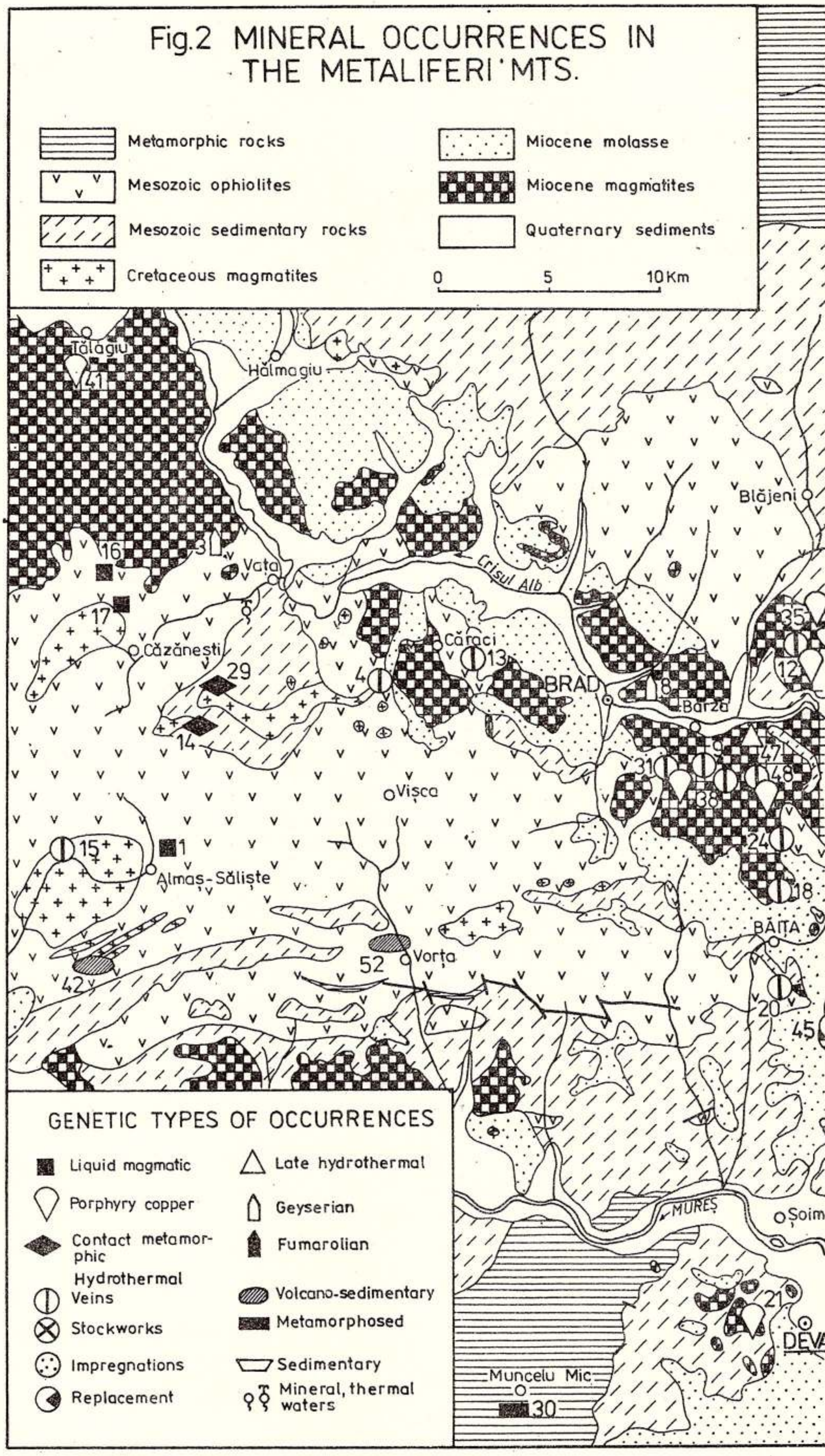
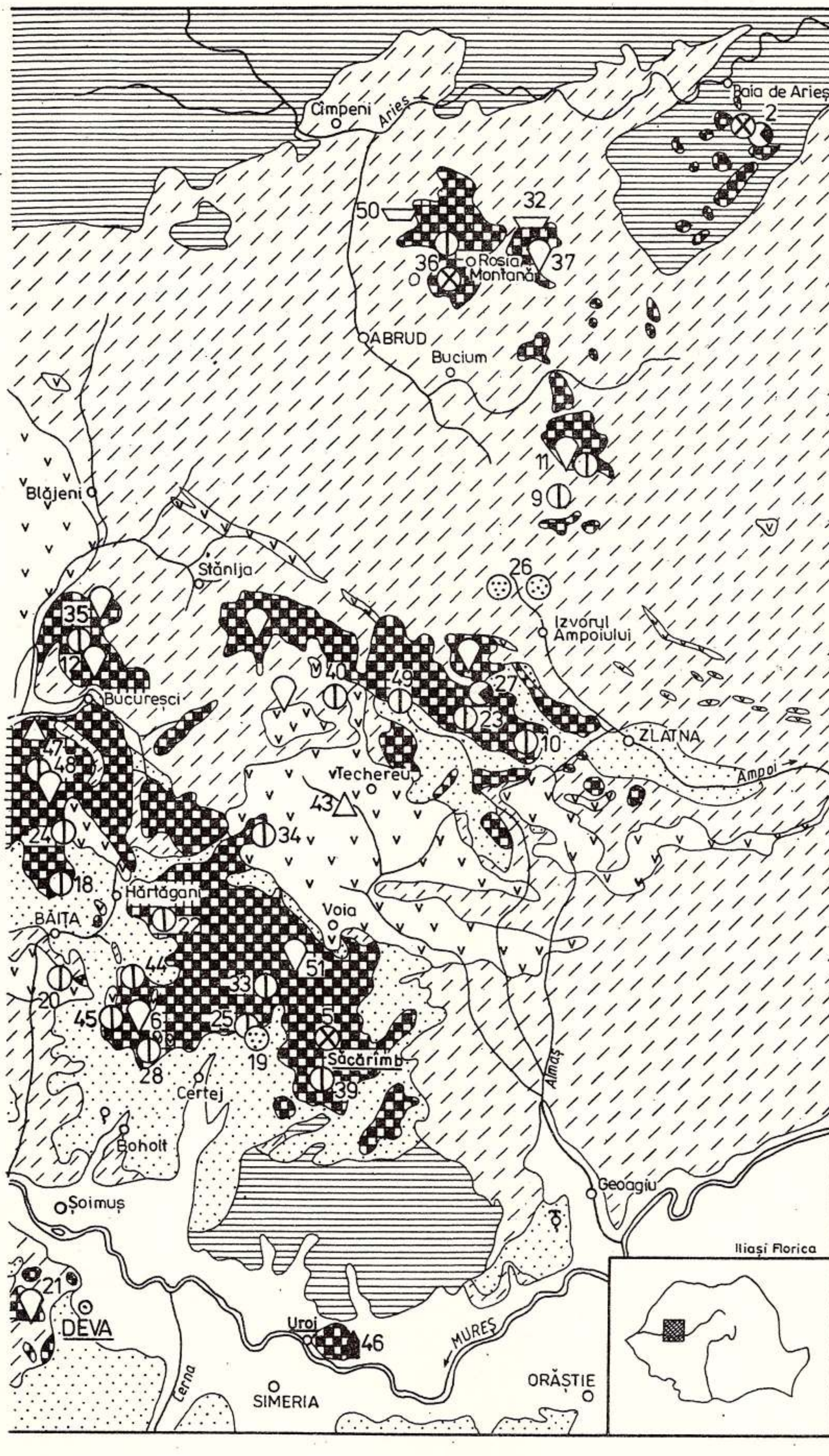


Fig.2 MINERAL OCCURRENCES IN THE METALIFERI MTS.
Metamorphic rocks
Mesozoic ophiolites
Mesozoic sedimentary rocks
Cretaceous magmatites
Miocene molasse
Miocene magmatites
Quaternary sediments
0
5
10Km
Tălagiu
Hălmagiu
Blăjeni
Vața
Crișul Alb
Căzănești
Căraci
BRAD
Barza
Vișca
Almaș-Săliște
Vorța
BĂIȚA
MUREȘ
Șoimuș
DEVA
Muncelu Mic
GENETIC TYPES OF OCCURRENCES
Liquid magmatic
Porphyry copper
Contact metamorphic
Hydrothermal
Veins
Stockworks
Impregnations
Replacement
Late hydrothermal
Geyserian
Fumarolian
Volcano-sedimentary
Metamorphosed
Sedimentary
Mineral, thermal waters



Baia de Arieș
Cîmpeni
Arieș
Roșia Montană
ABRUD
Bucium
Blăjeni
Stănija
Izvorul Ampoiului
Bucureșci
ZLATNA
Ampoi
Techereu
Hărtăgani
BĂIȚA
Voia
Săcărîmb
Certej
Boholt
Almaș
Geoagiu
Șoimuș
DEVA
Uroi
MUREȘ
Cerna
SIMERIA
ORĂȘTIE
Iliași Florica

Table 1
Main Mineralogical Features of the Mineral Occurrences and Mineral Deposits in the Metaliferi Mountains

Mineral Occurrence or Ore Deposit (Genetic type-see below)	Main and/or Most Interesting Minerals or Mineral Assemblages	Remarks
1. Almaş-Sălişte (Ia)	titano-magnetite, ilmenite, titanite, ulvospinel, rutile, hematite	Lenses and disseminations in gabbros
2. Baia de Arieş (IVb, IVd)	alabandite, sphalerite (iron- and manganese rich), galena, pyrite, sylvanite, altaite, hessite, nagyagite, tellurium, tetrahedrite, arsenopyrite, pyrargirite; rhodochrosite, calcite, kutnohorite; wollastonite, bustamite; wulfenite, pitticite.	Type locality of sylvanite; rhodochrosite-sylvanite intergrowths (in the stockwork gold rich ores); alternating bands of carbonates and sulphide (in the replacement bodies in marbles).
3. Basarabasa (VI ?)	quartz chalcedony; natrolite	Silicified woods, locally whole tree trunks
4. Birtin (IVa)	common sulphides, tetrahedrite, cerussite	Cerussite crusts and whole pseudomorphs after galena.
5. Bocşa-Săcărîmb (IVb)	sphalerite (iron-rich), galena, tetrahedrite, bournonite, chalcopyrite, pyrite, illite $2M_1$.	Chalcopyrite inclusions in sphalerite bear fine lamellae of iss*
6. Bolcana-Troiţa** (II)	chalcopyrite, pyrite, magnetite, bornite, molybdenite, hematite, rutile; K-feldspar, biotite; gypsum, anhydrite, tetrahedrite, galena, sphalerite and gold in veins cutting the porphyry copper ores	Chalcopyrite-very rich in gold;
7. Boteş (IVa)	hessite ("botesite"), pyrite, chalcopyrite, tetrahedrite; manganite, pyromorphite, adularia	Chalcopyrite-xx very rich in forms; tetrahedrite associated with adularia; hessite crystals up to 4 cm in size-about 17 forms
8. Brad (sanatorium) (VI)	chalcedony, opal, quartz, hematite; rarely found: epidote, barite, magnetite	Compact, fine grained aggregates of reddish, orange and other colour chalcedony
9. Brădişor (IVa)	gold (fineness 800), altaite, petzite, sylvanite, common sulphides, Ag-rich tetrahedrite, tetradymite, fibros jamesonite (in quartz), tellurium, calcite, barite	Elongated crystals of native tellurium up to 3 x 10 cm in size; typical association gold-barite; barite crystals decorated with small marcasite aggregates
10. Breaza (IVa)	alabandite, sphalerite (iron-free), pyrite, chalcopyrite, Ag-rich tetrahedrite, jamesonite, pyrargirite, gold (700) rhodochrosite, barite	Native gold associated with rhodochrosite and calcite. Iron-free sphalerite crystals up to 5 mm in size.
11. Bucium (IVa) (II)	pyrite, chalcopyrite, enargite, hessite, sylvanite, petzite, altaite bornite, Ag-rich tetrahedrite, pyrargirite; germanite (?); rhodochrosite, quartz; magnetite-chalcopyrite-pyrite-K-feldspar-biotite in the porphyry copper ores (Tarniţa)	Many occurences (mines): enargite-xx up to 4 cm in size; pyrite-xx up to 10 cm – the biggest so far in Romania with {210} habit type (Bucium-Izbita-Arama vein); tetrahedrite crystals, locally twinned; needle-like arsenopyrite, hessite crystals, native gold (Vulcoi-Corabia)

