SESIUNEA ŞTIINŢIFICĂ ANUALĂ
,, ION POPESCU VOITEŞTI ''

Departamentul de Geologie al Universității Babeș-Bolyai

Cluj-Napoca, 15 decembrie 2017

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Sorin Filipescu
Raluca Bindiu-Haitonic
Dan Mircea Tămaș

Presa Universitară Clujeană

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Preliminary Mineralogical Data on Bi- and Sn-minerals from Băița Bihor Ore Deposit, North Apuseni Mountains, Romania

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Key words: kesterite, wittichenite, sulfosalts, SEM, skarn, Băița Bihor, Apuseni Mountains

Introduction

The Băița Bihor ore deposit is known for several centuries as an important mining center in the northern part of the Apuseni Mountains, NW Romania. It represents in fact the largest ore deposit from the so-called Bihor metallogenetic district (Vlad, 1993). Băița Bihor is a polymetallic ore deposit (Cu, Mo, W, Bi etc.) related to distal skarns associated to Laramian magmatism (Stoicovici & Stoici, 1970) and its genesis was controlled especially by regional and local structural setting, *i.e.* thrust planes and faults intersections (Cioflică et al., 1974).

Geographically, Băița Bihor ore deposit is located in the north-western part of Bihor Mountains, at 3.5 km ENE of Băița village, which is mentioned in old documents by its Hungarian name, Rézbánya.

According to Stoici (1974) the basement of Băița Bihor perimeter (Fig. 1) consists of Bihor Unit, which is composed of Jurassic - Lower Cretaceous detritic and calcareous formations. This sedimentary basement is thrusted by Codru Unit which comprises a complete Triassic sequence composed of sandstones, limestones and dolomites (Bordea et al., 1975). The Codru Unit is at its turn unconformably overlain by Permian (Lower Carboniferous?) - Lower Triassic detritic sedimentary rocks of Arieșeni Nappe (Bleahu, 1963).

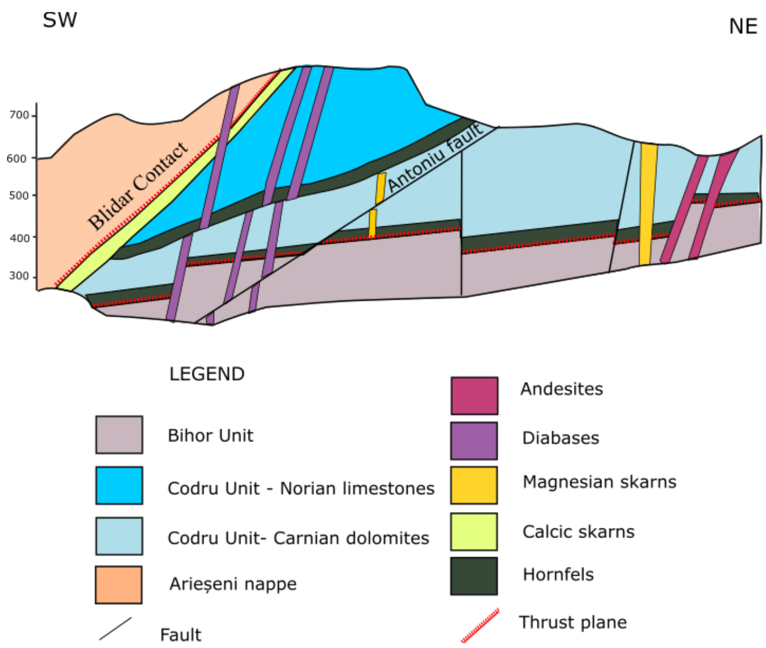

Fig. 1. Simplified geological cross-section through Băița Bihor perimeter (Stoici, 1974).

The sedimentary sequences of the aforementioned tectonic units were affected by the Late Cretaceous magmatism responsible for the emplacement of a deep-seated pluton with a composition ranging from granite to granodiorite and diorite (Stoicovici & Stoici, 1970), and several basic to intermediate composition dykes. Thereby, the set up of thermic metamorphism (hornfels), metasomatism (skarns) and metallogenesis (ore bodies) occurred distal to the Laramian pluton (Cioflică et al., 1974).

The thrust plane between the Permian sedimentary rock series of Arieșeni Nappe and the Triassic calcareous sequence of Codru Unit, known as Blidar Contact, played a major role in the ore deposit formation and it was interpreted as the main discharge zone of the post-magmatic mineralizing fluids (Stoici, 1974). Blidar Contact, together with other tectonic structures and prominent faults represented favorable sites that focused the mineralizations as well. As such, the plane representing the juxtaposition of Codru Unit over Bihor Unit is marked by the presence of hornfels and it was considered so far the lower limit of the ore bodies (Stoici, 1983).

The metasomatic interaction among the sedimentary carbonatic rocks and the Laramian pluton/fluids generated calcic to magnesian skarn bodies (Stoici & Vlad, 1991). The associated ore bodies have usually tabular and columnar (breccia pipe) morphologies (Cioflică et al., 1977). The pipe-like ore bodies, *e.g.* Baia Roșie, Antoniu, etc. (Fig. 2) developed vertically along the intersection zones of faults, while the tabular ore bodies are located along the thrust zones of the tectonic units.

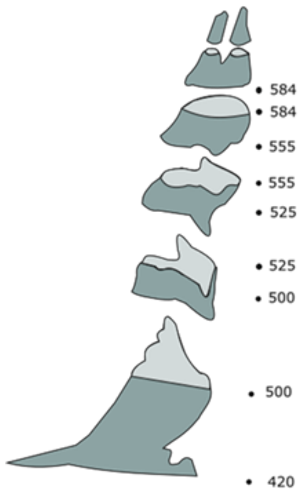

Fig. 2. Pipe-like morphology of Antoniu ore body from Băița Bihor ore deposit (redrawn after Cioflică et. al., 1977). Left of the drawing are listed the elevations in meters ASL.

The mineralizations related to the skarns from Băița Bihor are complex, with various metals concentrated within the ore, *e.g.* Mo, Bi, W, Pb, Cu, B ± Au, Ag, Te, Fe (Stoici, 1983). The age of the ore deposition was established at about 80 Ma by Zimmerman et al. (2008).

Băița Bihor ore deposit is well-known for its mineralogical variety, as for example as type locality of several mineral species, *i.e.* makovickyite (Žák et al., 1994), cuproneyite (Ilinca et al, 2010), and most recently, gratianite (Ciobanu et al., 2014).

The Băița-Bihor ore-deposit is located in the northernmost part of the Banatitic Magmatic and Metallogenetic Belt, which is characterized by the presence of Au-rich ores and a significant endowment in trace elements, especially Bi (Cook et al., 2002). It is well known the fact that the association of Bi-sulfosalts and (sulfo)-tellurides may indicate a possible Au-enrichment in skarns (Meinert, 2000). The same is particularly true for the skarn deposit from Băița-Bihor, but despite this evidence, the deposit has not been exploited primarily for Au so far.

Material and Methods

Several ore and rock samples collected within the underground mining works from the level XVIII were investigated. Special attention was given to the ore samples from the lower part of Antoniu ore body and its apophysis Antoniu 1N (both at an elevation of 227m ASL), collected below the contact between Codru and Bihor units. Furthermore, a series of ore samples from Blidar Contact have also been studied. These samples belong to the "Valeriu Lucca" Ore Deposit Collection, Department of Geology, Babeş-Bolyai University, Cluj-Napoca and they were collected by Professor Ioan Mârza in 1971. Macroscopically, all the studied ore samples consist mostly of massive bornite.

The macroscopic observations allowed us to select the most representative ore samples for the subsequent optic microscopic study. Standard polished sections were manufactured and studied at a Nikon Eclipse LV100N POL diascopic/episcopic illumination polarizing microscope from "*Géosciences Environnement Toulouse - Observatoire Midi-Pyrénées*" (GET Laboratory), Toulouse, France. The optical microscopy study allowed us to obtain preliminary mineralogical data. All identified and unidentified minerals by the means of their optical properties were documented by microphotographs showing also the relationships among different mineral species.

Several ore minerals still remained unidentified after the optical microscopy study and consequently they were further investigated by scanning electron microscopy (SEM). Thereby, two ore samples were studied at a JSM-6360 scanning electron microscope, using a 20 kV voltage from GET Laboratory, Toulouse, France. Back-scattered electrons images of several minerals, the spectra of the studied minerals and their semi-quantitative composition were also acquired.

Results

This study sought to investigate two series of ore samples which are representative for two major parts of Băița-Bihor ore deposit, *i*) Blidar contact (BBH-4731 series) and, *ii*) the lowermost part of Antoniu ore body (BBH-series). A comparative mineralogical study of these two ore zones in Băița Bihor ore deposits based exclusively on ore microscopy have been previously presented by Andrii and Tămaș (2015).

New optical microscopy investigations were carried out on the above mentioned two series of samples using a professional ore microscope. This approach allowed to confirm for the BBH-series samples (Antoniu ore body) the ore minerals already mentioned previously by Andrii (2016), *e.g.* copper sulfides (bornite, digenite), hessite, and electrum. Furthermore, several mineral grains of irregular shapes and various sizes that display in plane polarized light a creamy white to cream-greyish colour and a low relief (Fig. 3a) were also noticed. Under crossed-polarizers this ore mineral shows a weak to distinct anisotropy and no internal reflections.

The BBH-4731 series of samples consists of massive ore with bornite as the most frequent metallic mineral. The preliminary microscopy study shown that bornite occurs in association with digenite, chalcocite, covellite, chalcopyrite, hessite (Andrii and Tămaș, 2015) and two unidentified minerals. The first one has similar optical properties as the unknown mineral described from the previous samples, suggesting that it could be the same mineral species. The second unidentified mineral, on which we continue to focus, displays irregular shapes and small sizes (10 to maximum 25 micrometers). This mineral shows in plane polarized light (Fig. 3b) a greyish cream colour with an olive-green tint and a low relief. In crossed polarized light the mineral possesses a weak anisotropy and shows no internal reflections.

SEM investigations were carried out aiming the mineralogical identification of the still unknown mineral species after the optical microscopy study. Backscattered electron images

(BSE) confirmed the existence of these minerals and their different chemistry as compared with the Cu-sulfides assemblage (Fig. 3c and d) already identified by optical microscopy. The colour of the ore minerals in BSE mode reflects their chemistry, with whiter shades for the minerals containing heavier chemical elements, *e.g.* Au, Ag, Pb, Bi etc. The unidentified mineral from the samples series BBH and the first one from the samples series BBH-4731 have similar BSE appearance, as in the case of optical microscopy. The second unidentified ore mineral from the samples series BBH-4731 contains lighter chemical elements, as reflected by its greyish colour as compared with the first one (Fig. 3c, d).

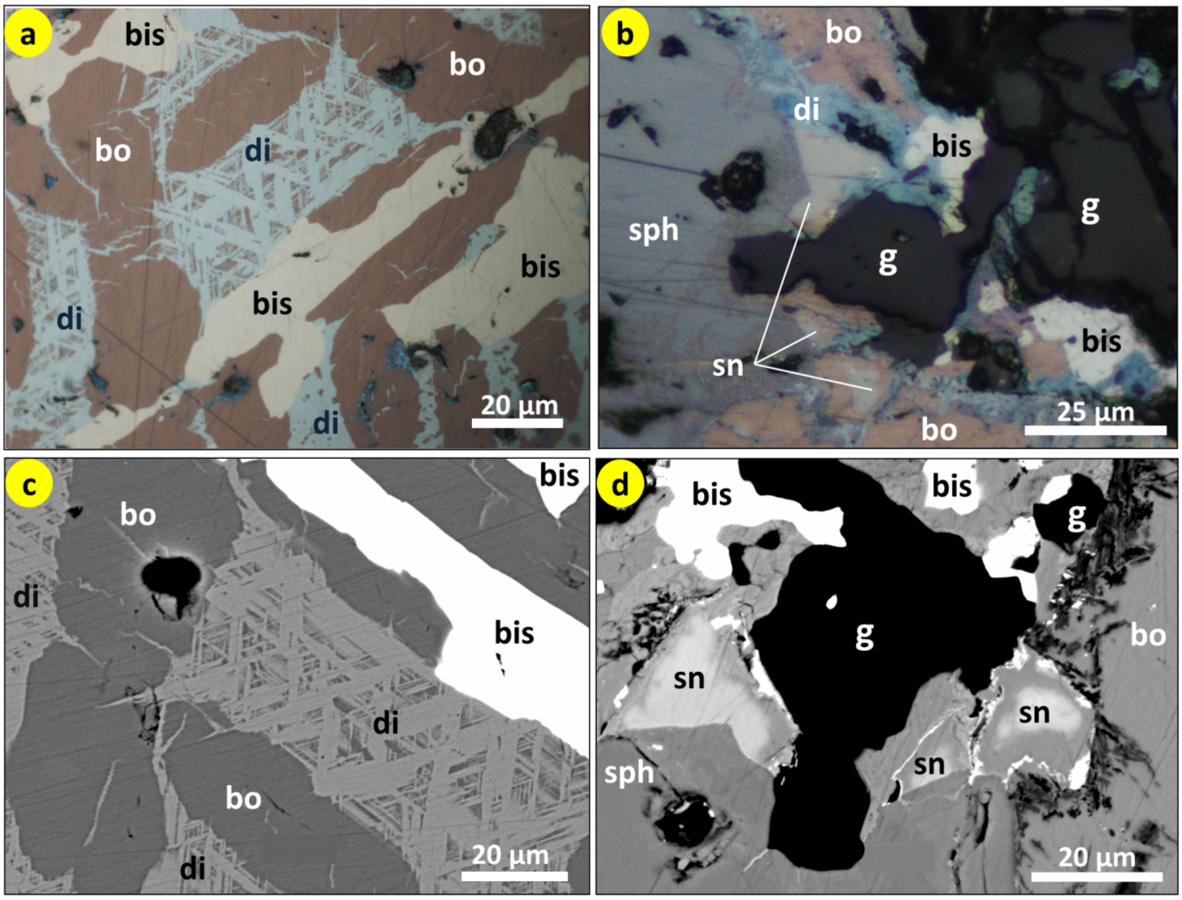

Fig. 3. Cu-sulfides and Bi- and Sn-minerals assemblage from Baita-Bihor ore deposit; reflected light photomicrographs in plane polarized light (a-b), and backscattered electrons images (c-d); a) irregular grains of Bi-minerals hosted in bornite which shows local substitutions by anastomosed digenite veinlets; b) bornite enclosing irregular grains of Sn- and Bi-minerals with associated vein-like digenite narrow rims and sphalerite; c) detail of Fig. 3a rotated 90^0 counterclockwise showing bornite that hosts two grains of Bi-minerals and it is partially replaced by digenite d) detail of Fig. 3b rotated 90^0 counterclockwise that confirms the presence of two Sn bearing mineral phases (inner part of the grains and associated greyish rim) accompanied by bornite, sphalerite and Bi-minerals. Abbreviations: bo - bornite; bis - Bi-sulfide; di - digenite; sn - Sn-sulfide; sph - sphalerite; g - gangue minerals.

The SEM spectra acquired for both unidentified ore minerals indicate the presence of Cu, Bi, and S as major chemical elements in the first unidentified mineral (Fig. 4a), and of Cu, Sn, Zn, Fe and S in the case of the second one (Fig. 4b).

Following the acquisition of SEM-EDS spectra, semi-quantitative analytical data were also aquired. The chemical data are summarized in Table 1.

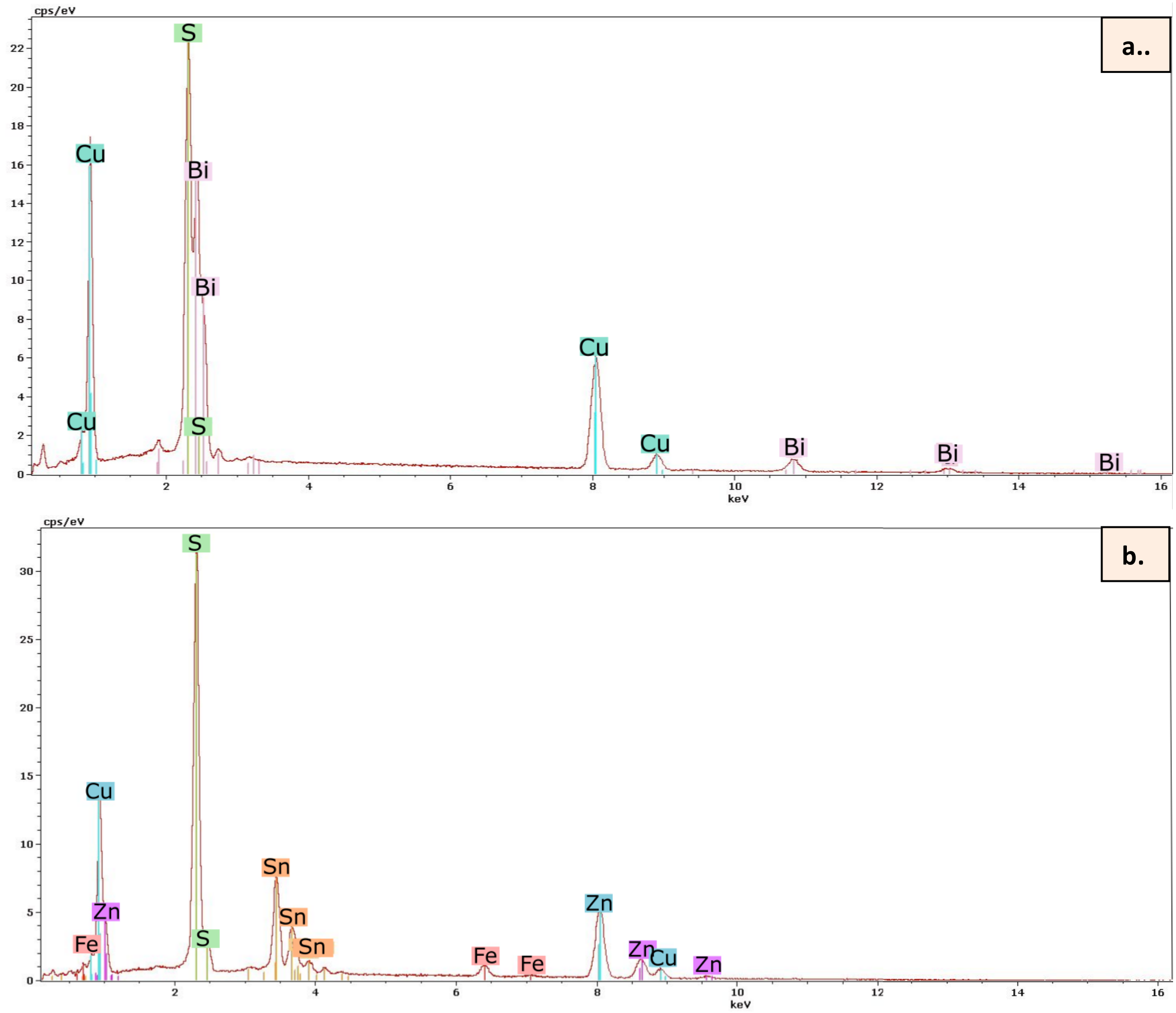

Fig. 4. SEM spectra of the unidentified minerals from the series BBH (a) and BBH-4731 (b), as marked in the Fig. 3. Note the presence of Cu, S, and Bi in the first spectra (a) and the presence of S, Cu, Sn, Zn and Fe in the second one (b).

Table 1. Normalized semi-quantitative analyses for the Bi- and Sn-bearing minerals from Băiţa Bihor, expressed in wt%. The significance of "-" is "below detection limit".

Sample	S	Cu	Bi	Sn	Zn	Fe	Ag	In(?)	Cd(?)	Total
BBH	21,03	42,34	35,16	-	-	-	0,63	-	-	100
BBH-4731	26,29	32,78	-	24,95	11,59	2,88	-	0,62	0,29	99,99

Discussions

The SEM-EDS spectra reveals for BBH samples the predominance of 3 main chemical elements, *i.e.* Cu, Bi and S, indicating that the investigated mineral is a Cu-Bi sulfosalt that contains also small amounts of Ag. According to these preliminary data have been identified three potential mineral species that could fit to the above mentioned chemical composition (Table 2). Despite their chemical similarity, these minerals do not possess similar optical properties, as indicated in Table 2 as well. Therefore, the number of likely mineral candidates according to both optical microscopy properties and chemistry could be restrained at two, *i.e.* hodrušite and wittichenite.

The semi-quantitative chemical data have facilitated to stint the number of the likely Cu-Bi sulfosalt candidates through the possibility of determining the empirical composition calculated on the basis of 7 atoms per formula unit, *e.g.* $(Cu_{3.11}, Ag_{0.02})_{\Sigma=3.13}Bi_{0,78}S_{3.06}$.

Thereby, the closest idealized structural formula is Cu_3BiS_3 which corresponds to wittichenite. This mineral was previously reported in Băița Bihor ore deposit by Giușcă in 1941 based primarily on microscopic study.

Table 2. General crystallography data and optical microscopy properties of several Cu-Bi minerals, according to Uytenbogaardt and Burke (1971) and Pracejus (2008). With italicized characters (last row) are listed the optical properties of the un-identified, yet Bi-mineral from Băița Bihor.

Mineral	Crystal system	Colour in reflected light	Bireflectance	Anisotropism
hodrušite $Cu_8Bi_{12}S_{22}$	monoclinic	creamy with slight pinkish tint	absent	weak
emplectite $CuBiS_2$	orthorhombic	creamy or yellowish white, sometimes with a light brown tint	slight	strong, turquoise tinted grey to dark brown
wittichenite Cu_3BiS_3	orthorhombic	cream-grey	absent	weak, dark brownish grey shades
unidentified Bi-mineral	*?*	*white to cream-greyish*	*absent*	*weak to distinct*

For BBH-4731, the SEM-EDS spectrum highlights enrichment in Cu, Sn, S, Zn and Fe, an important information that directs our research toward the Cu-Sn-Zn(Fe) sulfosalts group. From this group of minerals have been identified a number of five mineral species that possess similar chemistry (Table 3), from which only ferrokesterite and kesterite presents similarities regarding also their optical properties. Both of them are part of stannite group, with kesterite being the Zn-rich member and ferrokesterite possessing a Fe-enrichment. Among kesterite and ferrokesterite there is continuous substitution between Fe and Zn (Kissin and Owens, 1979).