Table 1 - continued

Mineral Occurrence or Ore Deposit (Genetic type-see below)	Main and/or Most Interesting Minerals or Mineral Assemblages	Remarks
12. Bucureşti-Rovina (Colnic) (IVa, II)	common sulphides, enargite, gold, canfieldite (?); sporadically garnet in breccias; magnetite-chalcopyrite-pyrite-biotite-K-feldspar-tourmaline in the porphyry copper ores	
13. Căraci (IVa)	alabandite, gold, nagyagite, sylvanite, rhodochrosite, barite, calcite; cerrussite, pyrolusite	Barite-and calcite-xx very rich in forms; some rare forms, e.g. $\{5.2.\bar{7}.6\}$, $\{5.4.\bar{9}.13\}$, $\{4.7.\bar{11}.18\}$ of calcite crystals
14. Căzăneşti (IIIb)	calcite	Pure, thermically recrystallized Jurassic limestones; large cleavage rhombohedrons (99.5 % $CaCO_3$)
15. Cerbia (IVa)	molybdenite, pyrite, chalcopyrite, rutile, sphalerite, galena, tetrahedrite; quartz; chalcopyrite	Short veins in Lower Cretaceous granodiorites
16. Ciungani (Ib)	pyrrhotite, pentlandite, magnetite, chalcopyrite, violarite, pyrite	A vein-like occurrence tectonically emplaced in basalts
17. Ciungani-Căzăneşti (Ia)	titano-magnetite, ilmenite, rutile, titanite, hematite; ulvospinel; pyrrhotite, chalcopyrite	Lenses in gabbros (0.18–0.61 % V_2O_3 in magnetite)
18. Ciinel (IVa)	common sulphides; gold, arsenopyrite pyrargirite, proustite; calcite, barite, quartz; native silver, kerargirite	Fineness of gold is of 580–630 in Ag-rich veins and of 620–680 in Au-rich veins (Haiduc, 1940); Needle-like native silver in small geodes with quartz; Pyrargirite-xx rich in forms.
19. Coranda-Hondol (IVc)	pyrite, iron-poor sphalerite, galena, tetrahedrite, meneghinite, kostovite (?), bournonite, mackinawite, pre-graphite, gold; a mica with a Li-free taeniolite-like X-ray powder pattern; fuchsite, plumbojarosite	Framboidal pyrite; As-zoned pyrite-xx; zoned As-Sb tetrahedrite; leaflet-like supergene galena. Increase of gold towards depth(!).
20. Crăciuneşti (Băiţa-C.) (IVa; IVb)	common sulphides, gold (600-700), pyrargirite, stephanite, Ag-rich terahedrite; barite, seladonite (formed on augite of basalts); ankerite, dolomite, calcite	The most beautiful galena-xx ever found in the Metaliferi Mts
21. Deva (II)	chalcopyrite, bornite, chalcocite, covellite, clausthalite, enargite, molybdenite, hematite; tenorite, vivianite, wulfenite, alunite, native copper; cuprian melanterite ("pisanite"), tirolite	Hematite, typically developed in the deepest parts parts of the porphyry copper system.
22. Draica (IVa)	common sulphides, gold, silver, argentite; barite, calcite; prehnite, cordierite, sillimanite	Prehnite, sillimanite, and cordierite occur in the host dacites; needle-and moss-like native silver

Table 1 – continued

Mineral Occurrence or Ore Deposit (Genetic type-see below)	Main and/or Most Interesting Minerals or Mineral Assemblages	Remarks
23. Faţa Băii	native tellurium ("aurum paradoxum", "sylvane", "lionite"), krennerite, frohbergite, nagyagite, jamesonite, Ag-rich tetrahedrite, orpiment, stibnite iron-free sphalerite, marcasite, gold (930 ‰), tellurite; quartz, calcite	Type locality of native tellurium*** and tellurite; tellurium occurs as prismatic crystals, 1 mm long or as fine layers alternating with pyrite, it includes gold and frohbergite; needle-like tellurite.
24. Hărţăgani (IVa, IVb)	common sulphides, arsenopyrite, tetrahedrite, jamesonite, rutile, bornite; quartz, calcite; gold	rose-like aggregates of black calcite crystals; the black colour is due to fine needle-like jamesonite inclusions
25. Hondol (IVa)	gold, arsenic, pyrite, rutile, quartz	Intimate intergrowths Au-As, pyrite-rutile; leaf- and rose- like gold aggregates up to 5-6 cm in diameter
26. Izvorul Ampoiului (Valea Dosului) (IVc, IVa)	cinnabar, metacinnabar, mercury, pyrite, marcasite; chalcedony, zeolites	The sole occurrence of mercury ores in the Metaliferi Mts
27. Larga (IVc)	pyrite, arsenopyrite, tetrahedrite, chalcopyrite, galena, sphalerite	Replacement bodies in siltites; "auriferous pyrite"
28. Măgura-Făerag (IVa)	common sulphides, gold, fibrous jamesonite, tennantite, arsenopyrite, barite, gypsum; stibiconite	
29. Măgureaua Vaţei (IIIa)	garnet (also melanite with 4.41 % TiO_2), vezuvianite, wollastonite, gehlenite (Cerboia Valley) and spurrite, tilleyite (Cornet Hill)	Gehlenite-xx up to 20 cm in size
30. Muncelul Mic (IX)	common sulphides with barite, siderite; minium, cerussite, malachite, azurite; zeolites	Compact aggregates or crystals up to 3 mm in size of cerussite, very rich in forms and locally twinned
31. Musariu (IVa)	gold (700), common sulphides, arsenic, silver, arseno-pyrite, pyrrhotite, Ag-rich tetrahedrite; barite, gypsum, malachite; chalcecedony, molybdenite (with pyrite, gold, chalcopyrite and arsenopyrite in a drill hole); also tourmaline;-tellurium, krennerite, sylvanite, hessite, calaverite, krennerite, weissite, frohbergite, pyrite, rutile, chalcopyrite (Berbeleac and David, 1982)	Gold crystals; barite associated with marcasite. Typical associations gold with calcite and gold with arsenic. Gold plates. The biggest gold concentration ever acquired in one day (6.11.1891) at the crosssing point of the Clara and Carpen veins (55 kg) (Brana, 1958); pure calcite veins up to 3 m thick
32. Muşca (Xb for A; (IVa for B)	A: copper, cuprite; tenorite, malachite B. copper, pyrite, chalcopyrite, enargite; quartz; chalcocite, vivianite	A. Concretions up to 3 cm in size in red claystones with thin beds rich in carbonaceous matter. B. Fissure fillings in andesites; well developed pyrite-xx with some 22 forms (including rare forms such as {543}, {632}, {751} etc.). Lamellar vivianite-xx up to 3 cm in length, of deep blue-green colour

Table 1 – continued

Mineral Occurrence or Ore Deposit (Genetic type-see below)	Main and/or Most Interesting Minerals or Mineral Assemblages	Remarks
33. Pîrîul lui Avram-Hondol (IVa)	enargite, luzonite, tennantite, pyrite, chalcopyrite, marcasite, hematite, galena, sphalerite; arsenic, gold; alunite	Short veins with compact copper-rich ores, locally forming a net of veinlets in silicified quartz-andesite host rock; marcasite spherical aggregates.
34. Porcurea/Vălişoara (IVa)	common sulphides, arsenopyrite, gold, pyrargirite, orpiment, barite, quartz, amethyst	Amethyst-xx of deep pink colour, the most appreciated samples in the Metaliferi Mountains (even in Romania) – of gem quality
35. Remetea (II)	chalcopyrite-pyrite-magnetite-biotite-K feldspar-molybdenite in porphyry copper ores.	Deep porphyry copper system; in the past only small occurrences of "cupriferous pyrite" (Ghiţulescu and Socolescu, 1940) were known
36. Roşia Montană (IVb, IVa)	gold (500), proustite, pearceite, stephanite, polybasite, alabandite, pyrite, Ag-rich tetrahedrite, marcasite, rhodochrosite (Petrulian, 1934); berthierite; rhodonite (?), helvite, amethyst; argentite, adularia, vivianite, alunite, gypsum, quartz, rutile.	Gold crystals (cubes, ikositetrahedrons), needle-like, skeletal and lamellar aggregates. Gold intergrown with rhodochrosite, calcite and tetrahedrite. The sole occurrences of berthierite and helvite in the Metaliferi Mts. Quartz-xx up to 3 cm in size in the host rhyodacites-type locality for the "Verespatak twin" law of high quartz. Huge amounts of rather pure adularia (Cetate hill); the rocks contain up to 13 % K_2O (Borcoş et al., 1983, 1984)
37. Roşia Poieni (II)	chalcopyrite-magnetite-pyrite-bornite-biotite-K feldspar; anhydrite, zeolites in porphyry copper ores.	Both impregnations and veinlets giving up 0.4 % Cu
38. Ruda-Barza (IVa)	gold (720), common sulphides in small amounts, quartz, calcite; older references include also argyropyrite, friseite, sternbergite, stephanite, cinnabar; copper, ankerite, dolomite.	Beautiful gold samples (leaves, dendrites etc). One of the oldest mine in the Brad area, including the celebrated Transylvanian "Eldorado", i.e. the "Rudaer Zwölf Apostel".
39. Săcărîmb (Nagyag) (IVa)	more than 100 mineral species (some 13 tellurides); See Table 4 for details.	Type locality of many tellurides (nagyagite, petzite, krennerite, stuetzite, muthmannite) and of krautite.
40. Stănija (IVa)	altaite, sylvanite, hessite, stuetzite, calaverite, petzite, coloradoite, gold (900), tellurium, tetradymite, Ag-rich tetrahedrite; fluorite; stibnite rosettes in calcite; barite; $SbTe_2$–recently discovered (Cioflica et al., 1992); common sulphides; cuprian pyrite with 1.2 % Cu (homogeneous) (Lazăr, Ottemann, 1973), nacrite, greenockite, stilbite, laumontite.	Many occurrences with gold and base metal sulphides: (a) Fericeaua (gold in calaverite, other tellurides; cuprian pyrite; $SbTe_2$. (b) Popa (red gold – 900) altaite intergrown with galena esp. in the Vilanela vein; stibnite; laumontite and stilbite in the ore veins). Other peculiarities: a natural gold-disk weighting 8 kg has been here once found (Helke, 1933); very old timbering fir wood impregnated with limonite (Brana, 1958)