Table 3. General crystallography data and optical microscopy properties of selected Cu-Sn-Zn(Fe) minerals according to Uytenbogaardt et Burke (1971) and Pracejus (2008). With italicized characters (last row) are listed the optical properties of the un-identified, yet Sn-mineral from Băița Bihor.

Mineral	Crystal system	Colour in reflected light	Bireflectance	Anisotropism
chatkalite $Cu_6FeSn_2S_8$	tetragonal	pale rose	absent	weak, in shades of brown.
ferrokesterite $Cu_2(Fe,Zn)SnS_4$	tetragonal, pseudocubic	medium grey	weak	weak, in shades of grey
stannite Cu_2FeSnS_4	tetragonal	medium grey with olive-green tint	absent	distinct, violet and slate-green
stannoidite $Cu_8(Fe,Zn)_3Sn_2S_{12}$	orthorhombic	pinkish brown	absent	distinct, pale salmon-brown to brown
kesterite $Cu_2(Zn,Fe)SnS_4$	tetragonal, pseudocubic	olive tinted grey	absent	weak
mawsonite $Cu_6Fe_2SnS_8$	tetragonal	orange to cream tinted orange	absent	very strong, orange brown to turquoise
unidentified Sn-mineral	*?*	*greyish cream with an olive-green tint*	*absent*	*weak*

The semi-quantitative data (Table 1) confirms the elevated contents of Cu (32.78 wt %), Sn (24.95 wt%), S (26.29 wt%), and Zn+Fe (14.47 wt %). Besides these chemical elements, several impurities have been also detected by SEM analyses (In, Cd) but in small amounts (less than 0.65 wt%). To restrain the number of possible minerals, the empirical formula was calculated on the basis of 8 atoms per formula unit, *e.g.* Cu $_{2.31}$ ($Zn_{0.79}$ $In_{0.02}$ $Cd_{0.01}$ $Fe_{0.23}$)$_{\Sigma=1.06}$ $Sn_{0.94}$ $S_{3.67}$. The idealized chemical formula closeest to the calculated chemical formula is $Cu_2(Zn,Fe)SnS_4$ which is specific to kesterite.

Conclusions

New mineralogical investigations including optical microscopy and SEM-EDS analyses allowed to confirm the presence of wittichenite and kesterite in Băiţa Bihor ore deposit.

Wittichenite, with the calculated formula ($Cu_{3.11}$, $Ag_{0.02}$)$_{\Sigma=3.13}$$Bi_{0,78}$$S_{3.06}$, was identified in ore samples from the lower part of Antoniu ore body, as well as from Blidar Contact ore zone. It occurs as anhedral isolated grains or grain aggregates hosted in bornite, and it is associated with digenite, hessite, electrum and kesterite. The presence of wittichenite may indicate a possible gold enrichment in skarn related Cu-rich ore.

Kesterite was observed in ore samples collected in 1971 from Blidar Contact ore zone by Professor Ioan Mârza. The identified anhedral kesterite grains are hosted mainly by bornite and are accompanied by digenite, chalcocite, covellite, chalcopyrite, and hessite. The calculated formula of kesterite is Cu $_{2.31}$ ($Zn_{0.79}$ $In_{0.02}$ $Cd_{0.01}$ $Fe_{0.23}$)$_{\Sigma=1.06}$ $Sn_{0.94}$ $S_{3.67}$.

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References

Andrii MP, 2016. Cercetări mineralogice şi metalogenetice în cadrul zăcământului Băiţa Bihor, Munţii Apuseni. Lucrare de licenţă, Universitatea Babeş-Bolyai, Cluj-Napoca, 58 p.

Andrii MP, Todor AL, Gherdea A, 2015. Cercetări mineralogice în zăcământul Băiţa Bihor, Munţii Apuseni. Volumul de abstracte al Simpozionului Naţional al Studenţilor Geologi, a XVI-a ediţie, 10 mai 2015, Iaşi, 9-10.

Bleahu M, 1963. Corelarea depozitelor paleozoice din Munţii Apuseni. Asoc. Geol. Carp. Balc., Congr. VIII, 1, Bucureşti.

Bordea S, Bleahu M, Bordea I, 1975. Date noi stratigrafice şi structurale asupra Bihorului de vest. Unitatea de Următ şi de Vetre. D.S. Inst. Geol., XI, 5, 61-83.

Cook NJ, Ciobanu CL, Bogdanov K, 2002. Trace mineralogy of the Upper Cretaceous Banatitic Magmatic and Metallogenetic Belt, SE Europe. 11th IAGOD Symp. Geocongress. CD vol. of ext. Abstr, Geol. Surv. Namibia.

Ciobanu CL, Brugger J, Cook NJ, Mills SJ, Elliot P, Damian G, Damian F, 2014. Graţianite, $MnBi_2S_4$, a new mineral from the Băiţa Bihor skarn, Romania. American Mineralogist, 99 (5-6), 1163-1170.

Cioflică G, Vlad Ş, Iosif V, Panican A, 1974. Metamorfismul termic şi metasomatic al formaţiunilor paleozoice din unitatea de Arieşeni de la Băiţa Bihorului. St. cerc. geol., geofiz., geogr., Seria geologie, 19, 43-68

Cioflică G, Vlad Ş, Volanschi E, Stoici S, 1977. Skarnele magneziene cu mineralizaţiile asociate de la Băiţa Bihorului. St. cerc. geol., geofiz., geogr., Geologie, 22, 39-57.

Giuşcă D, 1941. Note préliminaire sur la minéralisation des gisements de contact de Băiţa Bihorului. Mem. Sect. Ştiinţ. Acad. Roum. ser. II, XVI/6, 681-693.

Ilinca G, Makovicky E, Topa D, Zagler G, 2010. Cuproneyite, $Cu_7Pb_{27}Bi_{25}S_{68}$, a new mineral from Băiţa Bihor, Romania. Canadian Mineralogist, 50, 353-370.

Kissin SA, Owens DR, 1979. New data on stannite and related tin sulfides minerals. Canadian Mineralogist, 17, 125-135.

Meinert LD, 2000. Gold in skarns related to epizonal intrusions: SEG Reviews, 13, 347-375.

Pracejus B, 2008. The Ore Minerals Under the Microscope - An Optical Guide. First edition. Elsevier, Amsterdam, 875 p.

Stoici DS, 1974. Studiul geologic şi petrografic al bazinului superior al Crişului Negru - Băiţa Bihor cu privire specială asupra mineralizaţiei de bor şi a skarnelor magneziene. Inst. Geol. Geofiz., Stud. tehn. econ., Ser. I, Min.-Petr., 7, 199 p.

Stoici DS, 1983. Districtul metalogenetic Băiţa Bihorului: cercetări geologice şi miniere. Editura Academiei Republicii Socialiste România, Bucureşti, 189 p.

Stoici DS, Vlad ȘN, 1991. Molibdenul și wolframul. Ed. Tehnică, București, 311 p.

Stoicovici E, Stoici DS, 1970. Considerațiuni asupra magmatismului din Munții Bihor. Studia Univ. Babeş-Bolyai, Seria geol.-geogr., Cluj, 15/2, 3-15.

Uytenbogaardt W, Burke EAJ, 1971. Tables for microscopic identification of ore minerals. Second revised edition. Elsevier, Amsterdam, 390 p.

Vlad, Ş.N. (1993). Geologia resurselor minerale. Curs universitar. Partea I: Zăcăminte metalifere şi nemetalifere. Universitatea Ecologică, București, 90 p.

Žák L, Fryda J, Mumme WG, Paar WH, 1994. Makovickyite, $Ag_{1.5}Bi_{5.5}S_9$ from Băiţa Bihorului, Romania. The 4P natural member of the pavonite series. Neues Jahrb. Mineral., Abh. 168, 147-169.

Zimmerman A, Stein HJ, Koželj D, Bogdanov K, Berza T, 2008. Tectonic configuration of the Apuseni-Banat-Timok-Srednogorie belt, Balkans-South Carpathians, constrained by high precision RE-OS molybdenite ages. Miner. Deposits, Springer, Berlin, 43, p. 1-21.

Eocene micropaleontological assemblages and their relationship to the depositional environments in the Gura Humorului area (Tarcău Nappe, Eastern Carpathians)

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Key words: paleoenvironments, agglutinated foraminifera, calcareous nannofossils, Eocene, biostratigraphy

The micropaleontological assemblages and sedimentological data of two representative sections (GHP and GHE) from the Gura Humorului area (Tarcău Nappe, Eastern Carpathians) provide new palaeoenvironmental and biostratigraphical information of the Eocene deposits.

The deposits consist of mid fan turbidites in the first outcrop and of hemipelagic variegated shales in the second one. Modal composition of the sandstones of turbiditic intervals is litharenithic, with abundant lithic grains and subordinate metamorphic afanitic (textural fine grained) grains. Fragments of monocrystalline quartz are mostly subrounded and/or subangular, indicating a recycling from older clastic formations. Tectonized hemipelagites include scattered levels of breccias with carbonate clasts, metamorphic green clasts with afanitic texture and quartzarenitic sandstones.

Both sections are characterized by diverse foraminiferal assemblages consisting mostly of agglutinated species (*Nothia excelsa*, *Psammosiphonella cylindrica*, *Saccammina grzybowski*, *Recurvoides walteri*, *Haplophragmoides walteri*, *Reophax pilulifer*, *Saccamminoides carpathicus*, *Spiroplectammina spectabilis*, *Reticulophragmium amplectens*); the calcareous benthics are rare. Significant proportions of globular forms of *Saccammina* and *Psammosphaera* (M2a morphogroup) and rounded streptospiral *Recurvoides* spp., having high capability for dispersal and colonization of abiotic substrates in low carbonate availability and low oxygen conditions, are characteristic for the first section (GHP). All morphogroups in the second section (GHE) have variable distribution, suggesting changes in oxygenation and organic matter input; an important palaeoecological event (eutrophic conditions and cold waters) is indicated by the peak of M2c morphogroup (elongate keeled *Spiroplectammina spectabilis*). The foraminiferal assemblages are typical for "flysch-type" biofacies, characteristic for the upper bathyal to lower bathyal settings, with turbiditic and hemipelagic deposition, above the calcite carbonation depth.

The calcareous nannofossils (*Discoaster* spp.,), ascidian spicules and foraminifera (*Recurvoides* spp, *Spiroplectammina* spp) suggest mesotrophic to oligotrophic conditions with warm waters for the first section and colder eutrophic environments for the second.

Based on the presence of agglutinated foraminifer *Saccamminoides carpathicus* and the calcareous nannofossils *Discoaster deflandrei, D. barbadiensis, Helicosphaera bramlettei, Neococcolithus dubius, Zygrablithus bijugatus, Lanternithus minutus, Pontosphaera distincta, P. pulchra,* the age of the deposits is Bartonian for the first section. The second section is Priabonian in age based on high percentages of *Spiroplectammina spectabilis* and based on the identified calcareous nannoplankton assemblages: *Reticulofenestra umbilica, R. reticulata*, *R. dictyoda, R. bisecta, Discoaster saipanensis*, *Coccolithus formosus*, *Orthozygus* cf. *brytika*.