Table 1 – continued

Mineral Occurrence or Ore Deposit (Genetic type-see below)	Main and/or Most Interesting Minerals or Mineral Assemblages	Remarks
41. Tălagiu (II)	pyrite-chalcopyrite-magnetite-biotite-epidote-adularia-anhydrite-gypsum (porphyry copper ores); common sulphides, gold, and Ag-sulphosalts in veins around the porphyry system.	
42.Tămăşeşti (VIII)	fine-grained to amorphous manganese hydroxides, hematite, quartz.	Lenses and beds in Mesozoic basalts and Cretaceous marls.
43. Techerău (V)	quartz (amethyst), opal, chalcedony; augite crystals up to 2 cm in size in "melaphyres"; zeolites in their amydules (chabasite, heulandite, natrolite, stilbite)	Rounded aggregates up to 25 cm in diameter with banded and concentric agate. First record: Primics (1886).
44. Trestia (IVa)	common sulphides, gold, tetrahedrite; quartz (locally amethyst); gypsum, fluorite, barite	Moss-like and lamellar gold, locally associated with gypsum; small gold cubes on calcite or sphalerite crystal faces.
45. Troiţa (IVa)	sphalerite (iron poor), galena, tennantite, fibrous jamesonite, bournonite; barite, calcite, gypsum	Bournonite mamillated aggregates up to 2 cm in size on galena crystal faces.
46. Uroiu (Aranyerberg) (VIII)	pseudobrookite, hematite, anatase, rutile; hypersthene, cordierite, hydrogrossular (hibschite), tourmaline, tridymite, sulphur	Type locality of pseudobrookite.
47. Valea Arsului (V)	okenite, apophyllite, gyrolite, chabasite, stilbite, calcite	Fissure and cavities fillings in nearly fresh andesites
48. Valea Morii (IVa)	chalcopyrite-pyrite-magnetite-biotite-K feldspar-rutile-pinkish quartz etc. in the porphyry copper-gold ores. Vein ores: gold (700), common sulphides, emplectite, Ag-rich tetrahedrite, rhodochrosite; epsomite, gypsum	Gold associated with quartz, galena and sphalerite. Very typical-needle-like gold bearing along fibres small quartz and calcite crystals.
49. Vîrful Negrii (IVa)	common sulphides, gold, tetrahedrite, arsenopyrite, jamesonite, quartz, calcite.	Uncommon frequently found gold-galena intergrowths; also gold-sphalerite (Petrulian, 1942)
50. Vîrtop (Xa)	gold (875-1000), pyrite, magnetite	Placer gold in sandstones and conglomerates of Miocene age.
51. Voia (II)	chalcopyrite-pyrite-magnetite-biotite-K feldspar-anhydrite; gold, hematite, gypsum (in the porphyry copper ores); -common sulphides and Ag-sulphosalts in the nearby situated veins	Abundant anhydrite
52. Vorţa (VIIIa)	common sulphides, bornite, tetrahedrite; barite, calcite, nontronite; about 10 zeolite mineral species in the Vorţa-Furcşoara area (e.g. stilbite, mordenite, natrolite, chabasite, phillipsite, gmelinite etc. (Cioflica et al., 1985)	Pyrite atolls with iron-rich sphalerite, galena, tetrahedrite, bornite in their "lagoons". Compact ores, forming locally rounded aggregates in clayely rocks (local name "mugle"). (Udubaşa, 1976, unpubl. data)

Main sources of data: Ghiţulescu and Socolescu (1941), Brana (1958), Rădulescu and Dimitrescu (1966), Borcoş et al. (1983/1984), Udubaşa et al. (1992).

* iss – the intermediate solid solution of the Cu-Fe-S system, locally formed as quenched phase in some rapidly cooled ores; called "chalcopyrrhotite" by Ramdohr.

** The names of some porphyry coppers are here given in a different manner compared to Boştinescu (1984). As they are related (at least geographically) to old base metal or gold ore deposits, it seems appropiate to give them both names, e.g. Bolcana-Troiţa, where Bolcana is a creek and a hill situated near Troiţa base metal ore deposit. Further cases: Roşia-Poieni (not simply Poieni, as in the paper of Boştinescu), Bucium-Tarniţa (Tarniţa), Bucureşti-Rovina (Rovina).

*** Controversial views as to the type locality of native tellurium; see the description of the Săcărîmb ore deposit for further details: part II, stop 4).

Genetic types of mineral occurrences and ore deposits presented in the Table 1

I. Liquid magmatic
  (a) orthomagmatic; (b) liquation
II. Porphyry copper systems
III. Contact metamorphic
  (a) thermal recrystallization; (b) skarns ± hornfels
IV. Hydrothermal
  (a) veins; (b) stockworks; (c) impregnations; (d) replacement
V. Late hydrothermal
VI. Geyserian deposition
VII. Fumarolian, partly also pneumatolytic.
VIII. Volcano-sedimentary ores
  (a) Kuroko type
IX. Metamorphosed ores (vein-like)
X. Sedimentary
  (a) placer-like; (b) black shale-like

In the southern part of the Metaliferi Mountains, i.e. in the area to be visited, the ore deposits display a non-uniform distribution and their extension on a vertical scale is quite different (Fig. 3). The ores are of several compositional types, i.e. porphyry coppers (Voia, Bolcana-Troiţa), gold-tellurides (Săcărîmb), native gold (Hondol), gold-base metal ores (Măgura, Băiţa-Crăciuneşti), base metal ores (Bocşa-Săcărîmb/Leopold mine, a stockwork-like mineralization in brecciated lavas; Coranda-Hondol, with disseminated ores in slightly brecciated Cretaceous silty to sandy sedimentary deposits situated around a subvolcanic body; Troiţa – base metal sulfide ores forming simple veins). A peculiar position has the copper occurrence at Pîrîul lui Avram-Hondol, containing enargite, luzonite, famatinite, etc. in short, partly intersecting veins. Such ores are nearly always spatially and most probably genetically related to hidden porphyry coppers; they contain therefore "remote parageneses" which can be used in discovering porphyry systems. Similar situations are known: a) at Bucium, where the Arama ("Copper") vein containing enargite and other copper rich minerals is situated near the Bucium-Tarniţa porphyry copper, b) at Bucureşci-Colnic, and c) at Roşia Poieni, where enargite and the associated minerals are known in the nearby situated Muşca occurrence. Other cases: Reczk (Hungary), Butte (Montana, USA).

Some of the above-mentioned ore deposits contain many minerals, some of them first described here (Tab. 1). In addition some other mineral occurrences are known with no relationships with the mineralization processes. The coloured chalcedony occurrence near Brad has formed as a result of a geyserian-like activity. lying within pyroclasic rocks of andesitic composition. Late hydrothermal veinlets carrying zeolites, okenite, apophyllite etc. are known in many places; the occurrence on the Arsului Valley near Brad is one of the best studied and will be visited.

Very interesting is also the pseudobrookite occurrence at Uroiu (type locality of the mineral) hosted by highly oxidized pyroxene-bearing andesite. The area will be visited too.

On the regional scale in the Metaliferi Mountains no definite zoning of the ore deposits could be depicted (Fig. 2). However, the gold-telluride ores, in which the element association Au-Te-Mn is very obvious, lie at the corners of the "Gold Quandrangle". Nevertheless, the identification of native tellurium in association with gold-, silver-, copper- and iron tellurides at Musariu (Berbeleac, David, 1982) partly denies the rule.

The mineralization processes related to the Neogene igneous activity are polyascendent in character; however, the unfolding of the ore deposition events is somewhat similar, containing an iron sulphide dominated stage, a base metal sulphide stage, a sulphosalts and/or telluride stage and a gold stage (Cioflica et al., 1973).

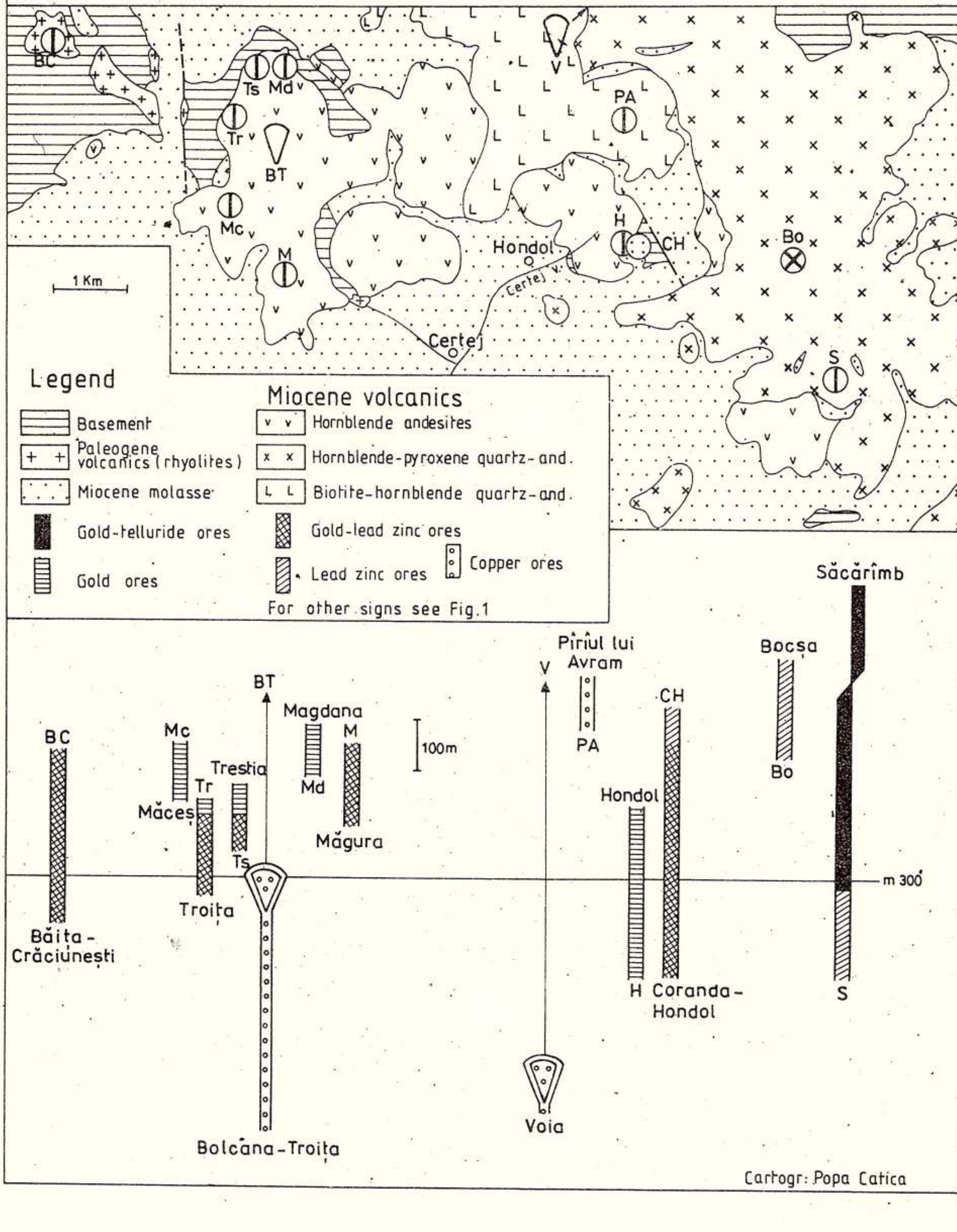


Fig.3 GEOLOGICAL SKETCH OF THE BĂIȚA-SĂCĂRÎMB AREA with the vertical distribution of the ore deposits

The veins are mostly simple, several tens of metres long, and up to 1 – 1.5 m thick. The ores are brecciated, masive; the bandes textures are rare well as geodes. The last feature is typical of the ore deposits in the Metaliferi Mountains, as contrasting with the similarly developed ore deposits in the Baia Mare mining district. This is why the ores in the Metaliferi Mountains furnished rather few "mine flowers" as compared with the Baia Mare area. However, beautiful forms of native gold – leaves, moss-like, even crystals – have been collected during the time; a part of these samples can be seen in the Gold Museum in the town of Brad. In the last time, the Hondol mine "produced" also nice samples with native gold, forming mostly "roses" up to 3–4 cm in size. Other mineralogical specialities are given in the Table 1.

Lack of regional zoning was presumably caused by the existence of numerous activity centres as well as by development of the metallogenetic activity in three main phases. According to Ghiţulescu, Socolescu (1941) and Cioflica et al. (1973) the metallogenic phases are as follows:

1) Gold silver ore deposits, associated with Badenian acidic volcanic rocks: Roşia Montană, Cîinel, Băiţa, Draica; they contain both native gold (especially Roşia Montană) and silver sulphosalts with base metal sulphides.

2) Gold-silver, base metal sulphide, and subordinately mercury ores. The productive structures are related to Sarmatian andesitic volcanics. It is the most widespread and quantitatively the most important metallogenetic phase, including practically the great majority of ore deposits in the Metaliferi Mountains. Included here are the important ore deposits at Săcărîmb, Barza-Musariu, Caraci, Baia de Arieş, Căraciu, Stănija, Boteş, Măgura etc. Purely gold ores, gold-telluride ores, as well as mixed gold-base metal ores have thus formed during this phase. The scarcely developed mercury ores at Izvorul Ampoiului (formerly Valea Dosului) belong also here. A typical feature of this phase is the development of the porphyry copper systems towards the end of the magmatic evolution. At least twelve such systems are so far known in the Metaliferi Mountains: Roşia Poieni, Bucium-Tarniţa, Remetea, Bucureşci-Colnic, Musariu, Valea Morii, Tălagiu, Bolcana-Troiţa and Voia, significantly extending the geochemical spectrum of the metallogeny in the area. They occur either as isolated, pure copper (± Mo) ores, e.g. Roşia Poieni and Deva (in a geological environment characterized by a crystalline basement) or as complex structures, with porphyry copper (usually gold rich) ores cut by/or enveloped with gold and/or base metal vein ores, e.g. Tălagiu, Bolcana-Troiţa, Musariu, Valea Morii (in a geological environment characterized by an ophiolitic basement). The mineral composition of the proper porphyry ores is usually simple, including chalcopyrite, pyrite, magnetite (locally typically developed on an early hematite), bornite etc. The latter veins cutting the porphyry ores contain either common sulphides (Bolcana Troiţa), silver sulphosalts (Tălagiu) or native gold ± gold-silver tellurides (Musariu):

A typical feature of the veins containing native gold is the presence of rutile, intimately associated with pyrite. It was presumed that rutile is hydrothermally derived, mostly by processing of the primary Fe-Ti oxides in the host rocks (Udubaşa, 1978, 1982). Such ores contains quartz as the main gangue mineral. A second type of gold ores is represented by veins relatively rich in calcite, containing also significant amounts of common sulphides and sulphosalts. Here, rutile is lacking; only sporadically anatase may in places be observed. In addition, globular grains or aggregates of pyrite seem to be very characteristic of this type of ores (Udubaşa, 1984).

3) Base metal sulphide ores, of minor interest, are related to Pannonian quartz-andesites (Cetraş type). They form veins of limited size in a strictly localized area (Cerburea-Cordurea north of the Săcărîmb area). Base metal sulphides with minor tellurides occur here.

A further feature of the ore deposits in the Metaliferi Mountains – if compared with those in the Baia Mare mining district – is the subordinate amount of stibnite, quite abundant in the Baia Mare mines, especially at Herja, Baia Sprie, Săsar, Băiuţ etc. However, there are at least two interesting stibnite occurrences in the Metaliferi Mountains, exhibiting radially featured aggregates of stibnite crystals in a fine-grained mass of clay minerals and calcite (Bulza, soth of the Mureş River, outside the map) and Stănija. At Bulza the stibnite aggregates may reach 6–7 cm in diameter. The same remark is true if barite is taken into consideration. Significant amounts of barite have been encountered only in the Băiţa-Crăciuneşti-Trestia-Troiţa area, forming translucent crystals up to 5 cm in size. The colour is nearly always grey, slighty bluish, contrasting again the Baia Mare barites, that may have all the possible colours.

Special emphasize deserves the anhydrite, abundantly formed in the porphyry copper deposits at Voia and Tălagiu; intergrowths of anhydrite and gypsum are quite frequenly found in the Bolcana porphyry copper deposits. Translucent crystals of gypsum up to 5–6 cm in size have been observed in the base metal sulphide ore veins at Troiţa.

Mineral occurrences of secondary origin are quite widespread in the Metaliferi Mts. The hydrographic basins of the Mureş, Criş, Arieş and Ampoi Rivers cover the whole area of the "Gold Quadrangle" and their alluvial deposits contain locally significant gold concentrations. Some new data thereabout are given by Galcenco and Velciov (1992). In addition, some heavy mineral concentrations of placer type are known in the area, such as those of Miocene age carrying iron and titanium minerals at Almaşu Mare, Pogor Hill, and Cornii Hill (Borcoş et al., 1983). Auriferous placers of Miocene age are also known, the most significant being that at Vîrtop-Cărpiniş (NW of Roşia Montană); there are some old galleries (Barbara-Ieruga and Zănoaga) by which this unique occurrence has been investigated (Ghiţulescu and Socolescu, 1940, 1941). Gold is of high fineness (875-1000) and occurs either as irregular grains or as leaves, some mm in size. The associated minerals are pyrite and magnetite. The auriferous beds are represented by clayey sandstones and conglomerates covering sedimentary deposits of Cretaceous age and being covered by volcanic rocks.

A small but very interesting occurrence is that at Muşca, North of the Roşia Poieni porphyry copper deposits. This copper rich occurrence contains two distinct mineral assemblages of different origin, i.e. (a) concretions up to 2–3 cm in size consisting of native copper and/or of cuprite, tenorite and malachite in thin carbonaceous layers within the clayey deposits of Cretaceous age: (b) veinlets in altered andesites carrying vivianite and/or quartz, pyrite, chalcopyrite, tetrahedrite, chalcocite and covellite (Petrulian and Brana, 1952). Pyrite forms crystals up to 2 cm in size, showing three habit types, i.e. (a) dodecahedron + octahedron + cube; (b) octahedron + cube (Giuşcă and Pavelescu, 1954).

Part 2 – Stops Description *(G. Udubaşa, R. O. Strusievicz, E. Dafin, Gr. Verdeş)*

During the two-days post-symposium excursion some stops of mineralogical interest will be visited, which are situated within the triangle Simeria-Deva-Brad. The stops include different kinds of mineral occurrences typically related to the Neogene andesitic rocks of the Metaliferi Mts (Southern part), i.e. the Săcărîmb gold-telluride ore deposit, the pseudobrookite occurrence at Uroiu (type locality of the mineral), occurrence of coloured chalcedony located in pyroclasic rocks, near Brad (sanatorium) and the quarry in the Valea Arsului (6 km east of Brad) in hornblende andesites containing small geodes with zeolites, apophyllite, and okenite. The Gold Museum in the Brad town will be visited too.

First day

Stop 1 – Coloured chalcedony near Brad (sanatorium)

Within pyroclastic rocks of andesitic character some lenses of intensely coloured chalcedony are known, croping out near sanatorium (Fig. 4). There are at least two superposed lenses or groups of lenses up to 30 m thick exhibiting two main types of chalcedony; the first (lower) lens includes mainly black or grey-blackish massive chalcedony; the second (upper) group of lenses consists of red, tan or light brown or yelow-orange chalcedony displaying chonchoidal fracture; the colour is sometimes interrupted by fine veinlets of colourless quartz or chalcedony. The marginal parts of the lenses are composed of porous chalcedony, mainly of light brown colour. Ghiţulescu et al. (1968) described also grey-blue and white varieties of chalcedony, which are, however, much rarer.

The mineralogical composition of the cherty rocks is dominated by chalcedony, often fibrous, with radial disposition, and opal, with subordinate amounts of epidote, barite, pyrite, marcasite and chalcopyrite, as well as manganite. The opal content increases from about two weight percent in the red varieties to 80–90 percent in the yellow-orange and grey-white varieties; opal is practically lacking in the light grey variety and forms the only mineral species in the blackish one. Rock fragments and some faunal remnants such as radiolaria, Ceritium, algae, leaves impressions etc are also present. Under the light microscope fine flakes of hematite and collomorph aggregates of goethite can also be observed.

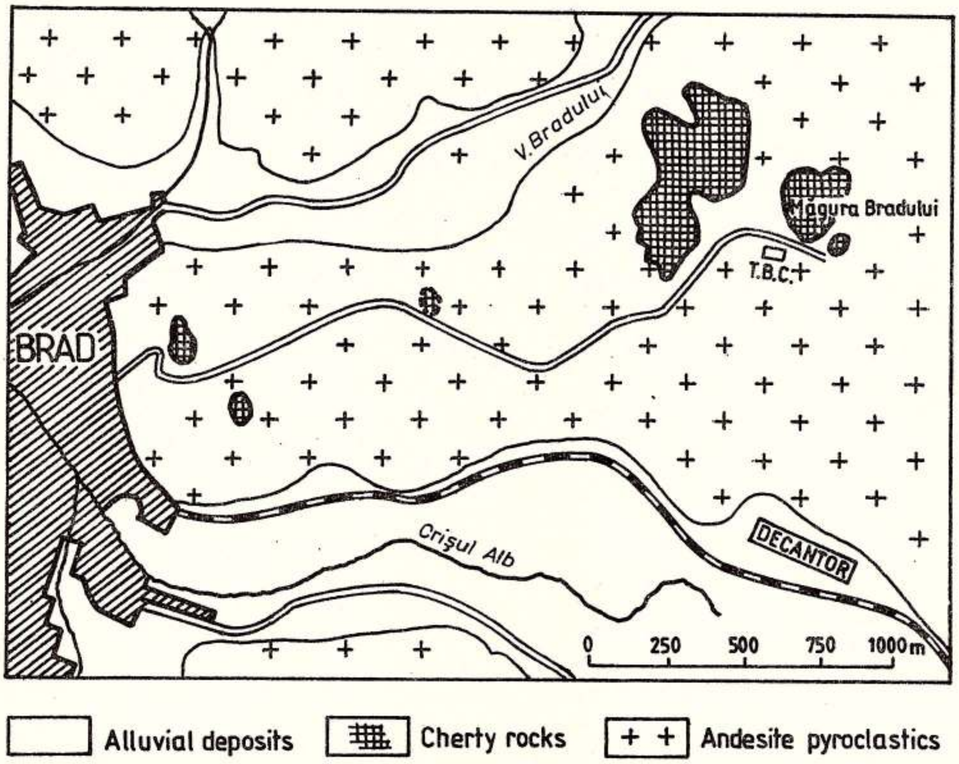


Fig. 4 – Geological sketch of the Brad area showing the distribution of the coloured chalcedony within the pyroclastic rocks of andesitic nature.
(acc. to Ghiţulescu et al., 1968)

The silica content varies between 78 and 94 % (Tab. 2).

Table 2
Chemical Composition of the Cherty Rocks from Brad (%)

	Red	Yelow-orange	Grey-white	Grey-blue	Grey	Dull
SiO_2	78–82	84–90	92–94	92.6	92	91
Al_2O_3	3	2.5	7	2.06	1.7	1.7
Fe_2O_3	13–16	10		4.09	5.3	5.29
CaO , MgO		0.1–0.2	0.3	0.25	0.3	0.39
Sb	0.1			>0.1	>0.1	
As	0.1			>0.1	>0.1	
S. gr.	2.29–2.38	2.5	2.49	2.58		2.62

Source: Ghiţulescu et al. (1968)

Ghiţulescu et al (1968) consider the origin of the silica-rich rocks to derive from a greyserian-like activity which furnished at least one million cubic metres of silica-rich solution linked to the final events of the Barza volcano.

Stop 2 – Zeolite-apophyllite-okenite assemblage in the Valea Arsului andesite quarry

The quarry is located some 6 km east of the Brad town on Valea Arsului (Burning Valley), in hornblende-pyroxene-bearing andesites of Sarmatian age, representing a neck intruding Mesozoic ophiolites and Neogene sedimentary deposits.

The andesite is generally fresh, massive and homogeneous, locally carrying some xenoliths of metamorphic rocks. The rock contains short veinlets or nests, sometimes also small geodes with zeolites, calcite, siderite, chlorite, epidote, okenite and apophyllite. The assemblage zeolites-okenite-apophyllite was more frequently found on the upper level of the quarry. At the present levels they have been more rarely encountered; the veinlets and the nests contain mostly zeolites (stilbite, chabasite, gyrolite and natrolite) as well as monominerallic aggregates of pale pink calcite.

Istrate (1980) and Istrate, Udubaşa (1981) gave a thorough description of the okenite and apophyllite, respectively. Isolated radial aggregates of okenite made up of white fibres were shown to grow on stilbite and/or apophyllite. The diameter of such aggregates may reach 1–2 cm. Beautiful samples are preseved in the National Museum of Geology, Bucharest. Euhedral, colourless and trauslucent crystals of apophyllite reaching 1 cm in size display two morphological types, i.e. (1) bipyramidal and (2) cube-octahedron-like individuals (Fig. 5)

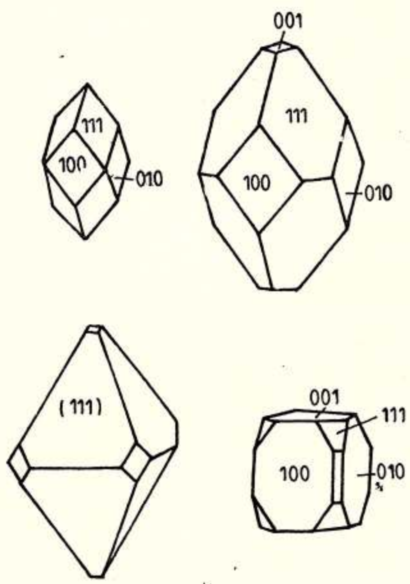


Fig. 5 – Morphology of the apophyllite crystals of the Valea Arsului quarry. (acc. to Istrate and Udubaşa, 1981)

The chemical composition of okenite and apophyllite is given in Table 3.