Based on biostratigraphic data, the deposits from the first section can be assigned to the Sucevița Formation, while the deposits from the second section to the Bisericani Formation.

The Lower Cretaceous deposits from the Kučaj zone (Carpatho-Balkanides, Eastern Serbia)

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Key words: Lower Cretaceous, Kučaj zone, Carpatho-Balkanides, Eastern Serbia

The south-eastern part of the Southern Carpathians continues south of Danube in Eastern Serbia with the Carpatho-Balkanides. The Kučaj zone of the Carpatho-Balkanides represents the continuation south of Danube of the Resiţa-Moldova Nouă zone (South Carpathians). Several sections have been investigated in the Kučaj zone between Pirot (to the south) and Žajecar (to the north).

The Urgonian deposits from the Kučaj zone are generally characterized by open shelf (or platform exterior) facies, dominated by bioclastic and bioclastic-ooidic wackestone and wakestone-packstone, with grainstone-rudstone intercalations. The bioclasts consist of bivalve (mostly rudists), gastropod, echinoderm, bryozoans and brachiopod fragments, and more rarely coral and sponge fragments. The following foraminifers have been identified: *Akcaya minuta, A. capitata, Bdelloidina urgonensis, Charentia cuvillieri, Ch. Nana, Choffatella decipiens, Coscinophragma cribrosa, Dictyoconus pachymarginalis, Earlandia conradi, Everticyclammina* div. sp., *Derventina filipescui, Dobrogelina* div. sp., *Mayncina bulgarica, Meandrospira bancilai, Montseciella arabica,* ?*Montseciella glanensis, Nautiloculina cretacea, Neotrocholina friburgensis, Orbitolinopsis* cf. *buccifer, Palorbitolina lenticularis, Paracoskinolina*? *jourdanensis, Pfenderina globosa, Praeorbitolina cormyi, Praereticulinella* sp., *Vercorsella scarsellai*, as well as other diverse miliolid, textulariid, and nodosariid foraminifers. The calcareous algae assemblage consist of: Dasycladales (*Clypeina maslovi, C. nigra, Griphoporella cretacea, Montiella elitzae, Neomeris cretacea, Neomizzia dacica, Salpingoporella melitae, S. muehlbergii, S.* cf. *patruliusi, S. pygmaea, Similiclypeina conradi, Suppiluliumaella elliotti, Terquemella* sp., *Triploporella carpatica, Triploporella praturloni, Zittelina massei)*, Bryopsidales (*Arabicodium* div. sp., *Boueina hochstetteri, Boueina* sp., *Nipponophycus* sp., *Permocalculus* div. sp.) and red algae (*Marinella lugeoni, Polystrata alba* and *Sporolithon rude*). The problematica *Crescentiella morronensis* and *Carpathoporella occidentalis* are associated.

Some of these microfossils were already identified within the Kučaj Mountains by Sudar et al. (2008). Similar micropaleontological assemblages of calcareous algae and foraminifers were identified within the Reşiţa-Moldova Nouă zone (Bucur, 1997, 2001).

The lithological and facies characteristics (dominance of the open shelf carbonate facies with clay-marl intercalations) as well as the micropaleontological assemblages make the studied deposits from the Kučaj zone quite similar with the Valea Minişului Formation of the Reşiţa-Moldova Nouă zone of late Barremian-early Aptian age. A distinct trait of the succession in the Kučaj zone is represented by the occasionally more abundant terrigenous quartz within some sequences.

Limestones belonging most probably to the lower Barremian with *Paracoskinolina*? *jourdanensis* were found only in the first part of the canyon between Gradište and Žukovac, as well as in a quarry located between Svrlig and Knjaževac. We also identified a micropaleontological assemblage with *Mesorbitolina parva* and *M. texana* in samples from Grlište section, which correspond to the Gargasian.

Concluding, the Lower Cretaceous deposits in Urgonian facies of the Kučaj zone (Carpatho-Balkanides, Eastern Serbia) contain facies and micropaleontological assemblages similar with those of the Valea Minişului Formation of the Reşiţa-Moldova Nouă zone, but they also present peculiarities related most probably to local depositional framework.

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References

Bucur II, 1997. The Mesozoic formations from the Reşiţa-Moldova Nouă zone. Cluj University Press, 214 pp. (in Romanian).

Bucur II, 2001. Lower Cretaceous algae of the Reşiţa-Moldova Nouă zone. In: Bucur, I.I., Filipescu, S., Săsăran, E. (eds.) Algae and carbonate platforms in western part of Romania. Field Trip Guidebook. Cluj University Press, 137-168.

Sudar M, Jovanovic D, Maran A, Polavder S, 2008. Late Barremian–Early Aptian Urgonian Limestones from the south-eastern Kučaj Mountains (Carpatho-Balkanides, eastern Serbia). Annales géologiques de la Péninsule Balkanique, 69, 13-30.

Eocene calcareous nannoplankton, mollusks and sedimentological data of the Turnu Rosu area (Sibiu county)

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Key words: calcareous nannoplankton, mollusks, sedimentology, Eocene, Southern Transylvania.

Five outcrops from Turnu Roşu area have been investigated for the content in calcareous nannoplankton and mollusks, Additionally, the first sedimentological data for this area are presented.

The Eocene deposits from Turnu Roşu (Porceşti) have been investigated by many authors as concerning selacians, foraminifera, molluscs, echinoids, and other fossils. Mészáros & Ianoliu (1972, 1973) studied the mollusk fauna, while Mészáros (1996) studied the stratigraphy and separated three formations: Valea Satului (Cuisian), Strada Muntelui (Lutetian – Priabonian) and Valea Nişului (Priabonian).

Outcrop 1 belongs to Valea Satului Formation, here represented by alluvial orthoconglomerates with grain supported medium-sorted texture, showing reverse grading together with faint embricated structures, giving a general S-N oriented paleocurrent trend. Sedimentary bodies are organized into superimposed channels with irregular erosional base. Depositional processes involve grain flow mechanisms of relative high density allowing to frame these deposits into a fan-delta sedimentary environment. The upper part of this outcrop marks a transition to marine nummulitic limestones with pectinids, ostreids, brachiopods, isolated corals, echinids and red algae, indicating a marine transgression and thus a progressively retrogradation of depositional facies. Intercalations of intraformational breccias, including sporadic extraformational clasts of quartzitic composition, can be remarked at different levels.

The gastropods *Cypraea* and *Ampullinopsis* were more frequently observed.

Outcrop 2 belongs to Strada Muntelui Formation and consists at the base of marine channelled conglomerates showing erosional base, with predominant pebbles of micaschists from Făgăraş Formation, rich in macrofauna represented by bivalves (oysters), gastropods, brachiopods, selacian teeth, and fragments of sirenids ribs. Structureless massive sandstones, quartzo-feldspatic in composition and rich in micas, occur at the top.

The calcareous nannoplankton assemblage contain: *Zygrablithus bijugatus* (NP11-NP25), *Pontosphaera pulchra* (NP9-NP16), *Reticulofenestra dictyoda*, *R. bisecta*, *Coccolithus pelagicus*, *C. eopelagicus*, *Lanternithus minutus* (NP14b-NP23), *Braarudosphaera bigelowii* (Cenomanian – Extant).

The calcareous nannoplankton assemblage belong probably to NP17-NP18 biozones (after Martini, 1971) (Middle to Upper Eocene – Bartonian - Priabonian).

Outcrop 3. The clays from the third outcrop (1,70 meter thick) contain frequent *Istmolithus recurvus* (NP19-NP22), and *Reticulofenestra dictyoda* (NP13- Oligocene), *R. bisecta* (NP17-NN1), *R. stavensis* (NP17-NN1)*, R. reticulata* (NP16-NP19-20)*, Coccolithus pelagicus* (NP2-Extant)*,* and *C. eopelagicus* (NP14-NP23). *Istmolithus recurvus* and reticulofenestrids are the most frequent. Sometimes entire coccospheres of *Reticulofenestra* are present.

This calcareous assemblage belongs to *Istmolithus recurvus* Biozone (NP19 after Martini, 1971) (Upper Eocene – Priabonian).

Outcrop 4 consists of Eocene limestones with echinoids, oysters, pectinids, fragments of *Campanile*, and levels with *Velates* in the upper part.

Outcrop 5 is about 7 meters thick and consists of limestones with molluscs: *Campanile, Velates*, pectinids. Levels with *Miltha* and *Velates*, echinoids spicules and selacians teeth are present at the base of the outcrop. *Pseudomiltha gigas* (Lucinidae) (mobile deep infaunal chemosymbiotic) and *Velates schmidelianus* (Naticidae) (suspension-feeder, soft bottom dweller) are the most frequent molluscs.

Very rare small reticulofenestrids and *Coccolithus pelagicus* were found.

Conclusions

The five outcrops have been analysed individually from chronostratigraphic and sedimentological point of view.

Lithostratigraphic correlations between the analysed successions are difficult to be established in the field, because of the intense faulting from the southern margin of the Transylvanian Basin. The local abundance of extraformational clasts of metamorphic origin can be linked to phases of tectonic uplift in the Southern Carpathians.

The calcareous nannoplankton assemblages prove different ages for the outcrops 2 and 3, from Bartonian to Priabonian (NP19 Biozone).

References

Martini E, 1971. Standard Tertiary and Quaternary Calcareous Nannoplankton Zonation. Proceedings of the II Planktonic Conference, Roma, 1970. Ed. Tecnoscienza, 739-785.

Mészáros N, Ianoliu C, 1972. Macrofauna eocenă de la Turnu Roşu – Porceşti (I) Studii şi Comunicări, Muzeul Brukenthal, 17, 21-30.

Mészáros N, Ianoliu C, 1973. Macrofauna eocenă de la Turnu Roşu – Porceşti (II) Studii şi Comunicări, Muzeul Brukenthal, 18, 13-21.

Mészáros N, 1996. Stratigrafia regiunii Turnu Roşu – Porceşti. Convergenţe Transilvane, Sibiu, 4, 42-45.

Sirenian fragments from Cluj Limestone Formation, Vlalea Pleşca (Cluj-Napoca)

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Key words: vertebrate paleontology, sirenians, microfacies, microfossils, Late Eocene, Transylvania, Romania.

This study represents a paleontological multidisciplinary approach that shares data on vertebrate paleontology and microfacies analysis. The main goal of this study is to relate some sirenian costal fragments found in the Cluj Limestone Formation (upper Eocene, Priabonian) and microfacies analysis of the matrix rock – limestone – bearing the vertebrate remains. The target of this correlation is to reconstruct the paleoenvironment where the ancient sirenians lived.

The vertebrate fragments (Fig.1), together with several limestone samples were collected in the mid-summer of 2017 from a slope scree pile nearby Sfantul Ioan location, on the road 107 R, ca. 1.5 km near the public transport depot in Mănaștur, Cluj-Napoca. The outcrop where the fossils came from is the Cluj Limestone Formation, part of Turea Group (Rusu, 1995; Kovács & Arnaud-Vanneau, 2004).