Table 3
Chemical Composition of Okenite and Apophyllite of Valea Arsului Quarry

	Okenite	Apophyllite
SiO_2	57.20	53.03
Al_2O_3	0.79	1.79
CaO	28.21	24.75
Na_2O		0.55
K_2O		3.70
F		
H_2O	13.79	15.62

Calculated formulae (Gh. Ilinca):

- okenite (10 oxygens): $Ca_{0.923}(Si_{1.749}Al_{0.028})O_{4.961}(OH)_{1.078}.H_2O$
- apophyllite (8 Si):$(K_{0.685}Na_{0.155})_{0.840}Ca_{3.840}Ca_{3.808}(Si_{7.694}Al_{0.306})_{8.0}O_{20.15}.OH.7.56H_2O$

The zeolites-dominated assemblage of this occurrence is presumed to have formed at temperatures of about 100–150^0 C under atmospheric pressure from low temperature solutions rich in volatiles (Istrate, Udubaşa, 1981), partly of residual character.

Stop 3 – "Gold-Museum" in Brad

The small Brad town has always been "the capital of gold" in the Metaliferi Mountains, being situated within the area with the richest and most productive gold deposits in the Carpathians. Brad was also the headquarters of the "Mica" Mining Society acting between the World Wars I and II. Beside the gold production furnished for centuries (the Mining Enterprise Barza is still operating) the Brad town posseses one of the "most precious museums" in Romania, i.e. the museum of gold samples from all the gold mines in the Metaliferi Mountains. The recorded setting up of museum goes back to 1912 but it seems that the collecting of gold samples began as early as 1896. Not only gold samples from the Brad area – as it was at the beginning of the collecting activity – but also from other ore deposits in Romania gradually entered the museum. There are also donated samples as well as samples obtained by exchanges with domestic and foreing museums. The museums still belongs to the Barza Mining Enterprize.

Over 2200 samples are contained by the museum, some 1000 of which are of gold; the remaining ones represent a systematic mineralogic collection with samples from different occurrences in Romania and in the world. In addition, the museum possesses also some archaeological pieces, old mining working tools as well as photographic records dating back to the beginning of the XX century.

The museum has 8 exhibiting rooms, most of them hosting an amazing number of gold samples of different size and forms. There are samples with needle-like, lamellar, moss-like gold or dendrites and even crystals of gold. Nice zoomorphic gold samples (lizards, ducks, pelicans, poppies, bird wings etc) and gold leaves and flowers, as well as nuggets are presented. In addition, most of the gold and silver tellurides are found here, among which those with nagyagite (Blättertellur) and sylvanite (Schrifterz) are outstanding samples.

The most intriguing and beautiful samples are those form the Valea Morii mine including threadlike gold with small crystals of calcite and quartz strung on its; there are also fine gold lamellae as well as gold-galena intergrowths. The famous sample with the gold crystal (about 1 cm in size) has been furnished by this marvellous mine too. Interesting are also the various associations of gold with barite, typical of the Brădişor mine.

The Musariu mine was and still is the king of gold mines in the Metaliferi Mountains. It produced the greast amounts of gold and furnished also beautiful gold samples. The animal-looking gold forms came from here. Very typical of the Musariu mine is the association of gold with calcite crystals (scalenohedra, rhombohedra), as well as the various intergrowths of gold with arsenic. The gold plate reminiscent of Romania's outline has been found in the Musariu mine.

Beside the systematic mineralogy comprising interesting samples of diamond (South Africa), sulphur (Italy), a big pyrite cube (10 cm in size) etc, the museum contains also a collection of agates from Romania, Australia and Brazil, samples of amber from the Baltic Sea coast and a special exhibition presenting many of the minerals having the type localities in the Metaliferi Mountains or in Romania, e.g. nagyagite, sylvanite, native tellurium, pseudobrookite, etc.

Stop 4 – Gold-Silver Telluride Ore Deposit of Săcărîmb

The classical epithermal Săcărîmb (formerly Nagyág) ore deposit lies in the south-eastern part of the Metaliferi Mountains (Siebenbürgisches Erzgebirge), some 20 km NE from Deva, the capital of the Hunedoara district.

The telluride-rich ore veins are located in a volcanic structure built up of hornblende-and pyroxene-bearing quartz-andesites of Sarmatian age. The rocks show a pervasive propylitic alteration and argillic zones directly connected to the vein walls. Locally developed silicification zones occur especially in the Neogene sedimentary rocks (sandstones and conglomerates). The vein area is relatively small (some 1000 sqm). The vertical development of the vein system is of about 600 m. Practically, all the major veins are contained by the central volcanic neck showing a gradual reduction of its diameter towards depth (Fig. 6). The garland-like distribution of the veins is somewhat asymmetrical as the eastern vein groups are more largely developed.

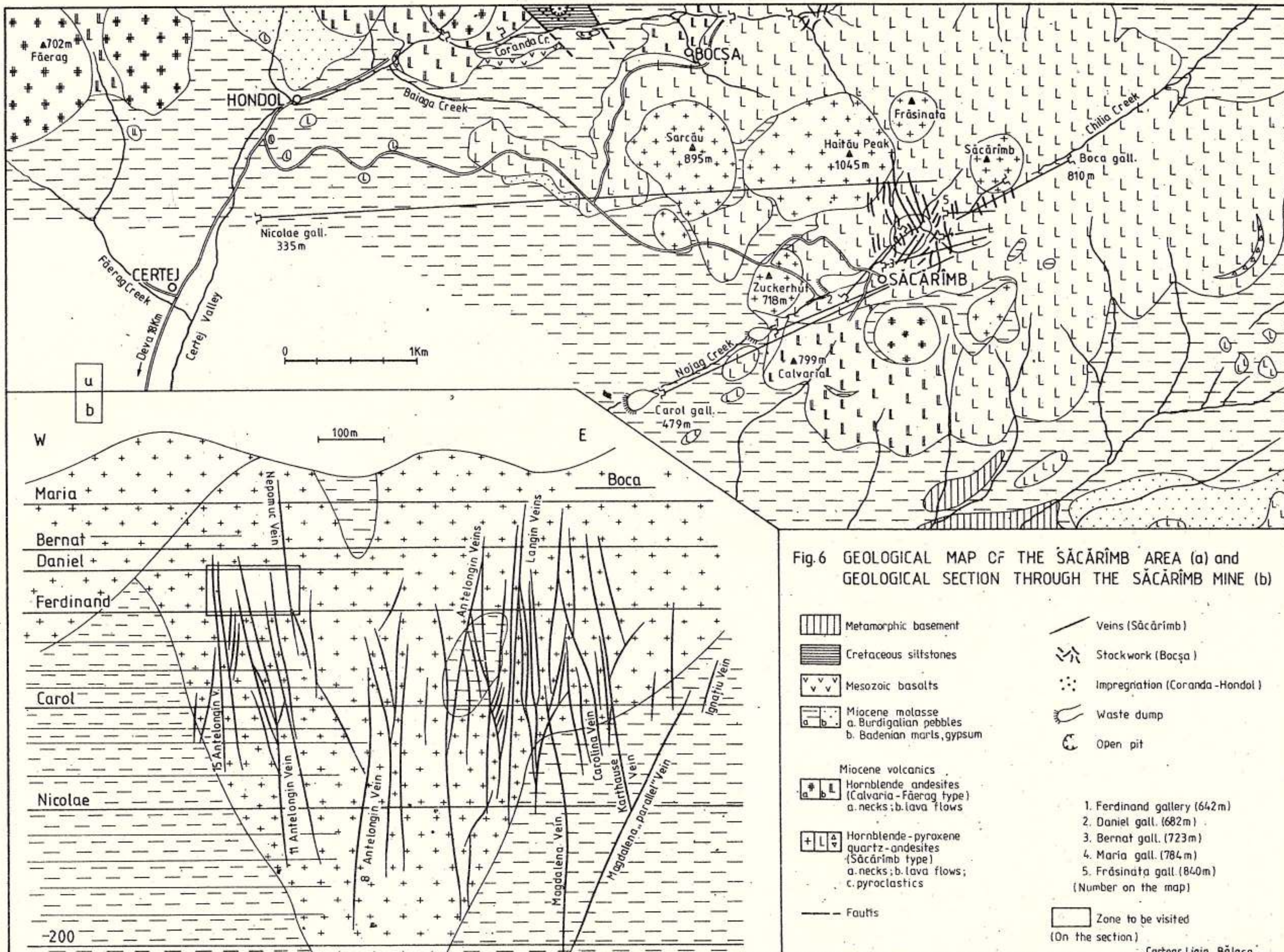


Fig. 6 GEOLOGICAL MAP OF THE SĂCĂRÎMB AREA (a) and GEOLOGICAL SECTION THROUGH THE SĂCĂRÎMB MINE (b)

Some 230 veins are known in the Săcărîmb area. Their number drastically diminishes towards depth. An average thickness of 0.3 m, locally reaching a maximum of about 2 m, has been estimated for the whole net of veins. Their length considerably varies, the most important ones being of 500–600 m.

A typical feature of the Săcărîmb ores is the development of the so-called "Glauch" veins, that is joint fillings consisting of very fine-grained, sometimes earthy material, reminiscent of fluidization products. Such veins are either gold-bearing or completely barren. The late formation of the Glauch veins by collecting material both from the country rocks and the ore veins may explain their random distribution and the contrasting precious metal contents.

Samples with gold-and silver-tellurides are now difficult to find in the slowly dying Săcărîmb mine. After nearly 250 years of continuous exploitation the Săcărîmb ores are ever poorer and large parts of the mine seem to be completely exhausted. However, still interesting metal contents do exist in the middle part of the mine.

Clay-, carbonate-, and quartz-rich vein filling can be seen in both horizons to be visited. Locally, sulphide rich pods mainly consisting of pyrite or alabandite with quartz are to be found. There are also pockets of massive alabandite showing large envelopes of white-pinkish fine grained aggregates of kutnohorite and rhodochrosite. Under the microscope the alabandite is fine-grained, massive, locally with numerous veinlets of rhodochrosite rimmed by filigree-like aggregates of pyrite and/or marcasite. Small grains of sphalerite, sometimes intimately intergrown with pyrrhotite and sphalerite-galena aggregates as macroinclusions in alabandite may be observed too.

Outstanding samples with tellurides from the Săcărîmb mine are hosted by some domestic museums, such as the Gold Museum in Brad, the mineralogical collections of the Universities of Bucharest and Cluj-Napoca and that of the Brukenthal Museum in Sibiu (Natural History Section) as well as the National Museum of Geology in Bucharest. Some samples do exist in the small minerals and rocks collection of the Coranda-Certej Mining Enterprise; such samples have been collected in recent years from different parts of the mine. Unfortunately, their number dramatically diminished in 1974 by the partial destroying of the host building provoked by a mud flood from the tailings ponds.

Nevertheless, samples with tellurides from the Săcărîmb mine may be found in many European museumms and they still furnish materials for further studies: The old samples are especially of great scientific value; on such samples some rare or new minerals have been lately identified, e.g. frohbergite, the first occurrence in Europe (Ramdohr and Udubaşa, 1973), krautite – a new mineral species (Fontan et al., 1975) as well as tellurantimony, the first occurrence in Romania (Popescu and Şimon, 1992).

The Săcărîmb ores are very rich in mineral species; more than 100 minerals have been described in the area, the most important being the gold-silver tellurides; some of them have their type locality at Săcărîmb, e. g. nagyagite, krennerite, petzite, stuetzite, muthmannite, as well as the hydrated manganese arseniate, the krautite. The Săcărîmb mine is still the sole occurrence of some other minerals in Romania, e.g. of plumbogumite, jordanite or in the Metaliferi Mountains, e.g. semseyite, erythrite, hoernesite etc. Some features of the Săcărîmb minerals are given in the Table 4, which includes also some historical data of mineralogical interest.