Fig. 1. Rib fragments found in the Cluj Limestone Formation (medial views)

The rib fragments look like a part of the same individual, based on the connection sections fitting well enough. Moreover, the rib seems to document a large portion of the bone. These fragments can be assigned to the Dugongidae family, representatives of the Sirenia Order. Domning (2009) considered that dugongids comprise the large majority of the species and specimens representing the already known fossil record of sirenians. The assignation was based on comparative anatomy, the rib exposing pachyostosis. However, this bone documents an abnormal type of porosity, which is different from other sirenian fossils discovered in same formation. The huge majority of the ribs collected in the Cluj Limestone Formation are marked by heavy pacyostosis process, being adapted to feeding under water, where the archimedic pressure was high. The porosity is herein interpreted as an atavism of this individual. Therefore, we have to deal with an exception and not a rule.

Ten thin sections were made from the vertebrate bearing limestone boulders in order to reveal microfacies specificity. The identified microfacies types are represented by bioclastic wackestone/packstone with foraminifera and red algae and bio-lithoclastic packstones with small skeletal fragments (bivalves, echinoid plates). The micropaleontological assemblage is dominated by foraminifera from which miliolids (*Pyrgo* sp.), alveolinids (*Borelis* sp.) and rotaliids (*Operculina* sp.) are the most common. Also much larger specimens of ?*Orbitolites* sp. and *Haddonia* sp. are common within these micritic limestones. Besides, fragments of geniculate red algae (*Corallina* sp.), small fragments of *Vulsella* bivalve shells and scarce serpulid tubes occur too.

The majority of the clasts are small, sub-angular in shape, medium to poorly graded, with various degrees of fragmentation, reworking and dissolution (mainly on shell fragments and foraminifera tests). In respect with these traits, the identified microfacies types characterize an inner-platform shallow-water sedimentary setting (possibly around 20-30 meters in depth above the fairweather wave-base). The Eocene sediments were deposited most probably as bioclastic shoals and sandy skeletal debris controlled by moderate to high hydrodynamic regimes. Moreover, the sirenian costal fragments bear abrasion marks which can be related with high energy episodes.

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References

Domning D, 2009. Sirenian Evolution. Encyclopedia of Marine Mammals 2nd Edition. Academic Press, 1016-1019.

Kovács S, Arnaud-Vanneau A, 2004. Upper Eocene paleobathymetry approach based on paleoecological assemblages from the Pleşca Valley 2. Outcrop, Transylvania. A preliminary report. Acta Palaeontologica Romaniae 4, 191-202.

Rusu A, 1995. Eocene formations in the Călata region (NW Transylvania). A critical review. Romanian Journal of Tectonics and Regional Geology, 76, 59-72.

Holocene fire regime disturbance on the south-eastern European (Romania) grasslands dynamics

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Key words: Holocene, grasslands, fire regime, fire morphologies, fire metrics, fuel source

While it is commonly admitted that fire disturbance drives important changes on the diversity and structures of natural and anthropogenic grassland systems, (e.g. tropical and North America temperate grasslands), the effect of fire on the European temperate tree-grass and grassland dynamics is wildly unknown and poorly studied. Furthermore, prescribed burning has been proposed as a tool to manage European grasslands that are in marked decline due to the afforestation of abandoned farmlands. However, little is known about the past fire regime, limited to a few decades of observational studies derived from remote sensing.

To better understand the effect of fire on temperate European open grassy systems and land cover changes, we performed a multi-proxy palaeoecological analysis (radiocarbon dating, macrocharcoal counts and morphologies, statistically defined fire metrics and pollen analysis) on a 10 meter long core profile extracted from Lake Oltina (south-east Romania). Here we present the first record of Holocene variability in fire regime, fuel source and fire types in extant steppe grasslands from south-eastern Europe based on five distinct periods in the past fire activity. We aim to determine which grassland / vegetation types in this region are more resilient to fire and how traits related to fire resistance and regeneration affect species persistence/resilience.

Between 7000-6000 cal yr BP, the pollen based vegetation reconstruction shows a forest-steppe environment, whereas charcoal record reveals a fire return interval (FRI) of 70 years, fire peaks of moderate magnitude and charcoal morphologies dominated by Poaceae and other herbaceous plants.

From 6000 to 3900 cal yr BP, the pollen record shows a slight increased proportion of forest cover, especially of *Quercus*, whereas fire became more frequent with fire events of low magnitude. The charcoal morphologies remained dominated by non-woody types, with a small increase in wood charcoal type.

During the 3900-2200 cal yr BP period, the pollen record shows a marked decline in forest cover, FRI increased to 90 years, fires were of high magnitude and the dominant charcoal morphologies were herbaceous type.

From 2200 to 910 cal yr BP, the regional vegetation became dominated by Poaceae and steppe herbs, including indicators of human impact. FRI became shorter (50 years) and characterized by fires of low magnitude, whereas charcoal morphologies show the predominance of herbs, Poaceae and deciduous leaves.

The most recent period (last 910 years shows a marked decline in fire activity, associated with charcoal morphologies dominated by? Poaceae and herbs.

Our results show a good association between the dominance of a grassy ecosystem and an enhanced fire activity and demonstrate the role of fire on the dynamics of this vegetation type. This study provides the first reconstruction of fire regime variability from the south eastern European grassy systems, as well as emphasizing the value of charcoal morphologies to determine the type of fire and biomass fuel.

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Documenting the evolution of avian wing shapes (BIRDWING)

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Key words: Feathers, Dinosaurs, Phylogenetics, Morphometrics, Aerodynamics.

Although birds are an extremely well-known and well-studied group of vertebrates, with more than 10,000 living species, surprisingly little is understood about the interplay between aerodynamics and the structural performance of their unique flight system. In particular, we still have a very incomplete understanding of how wing shapes and morphologies relate to flight style, and thus ecology, in birds. Unlike their living counterparts, bats, and the extinct reptilian pterosaurs, the sister-group to dinosaurs, birds possess a flight surface that is comprised of bones and feathers with the latter often making up around 50 percent of total functional wing length. Our research is aimed at understanding feathers, how they are constructed, how they develop, and how they comprise the wing in birds. Feathers, their shape, length, and form with respect to one another in the avian wing, form a flexible and dynamic aerodynamic surface. Thus, this discrete, novel, 30 month multi-disciplinary study will reconcile existing experimental measurements, theoretical modelling work, and the actual anatomy of birds into models that can then be widely applied to other flight systems, including biomimetic flying machines and feather bioengineering. We will use the results of this quantitative study on the wings of birds to better understand, for the first time, the feedback relationships between aerodynamics, functional and behavioural ecology and vice-versa.

Uncovering drivers of change in an old-growth temperate forest from the Eastern Romanian Carpathians

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Key words: vegetation history, disturbance regime, resilience, turnover, 'virgin' forest, ecosystem services.

Mountain ecosystems are hotspots of biological and cultural diversity as well as important centers of traditional ecological knowledge. They provide multiple ecosystem services across our planet (e.g., freshwater, timber and fuel wood, genetic resources, climate regulation), yet are particularly sensitive to rapid global development, subject to both natural and anthropogenic drivers of change.

The Eastern Romanian Carpathians are considered as rather undisturbed and rich in biodiversity compared to Western Europe and therefore represent an important region for nature conservation. However, inappropriate forestry practices over the last two centuries have caused the reduced proportion of several important tree species. Thus, contemporary attempts of balancing land use management with future climate change in the area prove to be a considerable challenge.

We used paleoecological data from a peat bog from temperate forested landscape of Eastern Carpathians (Romania) in order to assess resilience of the forest ecosystem to various drivers of change. Special focus is put on identifying plant communities associated with periods of high landscape stability, as well as evaluating the status of 'old-growth forest' in this region.

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Degradation processes of the aggregates from the asphaltic mixture

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Key words: aggregates, mineralogy, degradation, asphalt

The behavior of the aggregates after their incorporation into a synthetic material (e.g. asphalt mixture, concrete, mortar etc.) is controlled by both mineralogical composition and environmental conditions. The exposure of the aggregates under weather conditions lead to the transformation of their minerals.

The common aggregates used for the asphalt mixtures and concrete/mortar are of sedimentary (especially alluvial deposits), metamorphic and magmatic origin. Some minerals are common in all genetic types of aggregates while some of them are very specific for some types of rocks. According to the rock genesis, the aggregates forming minerals are of primary and secondary origin. The primary minerals are the result of crystallization processes from magma, recrystallization metamorphic processes or diagenetic sedimentary processes respectively. The secondary minerals are formed on the primary ones as the result of transformation processes which affected the rock both in situ, into natural conditions, and under atmospheric exposure, especially when the rock is used as row or building material.

Aggregates from the asphalt mixture are affected by degradation processes. According their mineralogy, in the presence of water, different weathering processes took place, and specific secondary minerals are formed. Calcite is one of the secondary minerals as the result of carbonation of aggregates in the presence of CO_2 enriched water from atmospheric precipitations.

Samples of asphalt from different locations (highway, roads etc.) from NW of Romania were collected in order to investigate the degradation processes of the aggregates. All investigated samples were collected based on their color and visible secondary products. Spots of light brown to white thin crusts, less than 1 mm thick and up to 20 cm in diameter, consisting of secondary minerals were identified on the asphalt mixture (Fig. 1). The secondary products are especially developed on the surface of aggregate grains as well as on the inner surface of the pores/free spaces existing in the wearing course. The white crust is often accompanied by a thin layer of iron hydroxides coating the surrounded aggregate.

Under the microscope, the thin white layer displays calcite as the main component. The brown-reddish color is due to the presence of iron hydroxides which impregnates the calcite grains (Fig. 2).

The X-Ray investigations performed on the white crust demonstrates the presence of calcite as the main component (Fig. 3). Quartz, feldspars (albite) and muscovite/illite from aggregate are also present in the samples.

The presence of calcite on the surface of aggregates is the result of degradation of the carbonates (calcite) in the presence of acid rainfalls. The CO_2 dissolved into atmospheric water lead to formation of H^+ and HCO_3^- . The H^+ react with the calcite ($CaCO_3$) from aggregates resulting Ca^{2+} and HCO_3^-.