The distribution of minerals within the Săcărîmb mine was not uniform. Ghiţulescu and Socolescu (1941) gave a general picture of the main mineral assemblages in the different vein groups, which typically contain the following parageneses:

– quartz, rhodochrosite, nagyagite, with abundant common sulphides: Magdalena vein group (SE part of the mine);

– quartz, barite, rhodochrosite, sylvanite, krennerite, gold, common sulphides: Longin vein (NE part of the mine);

– calcite, petzite: Nepomuc vein group (SW part of the mine); alabandite was quite abundant in the Nepomuc veins too.

By far incomplete, such an attempt is somewhat reminiscent of Höfer's (1866) "ore formations", i.e. quartz-tellurium (Quartz-Tellur Formation), rhodochrosite-tellurium (Rothspäthige-Tellur Formation), and sulphides (Formation der Schwefelmetalle) for which, however, no definite spatial boundaries could be given. The failure of a generalized paragenetic succession is obviously related to a non-simultaneous opening of the vein fractures. Nevertheless, the common sulphides were earlier deposited as compared to the tellurides but the sulphosalts were later. Giuşcă (1935) gave the most interesting example of such a sequence, i.e. sphalerite-galena-nagyagite-altaite-bournonite-tetrahedrite. The same author remarked the general tendency of decreasing tellurium and of increasing silver contents of the mineral species as the deposition proceeds. Recurrences are also possible, as well as metasomatic reactions and/or decomposition processes. Such an example is given by Udubaşa (1986)

Table 4
Mineral Species so far Identified in the Săcărîmb Area

Mineral species or varieties	Remarks
Agalmatolithe	See talc
1. Alabandite	Quite abundant everywhere in the mine, but especially in the ores of Magdalena and Nepomuc veins. Locally well developed crystals showing (102), (101), (110) and (021) faces. Contains about 2.7 % Fe. The mineral has been considered as a "negative sign" with respect to the presence of tellurides (e.g. Helke, 1934), a fact not entirely true (see, for example, Udubaşa, 1986).
2. Allanite[1]	
3. Almandine	
4. Altaite	Small crystals up to 0.1 mm in size, fine inclusions in galena and rims around the nagyagite lamellae (Helke, 1934; Giuşcă, 1935). Replaces sylvanite (Giuşcă, 1935).
5. Alunogene (?)	Old references only.
Amethyst	Rarely found in association with stibnite.
6. Anatase[1]	
7. Andalusite[1]	
8. Andradite[1]	
9. Ankerite	
10. Apatite[1]	
11. Apophyllite	With laumontite, in altered andesites.
12. Aragonite	Old references (e.g. Hingenau, 1857)
13. Argentite	Associated with tetrahedrite.
14. Argentopyrite	Minute inclusions in iron-rich sphalerite (Helke, 1934).
15. Arsenic	Small crystals or kidney-like aggregates, associated with rhodochrosite and tellurides. Forms lamellar aggregates on gypsum (Semper, 1900) or globules on dolomite (Helke, 1937)
16. Arsenolite	Old references only.
17. Arsenopyrite	Rare; accidentally found in the upper parts of the mine (Frăsinata gallery) (Udubaşa, 1961, unpubl. data)
"Aurum galena"	See nagyagite.
18. Barite	Intergrown with needle-like stibnite, an assemblage considered "not friendly to the gold" ("Erzräuber") (Höfer, 1866)
19. Biotite	Rock-forming mineral; quite abundant in some xenoliths.
Blättertellur	See nagyagite
Bosjemanite	See pickeringite
20. Boulangerite	Fills the cracks in the quartz crystals (Helke, 1934)
21. Bournonite	Beautiful crystals up to 3 mm in size, locally pseudomorphs after nagyagite. About 30 crystallographic forms. Also twinned crystals, typically forming the so-called "Rädelerz" (Helke, 1934). As-bearing.
Bunsenin	See krennerite.

Table 4 – continued

Mineral species or varieties	Remarks
22. Calaverite	Quite rare, but forming beautiful crystals isometrically developed. Host of minute inclusions of frohbergite and pyrrhotite (Ramdohr and Udubaşa, 1973).
23. Calcite	Widespread. Locally pseudomorphs after quartz crystals (5–6 cm in length).
24. Cerussite	Crystals up to 4 mm in size, rich in forms.
25. Chalcocite (?)	
26. Chalcopyrite	Small amounts; pseudomorphs after nagyagite and sylvanite
27. Cinnabar	Old references only.
28. Coloradoite	Observed by Ramdohr in one of his polished sections at the Heidelberg University, confirming thus an older description of Borchert (Helke, 1934). New data: Popescu and Şimon (1992).
29. Copper	Lamellar, on quartz; "heavy mineral" too[1].
30. Cordierite	In xenoliths in andesites, with sillimanite.
31. Corundum	In xenoliths, with sillimanite and spinel
Desmine	= stilbite
32. Diaspor[1]	
33. Diopside[1]	
34. Dolomite	Old references e.g. Hingenau (1857); bears small spherules of native arsenic (Helke, 1934)
"Elasmose"	See nagyagite
35. Empressite	Rare; associated with gold
36. Epidote[1]	
37. Epistilbite	Fissure filling in andesites.
38. Erythrite	Old references; if real, it would be the sole occurrence in the Metaliferi Mountains.
39. Eucairite	Doubtful identification; the sole occurrence in Romania.
"Federerz"	See heteromorphite (Semper, 1900)
40. Freieslebenite	Old references; Groth claimed in 1878 to have found the mineral in a museum sample from the Collection of the Strasbourg University (Helke, 1934).
41. Freibergite	Term used for Ag-rich tetrahedrites, without analytical support.
42. Frohbergite	Minute inclusions in calaverite and sylvanite, with pyrrhotite (Ramdohr and Udubaşa, 1973).
43. Galena	Abundant, especially in the ores of the Longin vein group. It contains inclusions of bournonite, hessite and altaite.
Gelberz	Old name of krennerite (Karsten, 1810)
44. Goethite	Main component of the supergene "limonite"
45. Gold	Quite rare and in small amounts. Occurs in ores of the Longin veins group, with ankerite, calcite, tellurides; simultaneously formed with petzite; present also as a decomposition product of nagyagite (Udubaşa, 1986). Intergrown with tetrahedrite (Helke, 1934)
46. Gypsum	Quite frequent in the Carolina vein, on reddish calcite (Höfer, 1866).
47. Halloysite	
48. Hematite[1]	
49. Hemimorphite	Small, tabular crystals of yellow colour.

Table 4 – continued

Mineral species or varieties	Remarks
50. Hessite	Crystals in geodes, with quartz, petzite, nagyagite, rhodochrosite. Inclusions in galena, associated with petzite (Helke, 1934).
51. Heteromorphite	Described as "Federerz" by Semper (1900).
52. Hoernesite	Red crystals associated with nagyagite; the sole occurrence in the Metaliferi Mountains and the second one in Romania.
53. Hornblende[1]	Rock forming mineral; phenocrysts up to 2–3 cm in size in andesites.
54. Hypersthene[1]	
55. Illite	Polytype $2M_1$, in argillitic zones near veins (Udubaşa et al., 1982, unpubl. data).
56. Ilmenite[1]	
57. Jamesonite	Rare; needle-like aggregates, especially in ores of the Carolina veins (Helke, 1934).
58. Jordanite	The sole, although doubtful, occurrence in Romania. Mentioned by Helke (1934).
Kattunerz	Nagyagite/rhodochrosite intergrowths (cotton-ore) (Semper, 1900).
Keramolite	Old name, partly defining the pickeringite.
Kottonerz	Krennerite, acc. to Binder (1958), probably intergrown with carbonates as in the case of nagyagite.
59. KRAUTITE	Type locality; discovered on museum samples from Săcărîmb and Cavnic (Fontan et al., 1975), being associated with rhodochrosite and nagyagite.
60. KRENNERITE	Type locality. Discovered by Krenner (1877) and named "Bunsenin" and simultaneously by Rath (1878) giving it the name krennerite. Abundant in the Longin vein group. Crystals very rich in forms (over 25), up to 2 mm in size. Named also "Gelberz", "Weiβtellur" and "Kottonerz" (see Binder, 1958)
61. Kutnohorite	First identified by M. Bălan (1982, unpubl. data) on material found on the waste dump of the Bernat gallery; coatings on alabandite. Similar intergrowths were found in ores of the Nepomuc veins (gallery to be visited, altitude 682 m) by one of the authors (G.U.).
62. Kyanite[1]	
63. Laumontite	Cavity filling in andesites, with apophyllite.
"Longinite"	Sylvanite (Höfer, 1866), derived from "Longin vein", where the mineral was abundant.
64. Maghemite	In andesites, typically developed on magnetite, in lava flows (Udubaşa, 1982, unpubl. data)
65. Magnetite[1]	
66. Malachite	
"Manganocalcite"	
67. Marcasite	Pseudomorphs on calcite crystals; also globular aggregates with lamellar-fibrous structure up to 2 cm in diameter; formd on thin, isolated veins, in the Maria gallery.
68. Melanterite	Mostly efflorescences on the timbering woods in old galleries.
69. Moissanite[1]	

Table 4 – continued

Mineral species or varieties	Remarks
70. MUTHMANNITE	Type locality. First description by Zambonini (1911) Rare. Intergrown with krennerite.
Müllerin	Old name of krennerite (Beudant, 1832)
71. NAGYAGITE	Type locality. The first record on a presumably new mineral goes back to 1772 as Born and Scapoli have described "aurum galena". Further names: "elasmose" (Beudant, 1832) "Blättererz" or "Blättertellur" (Karsten, 1800); the present name was given by Haidinger (1845). Forms lamellar aggregates, sometimes well developed crystals in geodes, with quartz, rhodochrosite, gold, sylvanite, sphalerite. The nagyagite lamellae show complex replacement or decomposition structures which begin with altaite rims, to which petzite, hessite, krennerite and gold finally add (Udubaşa, 1986). Optically, the nagyagite show inhomogeneities, taken as varieties (too or even three; see Helke, 1934; Giuşcă, 1935), which are, however, rare.
72. Orpiment	Small crystals, associated with realgar, calcite, sphalerite and quartz.
73. PETZITE	Type locality. First description by Haidinger (1842, 1845) in ores from the Nepomuc vein group. Helke (1834) observed several varieties of the mineral. New data (reflectivity, microprobe analyses) by Popescu and Şimon (1992). Old name: "Tellursilber".
74. Pharmacosiderite	
75. Pickeringite	Supergene mineral, described early either as "keramohalite" or "bosjemanite".
76. Plagionite	Rare. Helke (1934)
77. Plumbogumite.	Supergene, with cerussite.
78. Proustite	Microscopic grains (Tokody, 1030)
79. Pyrargirite	
80. Pyrite	Frequently found but in small amounts; crystals are rare, mostly {210}. Locally, framboidal aggregates of pyrite are present in mineralized sedimentary rocks.
81. Pyrolusite	
82. Pyrophyllite	Old references only.
83. Pyrrhotite	Rare. Contradictory old data as concerns its frequency and gold content (see Helke, 1934). More recently found as inclusions in tellurides (calaverite, sylvanite)(Ramdohr and Udubaşa, 1973) or associated with sphalerite, included in alabandite.
84. Quartz	Ubiquitous. Locally, crystals of normal habit up to 5–6 cm in size; pseudomorphs of calcite after quartz. Fine grained (Hornstein) as a constituent of the auriferous "Glauch" veins; very rarely – the pink variety (see amethyst). Preferred by sylvanite.
85. Realgar	Crystals up to 25 mm in size, with ankerite, barite, and quartz.
86. Rhodochrosite	Abundant, sometimes intergrown with kutnohorite, formed at the expense of alabandite; intergrown with nagyagite ("Kattunerz") or krennerite ("Kottonerz"). Pseudomorphs after barite. Crystals in vugs or kidney-like aggregates.
87. Rhodonite(?)	Doubtful, old references.
88. Rutile[1]	