Fig. 1. White spot of secondary crust on the aggregate from the asphalt mixture

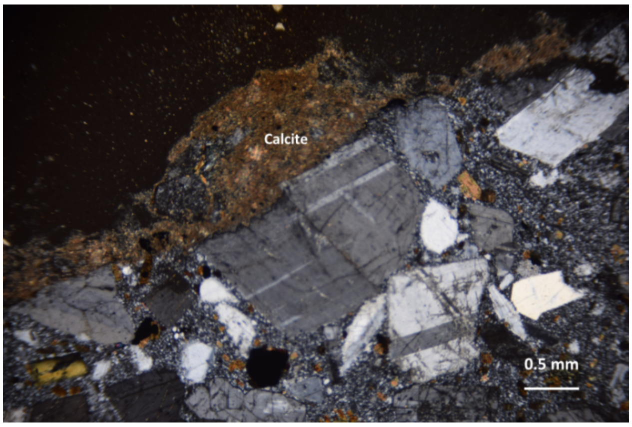

Fig. 2. Microscopic image with the secondary thin calcite crust on aggregate grain (crossed pollars)

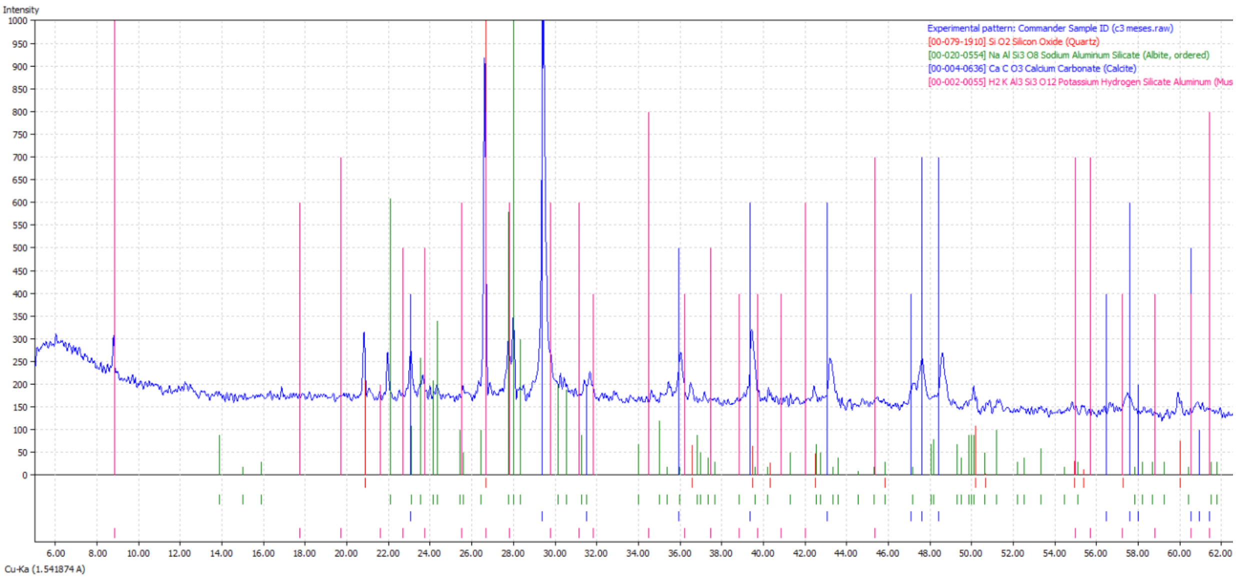

Fig. 3. X-ray pattern of the secondary carbonatic crust developed on the aggregates

The newly formed calcite from the white crust, at the surface of the aggregates, is the result of following reaction: $Ca^{2+} + 2(HCO_3^-) = CaCO_3 + H_2O + CO_2$

Thus, calcite from aggregates present as secondary minerals on plagioclase feldspars, or any other calcic mafic minerals, is dissolved in the presence of CO_2 enriched acid rainfalls. The newly formed calcite precipitates as thin white crust at the surface of aggregates, especially during dry season. Moreover, the presence of iron sulfides (ex. pyrite, marcasite) into the aggregates lead to formation of sulphuric acid in the presence of water and accelerates the degradation processes of the asphaltic mixture.

Early Badenian foraminifera assemblages and related paleoenvironments from the Hațeg Basin

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Key words: Early Badenian, Langhian, Hațeg Basin, biostratigraphy, paleoecology, foraminifera, statistics.

Foraminifera assemblages collected from a new outcrop on the side of the E79 road (45.521437 N, 23.059556 E, south of Galați village, Hunedoara county) have been studied in order to determine the age of the formation and the paleoenvironmental setting.

The formation consists of alternating centimetric to decimetric marls and sands preserving sedimentary structures characteristic for marine shoreface environment affected by tides (heterolithic structures) and storms (tempestites). The proximity of continental environments is suggested by local thin coal accumulations.

The micropaleontologic assemblage consists mainly of foraminifera, ostracods, echinoids, gastropods, bivalves, and otoliths. A previous study on foraminifera from the same section was done by Kövecsi & Silye (2013). Our assemblages were processed by standard micropaleontological methods and recovered from a 63µm sieve and determined based mainly on works of Cicha et al. (1998) and Papp & Schmid (1985).

Foraminifera are abundant and diverse, demonstrating optimal levels of salinity, oxygenation, temperature, and nutrient supply. Both benthic and planktonic taxa are present in large numbers. Calcareous benthic taxa consist of Textulariids (*Spirorutilus carinatus, Textularia lanceolata*), Miliolids (*Adelosina longirostra, Pseudotriloculina consorbina, Pyrgo simplex, Quinqueloculina hauerina, Triloculina gibba, Spiroloculina excavata*), Lagenids (*Amphycorina badenensis, Dimorphina variabilis, Laevidentalina elegans, Lagena striata, Lenticulina vortex, Marginulina hirsuta, Neugeborina longiscata*), Robertinids (*Ceratocancris haueri, Hoeglundina elegans*), Buliminids (*Bulimina striata mexicana, Bolivina dilatata dilatata, Fursenkoina acuta, Stilostomella adolphina, Uvigerina grilli*), Rotaliids (*Amphistegina mamilla, Anomalinoides badenensis, Elphidium fichtelianum, Hanzawaia boueana, Heterolepa dutemplei, Lobatula lobatula, Neoepoides schreibersi, Pullenia buloides*) etc. Planktonic taxa (Globigerinids) are mainly represented by *Globigerina concinna, Globigerina bulloides, Globigerinoides quadrilobatus, Globigerinoides trilobus, Globoquadrina langhiana,* and *Orbulina suturalis.* The assemblages are similar to the ones described from the Vienna Basin by d'Orbigny (1846) and Karrer (1862, 1863, 1865), as well as from Lăpugiu by Neugeboren (1847, 1850, 1051, 1852, 1856) and from Coștei by Karrer (1868).

Biostratigraphically, the assemblages belong to the *Orbulina suturalis* Biozone of the Langhian (early Badenian) or to the Lagenid Zone of the Badenian.

Beside the information provided by the paleoecological characters of the identified taxa, the preliminary statistical data (BFOI, P/B ratio, relative abundance) are helpful for a better description of the paleoenvironment, mainly highlighting the sea-level changes at local scale.

References

Cicha I, Rögl F, Rupp C, Ctyroká J, 1998. Oligocene - Miocene foraminifera of the Central Paratethys. Abhandlungen der Senckenbergischen Naturforschenden Gesellschaft, 549, 1-325.

Karrer F, 1862. Uber das Auftreten der Foraminiferen în dem marinen Tegel des Wiener Beckens. Sitzber. k. Akad. Wiss., Math.-Naturwiss. Wien, 44/1, 427-458.

Karrer F, 1863. Uber des Auftreten der Foraminiferen in den brackischen Schichten (Tegel und Sand) des Wiener Beckens. Sitz. k. Akad. Wiss. Wien 48, 72-101.

Karrer F, 1865. Über das Auftreten der Foraminiferen in der Mergeln der marinen Uferbildungen (Leythakalk) des Wiener Beckens. Sitzber. k. Akad. Wiss., Math. - Naturwiss. Wien, 50/1-5, 692-721.

Karrer F, 1868. Die Miocene Foraminiferenfauna von Kostej im Banat. Sber. k. Akad. Wiss., Math.-Naturwiss. Wien, 58/1-2, 121-193.

Kövecsi S, Silye L, 2013. Badenian Benthic foraminifers from the Haţeg Basin. In: Ţabără D (ed.) - The 9th Romanian Symposium on Paleontology, Iaşi, October 25-26, 2013. 65.

Neugeboren JL, 1847. Über die Foraminiferen des Tegels von Felsö-Lapugy. Ber. Mitt. Freund. Naturwiss. Wien, 2, 163-164.

Neugeboren, J.L., 1850 - Der Tegelthon von Ober - Lapugy unweit Dobra und sein Gehalt an Foraminiferen - Gehausen. Verh. u. Mitt. sieb. Ver. Naturwiss. Hermannstadt, I, nr. 11, p. 163-171, Sibiu.

Neugeboren JL, 1851-1852. Foraminiferen von Ober - Lapugy. Verh. u. Mitt. sieb. Ver. Naturwiss. Hermannstadt, II, 8, 124-135; II, 9, 140-145; III, 3, 34-43.

Neugeboren JL, 1852. Foraminiferen von Ober-Lapugy beschrieben und nach der Naturgezeichnet. Vierter Artikel (Schluss). Verh. u. Mitt. sieb. Ver. Naturwiss. Hermannstadt, III, 50-59.

Neugeboren JL, 1856. Die Foraminiferen aus der Ordung der Stichostegier von ober-Lapugy în Siebenburgen. Denk. Akad. Wiss. Wien, Math. - Naturwiss. Wien, 12 (2), 65-106.

D'Orbigny A, 1846. Foraminiferes fossiles du Bassin Tertiaire de Vienne (Autriche). XXXVII, 312 p. Gide et Comp. Paris.

Papp A, Schmid ME, 1985. The Fossil Foraminifera of the Tertiary Basin of Vienna. Revision of the Monograph by Alcide d'Orbigny (1846). Abhandlungen der Geologischen Bundesanstalt Wien, 37, 107 p.

Cu-sulfosalts in Băiuţ Metallogenetic Field, Baia Mare District, Gutâi Mountains - preliminary scanning electron microscopy data

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Introduction

The Băiuţ metallogenetic field is situated in the north-western part of the Eastern Carpathians, in the Gutâi Mountains, and represents the easternmost section of Baia Mare metallogenetic district, Maramureş county (Borcoş & Gheorghiţă, 1976). At the scale of Baia Mare metallogenetic district three metallogenetic fields have been separated from west to east (Borcoş et al.,1984; Kovacs and Fülöp, 2010), as follows: *i*) Ilba – Nistru; *ii*) Săsar – Dealul Crucii; and *iii*) Herja – Băiuţ. The Săsar – Dealul Crucii metallogenetic field has a gold-silver character, while the other two are typically base metals with Au and Ag by products (Kovacs & Fülöp, in Iancu & Kovacs, 2010).

The geological structure of the Baia Mare metallogenetic district is built up of three major structural units, *i.e.* the pre-Neogene basement (Paleogene sedimentary rocks/flysch-like deposits), the Neogene sedimentary rocks cover, and the Neogene volcanic rocks (Săndulescu, 1984). The most important tectonic feature of Baia Mare metallogenetic district is represented by the west-east trending Bogdan Vodă-Dragoş Vodă fault system, located along the southern boundary of the Gutâi Mountains (Săndulescu, 1984; Borcoş, 1994).

The ore deposits from Baia Mare area are genetically linked to the Neogene volcanism which spanned in time from 15.4 to 7 Ma (Pécskay et al., 1995; Fülöp, 2003). Two types of volcanism were identified within Oaş - Gutâi Mountains (Kovacs & Fülöp, 2003), *e.g. i*) an early acid volcanism that started in Badenian, and *ii*) a subsequent intermediate volcanism, during Sarmatian and Pannonian.