Table 4 – continued

Mineral species or varieties	Remarks
89. Semseyite	Fine inclusions in galena (Helke, 1934). The sole occurrence in the Metaliferi Mountains.
90. Siderite	
91. Sillimanite	In xenoliths in andesites, with corundum and spinel.
92. Silver	Needle-and moss-like forms, developed on nagyagite crystals.
93. Skorodite	
94. Skutterudite	Described as smaltite; with arsenic and galena.
95. Smithsonite	
96. Sphalerite	Iron-poor, locally with two colour varieties, i.e. light yellow (0.31 wt - % Fe) and yellow-brown (3.0 wt - % Fe) showing also different sulphur isotopic composition, i.e. δ^{34}S of +0.25 and +4.43 ‰, respectively (Udubaşa, 1986). Locally blackish crystals. Compact aggregates. Helke (1934) observed also nearly colourless sphalerite crystals with brownish rims. The "antipathy" sphalerite/alabandite, noted in old references, is not entirely true.
97. Spinel	In xenoliths in andesites, with corundum and sillimanite. Also found in heavy mineral concentrates by Bălan (1982, unpubl. data).
98. Sillimanite[1]	
99. Stibiconite	
100. Stibnite	Rare. Found in ores of the Carolina and Longin veins, with rhodochrosite and amethyst, more rarely with barite. Crystallographic study by Tokody (1939).
101. Stilbite	Fissure filling in andesites.
102. STUETZITE	Type locality. First description by Schrauf (1878) on an old sample ,from the collection of the Vienna University. New data (reflectivity, microprobe analyses) by Popescu and Şimon (1992).
103. Sulphur	In geodes, with alabandite (Höfer, 1866) or with siderite and realgar (Hingenau, 1857).
104. Sylvanite	Săcărîmb is not the type locality of the mineral (see Udubaşa et al., 1992). Quite abundant in ores of the Longin vein group. Graphic intergrowth with hessite; associated with sphalerite, altaite, alabandite, and krennerite; sometimes with dolomite (Helke, 1934); preferred association with quartz, as against the nagyagite-rhodochrosite association (Höfer, 1866). Lamellar crystals, often twinned. Old names: "Schriftgold" (Born, 1790), "Schrifterz" (Esmark, 1798), "Schrifttelur" (Hausmann, 1813).
105. Talc (?)	Doubtful, old references ("agalmatolithe" of Hingenau, 1857).
106. Tellurantimony	Recently identified by Popescu and Şimon (1992); first occurrence in Romania.
107. Tellurite	
108. Tellurium	Săcărîmb is not the type locally of native tellurium. Controversial views as concerns the type locality (either Săcărîmb or Faţa Băii, in Romania; Börszöny in Hungary also given). Careful examination of old records made by Binder (1958) undoubtedly shows that the type locality of the native tellurium is Faţa Băii (old name Facebánya), where it was quite abundantly found, especially in

Table 4 – continued

Mineral species or varieties	Remarks
	the Maria Hülf gallery. We dare say that the enigmatical "Spiessglanzkönig" from this gallery, widely discussed in 1783 by Born, Müller von Reichenstein – the discoverer of tellurium, and Ruprecht, was in fact native tellurium, secondarily formed on tellurides. At Săcărîmb tellurium was found especially in ores of the Carolina vein. Whitish prisms up to 3x1 cm in size, associated with alabandite, nagyagite, rhodochrosite etc. Forms microscopic inclusions in petzite and hessite (Giuşcă, 1936).
Tellursilber	Old name of petzite.
109. Tetrahedrite	Silver-bearing (freibergite, acc. to Höfer, 1866). Mainly in ores of the Longin vein group. Forms inclusions in pyrite. Replaces krennerite (Giuşcă, 1935). Intergrown with sylvanite and krennerite (Helke, 1934).
110. Titanite[1]	
111. Valentinite	
112. Vivianite	Earthy. Only old references (e.g. Hingenau, 1857)
113. Wad	Described as asbolane, associated with rhodochrosite.
"Weisstellur"	Old name of krennerite (Petz, 1842).
114. Wurtzite	Pseudomorphs of sphalerite after wurtzite (Helke, 1934), with inherited fibrous structure and hexagonal outline.
115. Xanthoconite	Tokody (1930)
116. Zircon[1]	

The list is based on the data of Helke (1934), Giuşcă (1935, 1936), Palache et al. (1961), Rădulescu and Dimitrescu (1966), Ianovici et al. (1969), Udubaşa et al. (1992), with supplementary data from other sources as showed in the table.

[1] Minerals found by M. Bălan (1982, 1984, unpubl. data) in heavy mineral concentrates collected from alluvial and elluvial deposits in the Săcărîmb area.

Capitalized: minerals whose type locality is Săcărîmb.

in the case of nagyagite; its decomposition commences with the development of the fine altaite rims around the nagyagite lamellae; further reactions result in fine intergrowths of altaite, petzite, hessite, krennerite and gold, which may completely replace the nagyagite lamellae.

The nagyagite is the most complex mineral species formed in the Săcărîmb ores. Chemical analyses of the mineral are numerous, among which those made by Giuşcă seem to be the most adequate. Stumpfl (1970) noted that "the agreement between a "classical" chemical analysis and electron probe analysis of the Nagyag material is remarkable" (p. 814). However, Stumpfl found no chemical variation across nagyagite crystals as Giuşcă (1937) and Ramdohr (in some polished sections of his collection at the Heidelberg University) have noted. The structure of nagyagite is still unsolved, as is its synthesis.

The formula given by Stumpfl as being related to a Te⇌S substitution seems not to be better substantiated as that given by other authors (e.g. Giuşcă), in which the dominant substitution is Te⇌Sb. In 13 chemical analyses of nagyagite collected by Rădulescu and Dimitrescu (1966) the sulphur content has a narrower variation interval (9.10–11.90 wt.-%) as compared with the contents of Sb (6.05–9.07) and Te (11.55–29.88) which, in addition, seem to compensate each other. From the data given in Table 5 it results that the most probable ideal formula of nagyagite seems to be the following:

$$AuPb_7(Te_3Sb_2)_5S_9$$

Table 5
Nagyagite compositions and formullae

	Au	Pb	Te	Sb	S
1.	7.65	56.36	16.24	8.16	11.38
2.	7.6	57.6	16.4	7.4	10.0

(1) Giuşcă (1937) – wet chemical analysis
(2) Stumpfl (1970) – electron probe analysis
Proposed formullae:
(1) $AuPb_7(Te_{3.28}Sb_{1.72})_5S_{9.13}$ Gh. Ilinca, IGG Bucharest
(2) $Au_{0.97}Pb_7(Te_{3.24}Sb_{1.53})_{4.77}S_{7.85}$ Gh. Ilinca, IGG Bucharest
(3) $Pb_5Au_{0.66}Sb_{1.06}(Te_{2.23}S_{5.40})_{7.63}$ E. Stumpfl (1970)

Some historical data on the Săcărîmb mine

The first mining working undertaken in the Săcărîmb area is the Maria gallery (altitude 784 m), probably in 1746. There follows a nearly 250 years period of continuous exploitation of the mine. In the meantime more than 300 km of exploratory, extraction and stope preparation mining workings have been done in the area. The main horizons of the mine include a vertical interval of about 450 m and a time interval of about 150 years, i.e.:

Maria horizon (784 m) (1746)
Bernat horizon (723 m) (1757)
Josephi horizon (637 m) (1765) lately named Ferdinand
Franz horizon (494 m) (1824) lately named Carol
Franz Joseph horizon (335 m) (1898) lately named Nicolae

Numerous intermediate horizons have been also done to open the richest parts of the veins, as well as another five horizons under the "Erbstollen" Nicolae, i.e. from –40 m to –200 m and the uppermost horizon, Frăsinata (altitude 840 m). In 1940 the image of the horizontal workings was still an amazingly dense net (Fig. 7). At the beginning the gold tenor was of about 80–100 g/t and it gradually diminished down to 2–3 g/t in the present-day mine workings.

During the period 1748–1930 some 50,561 kg of Au+Ag were produced, giving an annual production of 276 kg of precious metals (Helke, 1934). Afterwards the production was of about 300 kg Au and 500 kg Ag annually (Ghiţulescu and Socolescu, 1941). After the World War II the production data became secret. If an average annual value of 500 kg Au+Ag would be estimated for the period 1941–1991, the total amount of gold and silver extracted from the Săcărîmb veins would be of some 85,000 kg.

The precious metal contents continuously decreased towards depth. In the deepest parts of the mine (under the Nicolae horizon) the veins have had a reduced thickness and have contained almost only common sulphides with some gold included in them. The tellurium content in galena was only of 200–400 ppm. Finally, even the base metal contents became unsatisfactory and the lower part of the mine was closed. The mining activity continued either in exploiting the old waste fills (contained locally up to 2–3 g/t Au and more) or in searching the ending parts of the veins, the zones between the main veins or those between the main horizons (such as the zones to be visited).

About 150 published papers do exist on the Săcărîmb area. The history of the Săcărîmb gold-telluride ore deposit began in 1744 or 1745 when a Romanian countryman showed to Ignaz von Born an ore sample which has proved to be very rich in gold (Schmidt, 1897). After this somewhat casual find, the Săcărîmb mine furnished materials for many mineralogical studies, economic geology, mining geology and petrography. A short chronological selection is given below (Table 6) including especially the main "events" of the mineralogical knowledge. Săcărîmb/Nagyag is the type locality of many minerals.

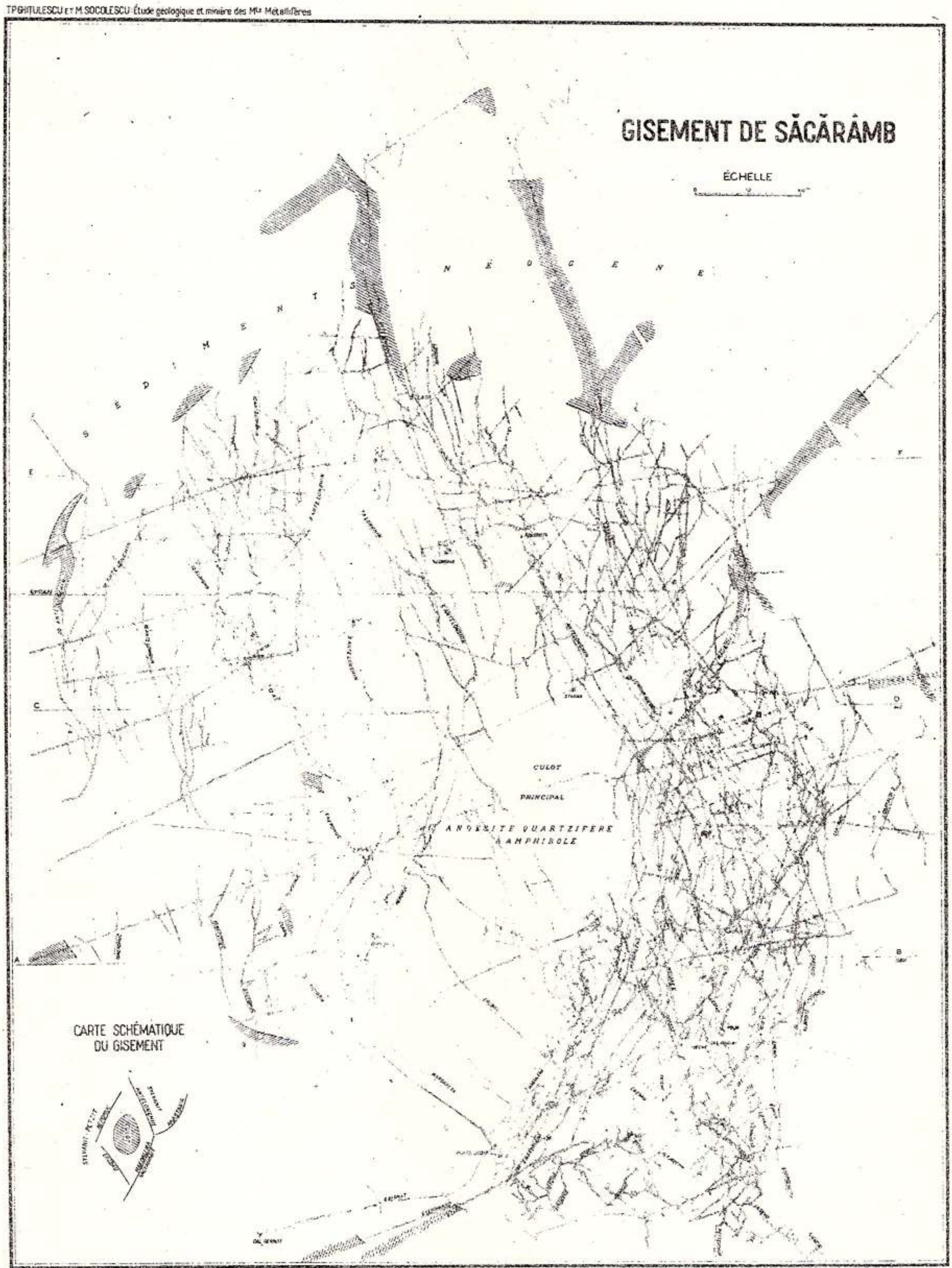


Fig. 7 – Underground mining workings in the Săcărîmb mine.
(acc. to Ghiţulescu and Socolescu, 1941)