The Băiuţ metallogenetic field is composed of three distinct Pb-Zn-Cu-Au(Ag) ore deposits, Breiner, Văratec and Cisma. The Breiner ore deposit is located in the western part of Băiuţ metallogenetic field and it is composed of ENE-VSV trending Robu and Băiuţ veins, altogether with Petru and Pavel vein which is parallel with Băiuţ vein and is situated in the southern part of the deposit (Edelstein et al., 1992). In its ENE section, the Băiuţ vein has two branches, Kelemen and Iosif respectively (Mariaş, 2005). The Văratec ore deposit is located in the central-western part of Băiuţ metallogenetic field and it is represented by Livia, Ioan, Alexandru and Botiza veins. Livia ore body represents the ENE continuation of Robu vein from Breiner ore deposit (Iştvan, 1992; Mariaş, 2005). The Cisma ore deposit, or more precisely Cisma and Poiana Botizei ore deposits are located in the eastern part of Băiuţ metallogenetic field and they are composed of Cisma, Banduriţa (Borcoş & Gheorghiţă, 1976; Damian et al., 2016), Prisăcele, Coasta Ursului and Olimpiu veins (Iştvan et al., 1995, Mariaş, 2005).

The Băiuţ area is an old mining centre with several centuries of mining activity. Among the modern investigations on the geology and on the ore deposits from this perimeter we may mention Stoicovici (1947), Dimitrescu & Bleahu (1955), Manilici & Kalmár (1973). More recent studies belong to Iştvan et al. (1995), Cook (1998), Damian & Costin (1999), Costin (2003 and 2005), Costin & Vlad (2005), Damian et al. (2016), and Plotinskaya et. al. (2012).

The first mention of enargite in Băiuţ area was made by András (2017) on the basis of optical microscopy observations. Apart enargite, András (2017) identified by optical microscopy several ore minerals in different mining fields, *i.e*. pyrite, chalcopyrite, galena, sphalerite, pyrrhotite, tetrahedrite, hematite and covellite. The present study offers the first SEM semi-quantitative chemical data suggesting the presence of enargite-type minerals in Băiuţ metallogenetic field. Enargite Cu_3AsS_4 (orthorhombic) is a Cu-sulfosalt (thioarsenate, according to Moëlo et al., 2008). It is dimorphous with luzonite (Cu_3AsS_4 - tetragonal) and it is a member of the luzonite - famatinite (Cu_3SbS_4) series.

Enargite has an important genetic significance indicating the sulfidation state of the sulfides mineral assemblage within epithermal ore deposits. The copper-rich sulfosalts mineral assemblages containing enargite, tennantite and pyrite is typically for high sulfidation and in a lesser extent for intermediate sulfidation epithermal ore deposits (Einaudi et al., 2003). Hedenquist et al. (1994) consider that enargite is an "exotic" ore mineral in low sulfidation epithermal ore deposits.

Since mid-1990'ies the ore deposits in Neogene Baia Mare metallogenetic district were considered to be typical examples of low sulfidation epithermal ore deposits (Mariaş, 2005; etc.). The presence of enargite in Băiuţ metallogenetic field may conduct to new metallogenetic interpretations of the epithermal ore deposits from Baia Mare district. However, mentioned until now only on the basis of optical properties, as stated above, the enargite from Băiuţ ore deposit field should be also confirmed by other analytical methods prior to any metallogenetic reinterpretation.

Material and Methods

The studied sample is represented by an ore fragment collected on the location of the former Cisma ore stock pile nearby Băiuţ processing plant. It consists of massive sulfides ore with galena, pyrite and quartz gangue visible macroscopically. The previous mineralogical study (András, 2017) revealed the mineralogy of the ore and the associated gangue minerals. This author identified microscopically galena, chalcopyrite, tetrahedrite, sphalerite, hematite, covellite, and enargite, while by X-ray diffraction was confirmed the occurrence of kaolinite as ubiquitous associated alteration/clay mineral.

The available polished sections were detailed studied using a Nikon Eclipse LV100N POL polarising microscope at "***Géosciences Environnement Toulouse - Observatoire Midi-Pyrénées***" (GET) from Toulouse, France. Additionally, representative microphotographs of the identified and unidentified minerals were also made. The optical microscopy study was enriched by SEM-EDS observations and semi-quantitative chemical analyses carried out using a JSM-6360 scanning electron microscope with a 20 kV voltage. The SEM investigations were made in GET laboratory from Toulouse, France as well.

Results

The reflected light ore microscopy revealed the presence of common sulfides in the studied polished sections. Besides galena, chalcopyrite, sphalerite and minor pyrite several other ore minerals were noticed under the optical microscope, *e.g*. tetrahedrite and hematite. Moreover, a mineral with a pale brown reflection colour with pinkish to greyish tint, a weak bireflectance and a strong anisotropy, violet to purple was also frequently observed. These optical properties certified by a series of microphotographs (Fig. 1 and 2a) are similar to those of enargite (Uytenbogaardt & Burke, 1971).

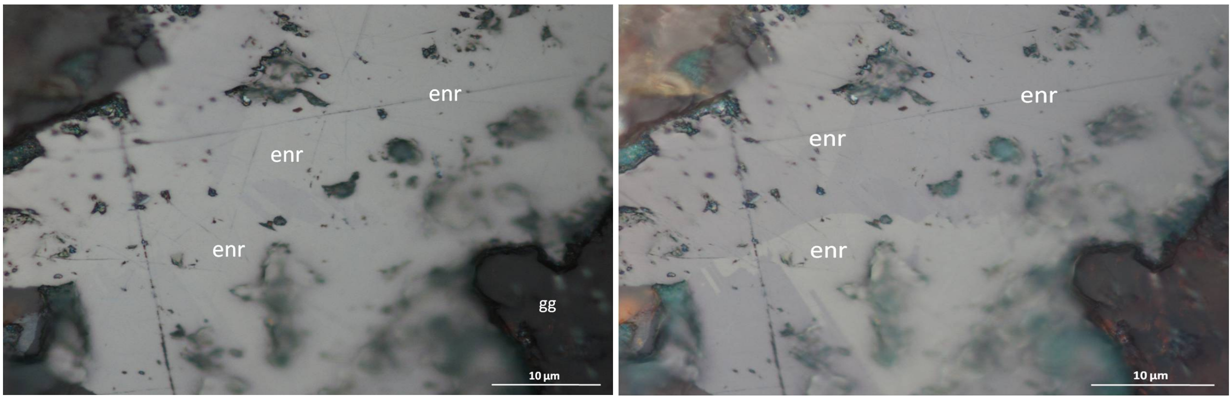

Fig. 1. Reflected-light microphotographs in plane-polarised light (a) and under crossed polarisers (b). a) Presumed enargite with pale brown reflection colour with greyish to purple tints due to its visible bireflectance; b) strong anisotropy with creamy and purple shades; the purple tint is more intense than in plane polarised light. Abbreviations: enr - enargite-like mineral; gg - gangue minerals.

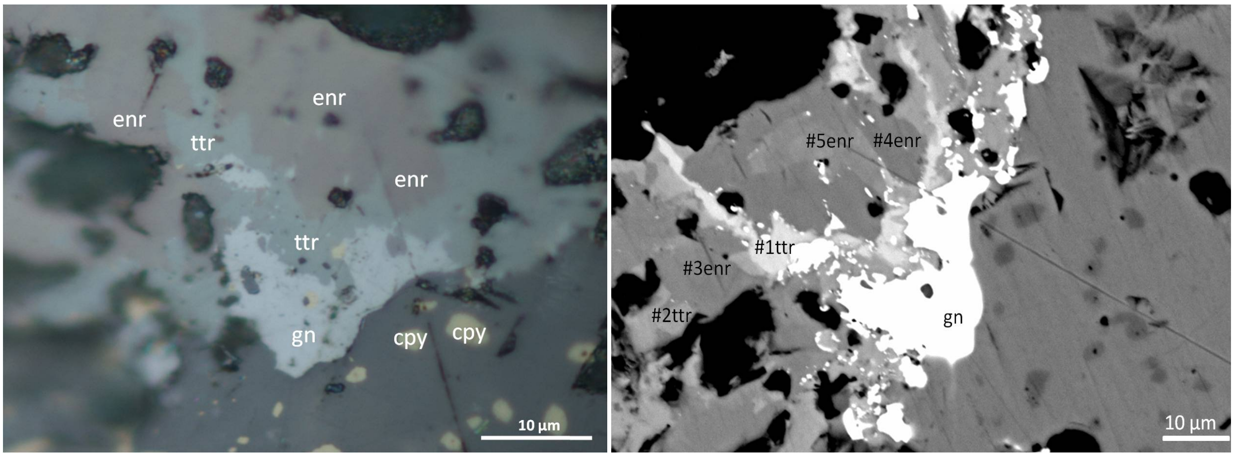

Fig. 2. Reflected-light microphotograph in plane-polarized light (a), and backscattered SEM image (b). a) Galena, tetrahedrite and presumed enargite accompanied by sphalerite with chalcopyrite inclusions; note the evident brownish reflection colour of presumed enargite grains and its weak but still visible bireflectance; b) the same image as (a) slighltly rotated counterclocwise, pointing out the chemical inhomogeneities within the presumed enargite grains. #1 to #5 represent the locations of SEM-EDS semi-quantitative chemical point analyses. Abbreviations: cpy - chalcopyrite; enr - enargite-like minerals; gn - galena; sph - sphalerite; ttr - tetrahedrite group minerals.

The optical microscopy observations were reinforced by additional SEM – EDS analyses that indicate approximately the chemistry of the analysed mineral grains. The obtained spectra confirm the occurrence of Cu-sulfosalts, *e.g.* Ag-bearing tetrahedrite-like composition (Fig. 3a), and enargite-like composition with some of As replaced by Sb (Fig. 3b).

Apart the spectra, semi-quantitative chemical data were also obtained for several mineral grains. These chemical data are summarized in Table 1, and they correspond to the point analyses shown in Fig. 2b.

Interpretation

Tetrahedrite $(Cu,Fe)_{12}Sb_4S_{13}$ is a member of the tetrahedrite mineral group, with the $A_{12}B_4X_{13}$ generalized chemical formula, where A = Ag, Cu, Fe, Hg, Zn; B = As, Sb, Te; X = S, Se, Te (Mandarino, 1999; Sack & Lichtner, 2009). According to the same authors, tetrahedrite group contains the following mineral species: argentotetrahedrite, argentotennantite, freibergite, giraudite, goldfieldite, hakite, tennantite and tetrahedrite. As concerns the discriminative optical microscopy properties in reflected light, tetrahedrite has a grey to olive brown reflection colour and it is isotropic (Uytenbogaardt & Burke, 1971).