Table 6

Historical Development of the Mineralogical Knowledge of the Săcărîmb ore deposit

1717	Köleseri's "Auraria Romano-Dacica" is probably one of the first assessments of the Transylvanian gold.
1744–1745.	– Born's chance to receive a sample of gold-rich ore which contained the "future nagyagite".
1772	Born and Scapoli named the mineral "aurum galena"
1783	Hacquet: first crystallographic record of the Săcărîmb gold (Mineralogische Rhapsodien"). Also the first report on the gold in the area by Müller von Reichenstein.
1800	Beudant: a further name of nygyagite: "elasmose".
1803	Stütz: systematic presentation of many minerals.
1832	Karsten gave the future nagyagite the name "Blättererz".
1842, 1845	Haidinger gave the name nagyagite; first description of petzite, previously described by Petz as "Tellursilber".
1857	Hingenau: new mineral data
1866	Höfer: further mineralogical data
1877	Krenner in Budapest and von Rath in Bonn simultaneously described a new mineral, named by Krenner "Bunsenin". Neatly and frankly, G. von Rath gave the mineral the name "krennerite". Previously used names: Gelberz, Weisstellur, Müllerin, Kottonerz.
1878	Schrauf: detailed crystallographic data on nagyagite; first description of stuetzite; the latter has been discredited by Thompson in 1951, but lately redefined.
1885	Sipoecz: chemical analyses of nagyagite
1887	Inkey: first geological monography of the area, with many data on the minerals.
1894	Vrba: crystallographic study of sylvanite (28 forms)
1897	Přivoznik: chemical analyses of nagyagite.
1911	Haidinger: first description of muthmannite. Thompson (1949) failed to synthesize muthmannite and considered it as dubtful species. Later data showed that muthmannite is, however, a valid mineral species.
1924	Boldirew: chemical analyses of nagyagite
1930	Tokody: description of xanthoconite and proustite
1934	Helke: first modern ore microscopy study
1935	Gossner: structural data on nagyagite (tetragonal symmetry).
1935, 1936, 1937	Giuşcă: many ore microscopical and chemical data on tellurides; his nagyagite formula $AuPb_7(Te,Sb)_5S_9$ seems to be the most appropiate.
1941	Ghiţulescu and Socolescu – first monography of the Metaliferi Mts; many data on Săcărîmb.
1958	Binder: Historical data on mineralogical discoveries in Transylvania, in the Săcărîmb area included.
1970	Stumpfl: microprobe analyses of nagyagite; his formula implies substitution Te⇌S rather than Te⇌Sb, as Giuşcă proposed.
1973	Ramdohr and Udubaşa: frohbergite identification.
1975	Fontan, Orliac, Permingeat: discovery of krautite.
1986	Udubaşa: step-by-step decomposition of nagyagite.
1992	Popescu and Şimon: record of coloradoite and tellurantimony.

In addition to this, it is worth of mention that during the past century the Săcărîmb mine was a practical training site for young mining engineers from many European countries. The mining school of Săcărîmb was the best (at least) in Transylvania; in 1839 J.Grimm wrote a practical guide for miners, especially for the beginners ("Praktische Anleitung zur Bergbaukunde für den Siebenbürgen Bergmann, insbesondere für die Zöglinge der Nagyager Bergschule" - Wien, 1839).

Stop 5 – **Pseudobrookite occurrence at Uroiu (type locality)**

The type locality of pseudobrookite is an isolated hill called Măgura Uroiului (or Uroiu, as is the name of a small village at the Northern slope of the hill), situated some 3 km NE of the city of Simeria (old name Piski). At sunset the hill has a golden appearance from which its old, Hungarian-German composite name, Aranyer Berg ("the Golden Hill") derived. Although it belongs to the Metaliferi Mountains and it is situated not far from the "Golden Quadrangle" the Uroiu Hill did not produce any gold. However, it became famous in 1878 as the late Professor Anton Koch from the Cluj University discovered here the new mineral called pseudobrookite.

The hill itself resembles a volcanic neck, but it is constituted by some superposed lava flows consisting of pyroxene andesites (Fig. 8). An Upper Badenian age of the rocks is presumed; nevertheless they may be younger as well, a fact explaining the uniqueness of the chemical composition and general appearance. No similar rocks are known in the Metaliferi Mountains yet.

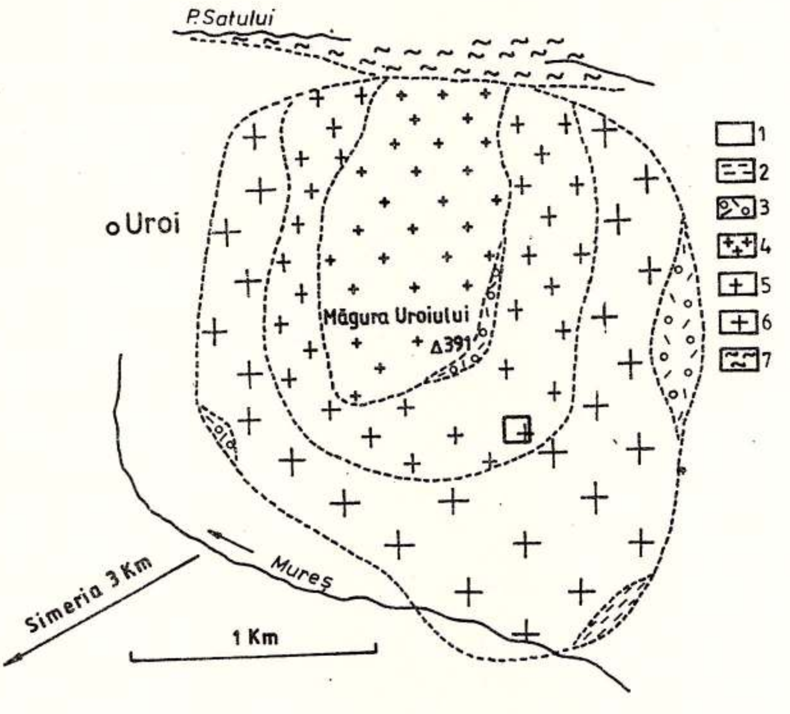


Fig. 8 – Geological map of the Uroiu area (acc. to Berbeleac, 1962). 1. Quaternary; 2. Sarmatian sedimentary deposits; 3. Volcanic pyroclastics; 4–6. the third, second and first lava flows, respectively; 7. Low-grade metamorphic rocks.
Quandrangle: area to be visited, where pseudobrookite may be found in the red coloured andesites.

Berbeleac (1962) recognized three successive lava flows of quite differently featured rocks. The first flow is represented by massive, fine-grained grey andesites. The second one contains andesites with a trachytic structure and generally of brick-red colour, being the best exposed rocks sequence. The third lava flow is only 2–3 m thick, underlying a thin level of pyroclastics.

Small spherical or tubular orifices filled with cracked, transparent quartz are to be noticed in the andesites.

Xenoliths of gabbroic, dioritic or metamorphic rocks ranging in size from one to several cm are common in all types of andesites. Contact minerals such as anorthite, garnet, cordierite, epidote etc have been described to occur as rims around the xenoliths (Laţiu, 1937).

The primary mineral assemblages of andesites consist of andesine, augite, hypersthene, biotite, apatite, magnetite and hematite. Laţiu (1937) gave the following mineral composition of the Uroiu andesites (average values of microscopic measurements with the integrating stage) (Tab. 7).

Table 7
Mineral composition of the Uroiu andesites

Plagioclase feldspars	54.81 %
Pyroxenes	22.48 %
Opaque minerals*	21.68 %
Apatite	1.09 %

* of which 2.18 % magnetite

It is still unclear if pseudobrookite abundantly occurring in the brick-red andesites represents only a late overprint (pneumatolytic and/or postvulcanic-fumarolian) or has formed in highly oxidized portion of andesitic magma. The abundant pseudobrookite formation around and within xenoliths may substantiate the latter hypothesis. Anyhow, chemical analyses of grey and brick-red andesite varieties show some differences (Tab. 8) especially concerning the bivalent iron which is completely lacking in the brick-red andesites. Such rocks show under reflected light microscope numerous grains or flakes of hematite (and hydrohematite, sometimes pseudobrookite, too) pervasively developed both in the matrix and the phenocrysts.

Table 8
Chemical analyses of Uroiu andesites (%)

	Grey variety	Brick-red variety
SiO_2	55.35	57.69
TiO_2	1.14	2.02
Al_2O_3	15.30	15.60
Fe_2O_3	3.13	5.90
FeO	1.61	
MnO	0.08	0.11
MgO	3.67	4.53
CaO	5.70	6.61
K_2O	4.15	3.69
Na_2O	4.02	3.80
P_2O_5	0.67	0.16
H_2O	0.81	0.19
S	0.07	0.05
Fe	0.06	0.04
Σ	99.76	100.39

The pseudobrookite has been observed only in the brick-red andesites either around the xenoliths (associated with hydrogrossular/hibschite, tridymite, apatite, hypersthene, titanite) or on fissures with locally developed elongated geodes (associated with hematite, hypersthene, rutile etc). Apatite and titanite are rare, whereas the other minerals can be often found.

The hypersthene is present mostly as small (0.5–1 mm) elongated crystals of reddish colour, locally accompanying the pseudobrookite. Its special appearance led Krenner to consider it as a new species ("szaboite") which is in fact only altered (oxidized) hypersthene. If fresh the hypersthene crystals are transparent, yellowish-brown in colour and exibit longitudinal striae. The amphibole forms needle-like crystals up to 1 mm in size, of red-orange colour. Small aggregates of tridymite and of hibschite may be formed especially near the xenoliths. Hematite is everywhere present in the rocks and together with pseudobrookite and hypersthene form the cavities fillings in the brick-red andesites.

Pseudobrookite occurs either as a component of the transformation assemblages developed around the xenoliths or as thin tabular crystals, slightly elongated in the direction of c axis. The colour is black, with metallic luster. Crystallographic studies of Koch (1878), von Rath (1880), Traube (1892), Laţiu (1937) revealed the presence of the following forms of Uroiu occurrences:

a {100} – brachypinacoid (dominant), often with longitudinal striae

b {010} – pinacoid
l {110}, m {120} – vertical prisms
d {101}, e {103} – horizontal prisms
p {133}, o {772} – rhombic bipyramids
Rare forms: {001}, {011}, {123} and {720}

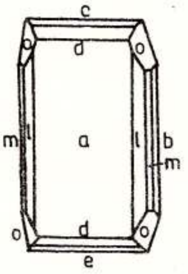


Fig. 9 – Typical pseudobrookite crystal of Uroiu (after Traube, 1892).

The most typical crystals are given in Fig. 9. The main components as revealed by wet chemical analyses show quite wide variations, e.g. TiO_2 41.27–52.74, Fe_2O_3 42.29–58.20, MgO 0–4.28.

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- servicii de consultanţă.

Departamentul învăţămînt:
- cursuri complete pentru începători şi avansaţi AutoCAD, PADS 2000, OrCAD, C++, sistem de operare în MS-DOS.

Departamentul comercial:
- calculatoare tip IBM PC, testate şi asamblate în SUA;
- imprimante şi accesorii pentru calculatoare;
- benzi magnetice, pile de discuri magnetice, inele de stocare, piese de schimb şi accesorii de producţie americană pentru echipamente periferice;
- dealer autorizat al firmei VEMCO-MULTI-SCANN SUA, specializată în producţia de scannere şi plottere;
- dealer autorizat al firmei ERGOTECH SUA, specializată în producţia de ecrane de protecţie.