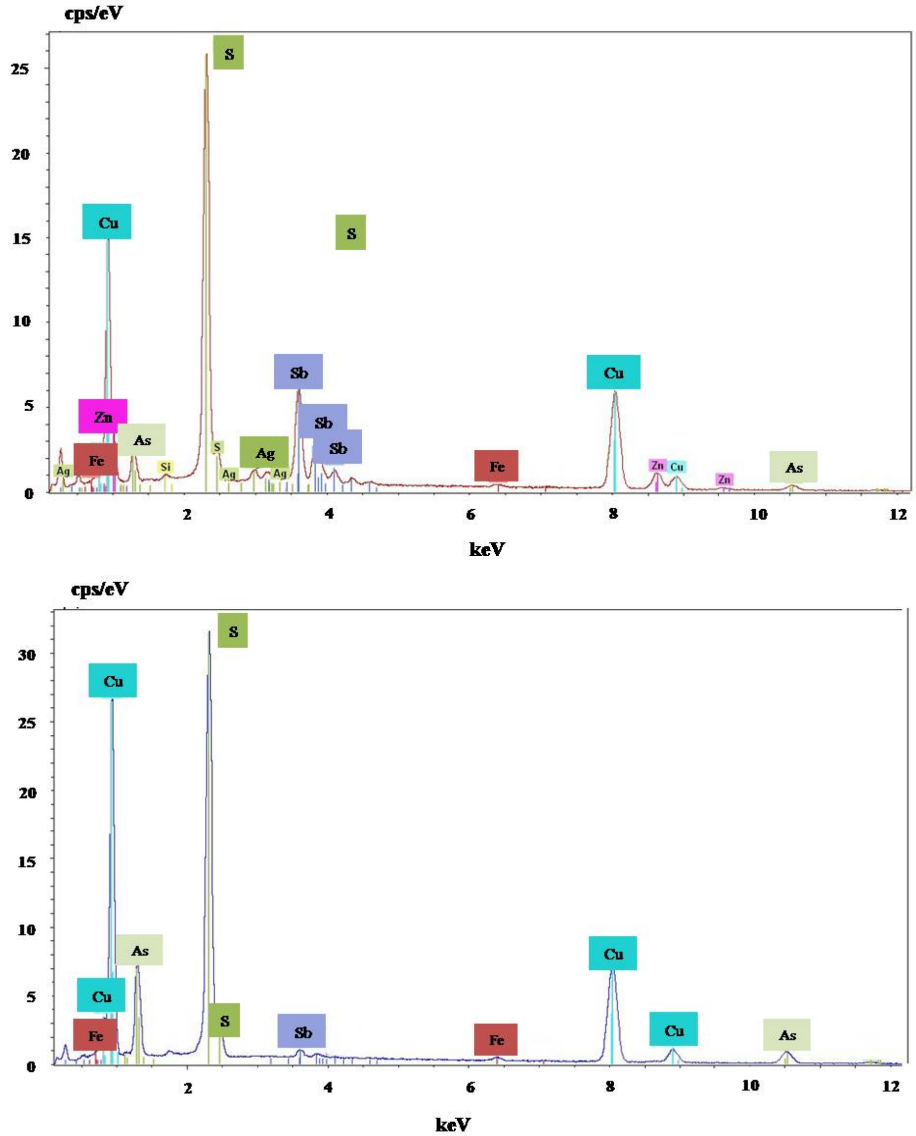

Fig. 3. Examples of SEM – EDS spectra obtained for the analyzed mineral grains from Băiuţ ore deposit; up) SEM-EDS spectrum of a tetrahedrite-like grain, corresponding to the semi-quantitative analyses BT4947_C3_#1 from Table 1; down) SEM-EDS spectrum of an enargite-like grain, corresponding to the semi-quantitative analyses BT4947_C3_#5 from Table 1.

Table 1. Semi-quantitative chemical data (in wt %) obtained for several mineral grains as shown in Fig. 2b. The first two rows correspond to tetrahedrite-like compositions, while the last three rows correspond to enargite-like compositions.

Point no. analysis	Cu	Ag	Zn	Fe	As	Sb	S
BT4947_C3_#1	38	2	8	1	6	23	22
BT4947_C3_#2	42	1	8	1	20	3	26
BT4947_C3_#3	49	0	1	1	18	2	29
BT4947_C3_#4	48	0	1	1	19	1	30
BT4947_C3_#5	48	0	0.12	1	15	7	28

According to Ianovici et al. (1979) enargite belongs to the enargite group, which contains the following mineral species: famatinite (Cu_3SbS_4), enargite (Cu_3AsS_4), samsonite ($Ag_4MnSb_2S_6$), geocronite ($Pb_5(Sb,As)_2S_8$), gratonite ($Pb_9As_4S_{15}$), lengenbachite ($Pb_9(Ag,Cu_2)As_4S_{13}$), jordanite ($Pb_{14}As_7S_{21}$), and lillianite ($Pb_3Bi_2S_6$). The most common minerals from the enargite group are enargite itself and famatinite. In plane polarised light enargite is greyish brown with a light pink tint and presents a strong purple red to olive green anisotropy, while famatinite is pale brown with a pinkish tint and has a strong yellow greenish to purple red anisotropy. Luzonite is the tetragonal dimorphous equivalent of enargite and it is pale brown with a pinkish tint in plane polarised reflected light, being quite similar to bornite and it shows a strong yellow greenish to purple anisotropy.

The available SEM-EDS data (Fig. 3 and Table 1) point out the presence of at least two groups of Cu-As-Sb bearing mineral species, *e.g. i*) tetrahedrite - tennantite, and *ii*) enargite (luzonite) - famatinite. Without EPMA quantitative chemical data the discrimination among related mineral species with close microscopic properties and quite similar chemical compositions should ground on both these properties.

As concerns the tetrahedrite-type minerals, one can notice that two mineral species were in fact analysed, as indicated by their contrasting chemistry regarding Sb vs. As participation (Table 1), and consequently different BSE appearance, whitish and greyish respectively (Fig. 2b). This facts are also reflected by the calculated chemical formulas, corresponding to the point analysis BT4947_C3_#1 and BT4947_C3_#2 (Table 1), *e.g.* $(Cu,Fe,Ag,Zn)_{12.82}(Sb_{3.20},As_{1.36})_{\Sigma=4.56}S_{11.63}$ (#1), and $(Cu,Fe,Ag,Zn)_{12.29}(As_{4.05},Sb_{0.38})_{\Sigma=4.42}S_{12.29}$ (#2).

As compared to the ideal chemical formulas of tetrahedrite vs. tennantite, $(Cu,Fe,Ag,Zn)_{12}Sb_4S_{13}$ vs. $(Cu,Ag,Zn,Fe)_{12}As_4S_{13}$, respectively it seems that the mineral grain #1 (Fig. 2b, Table 1) has a composition closer to tetrahedrite, while the mineral grain #2 (Fig. 2b, Table 1) is almost pure tennantite. This results are also sustained by the excess of (Cu,Ag,Zn,Fe) and S and the deficit in As within the analysed tennatite as compared to the analysed tetrahedrite which is (Cu,Ag,Zn,Fe) and S-poorer and Sb-richer. The same relationship exists among the ideal composition of tetrahedrite and tennantite.

The semi-quantitative chemical data corresponding to the analysed points no. #3 to 5 (Table 1) are close to the chemical composition of enargite-type minerals. Moreover, due to the As elevated content and Sb minor one, these chemical analyses suggest that the mineral grains analysed are closer to the As-rich member enargite, ideally Cu_3AsS_4. The calculated chemical formulas for each point analysis are $(Cu,Zn,Fe)_{3.27}(As_{0.98},Sb_{0.07})_{\Sigma=1.05}S_{3.68}$ (#3), $(Cu,Zn,Fe)_{3.16}(As_{1.05},Sb_{0.03})_{\Sigma=1.08}S_{3.75}$ (#4), and $(Cu,Zn,Fe)_{3.25}(As_{0.84},Sb_{0.24})_{\Sigma=1.08}S_{3.67}$ (#5), respectively. The chemical variability of the analysed mineral grains is closely reflected by different shades of grey of these mineral grains in BSE images (Fig. 2b).

The SEM-EDS semi-quantitative chemical compositions for the three analysed mineral grains (#3 to 5) and the calculated chemical formulas suggest that the chemistry of the analysed mineral grains is quite close to enargite-luzonite, the As-rich member of enargite-famatinite series. In the absence of X-ray data the distinction between enargite and its dimorphous luzonite would be possible by the means of microscopic properties. While the optical properties of enargite and luzonite in plane polarised light are quite similar, these two minerals have different anisotropy, *i.e. i*) strong purple red to olive green for enargite, and *ii*) strong yellow greenish to purple for luzonite. The optical microscopy study pointed out that the observed anisotropy of the mineral grains #3 to 5 is closer to those of enargite, with no yellow greenish shades.

Conclusions

Optical microscopy combined with SEM-EDS semi-quantitative data allowed us to confirm the presence of tetrahedrite, tennatite and enargite in ore samples from Băiuţ metallogenetic field. While tetrahedrite and tennatite are more common sulfosalts in Baia Mare metallogenetic district, the occurrence of enargite represents the first mention of this mineral in the whole Baia Mare area. The available semi-quantitative data for enargite indicate that As is partially replaced by Sb. Due to the semi-quantitative character of the available chemical data, not negligible deviations of the calculated chemical formulas as compared to the ideal ones exist. More accurate chemical data, *e.g.* EPMA analyses could ultimately confirm the occurrence of enargite in Băiuţ metallogenetic district and give its accurate chemical composition.

References

András K, 2017. Mineralogical study of the ore deposits from the Băiuţ district (Maramureş county), focusing on the Văratec, Cisma, Coasta Ursului, Johan Hell, Breiner and Poiana Botizei deposits. Master`s thesis, Babeş – Bolyai University in Cluj Napoca, 75 p (in Romanian).

Borcoş M, 1994. Neogene volcanicity/metallogeny in the Oaş – Gutâi Mts, in: Borcoş, M., Vlad, S. eds., Plate Tectonics and Metallogeny in the East Carpathians and Apuseni Mts., Field trip guide for IGCP Project no. 356, 20-22.

Borcoş M, Gheorghiţă I, 1976. Neogene hydrothermal ore deposits in the volcanic GutâiMountains. IV. Băiuţ - Văratec - Botiza metallogenic field. Rev. Roum. Geol.,Geophys. et Geogr., Geologie, 20 (2), 197-209.

Borcoş M, Kräuter HG, Udubaşa G, Săndulescu M, Năstăseanu S, Biţoianu C, 1984. Mineral resources map. Sc. 1:1 000 000 with explanatory text, second ed., Inst. Geol. Of Romania, Bucharest.

Cook NJ, 1998. Bismuth sulfphosalts from hydrothermal vein deposits of Neogene age, NW Romania. Mitt. Österr. Miner. Ges. 143, 19-39.

Costin D, 2003. Compositional data on bournonite – CuPbSb3 from Văratec ore deposit, Băiuţ mine field, Eastern Carpathians, Romania. Studia Univ. Babes – Bolyai, Geologia, Cluj Napoca, 48 (1), 45-54.

Costin D, 2005. The petrology, mineralogy and geochemistry of the epithermal system of the Văratec – Băiuţ deposit, Romania (in Romanian). PhD Thesis, Babes–Bolyai University in Cluj Napoca, 302 p.

Costin D, Vlad Ş, 2005. Ore formation at Văratec–Băiuţ, Baia Mare region, East Carpathians, Romania. IGCP no. 486, Proceedings of the 2005 Field Workshop, Kiten, Bulgaria, 14-19 September 2005. Geochemistry, Mineralogy and Petrology, 43, 64-68.

Damian G, Costin D, 1999. New data about the bismuth sulphosalts from the hydrothermal mineralisations from Văratec-Băiuţ, Baia Mare District. Rom. J. of Mineralogy Bucharest, 79, Suppl. 1, 28.

Damian G, Damian F, Konečný P, Kollárová V, 2016. A new occurence of wolframite-ferberite in Romania. Rom. J. Mineral Deposits, 89 (1-2), 49-54.

Dimitrescu R, Bleahu M, 1955. Geological researches in the Băiuţ (Baia Mare) area. Dări de Seamă ale Şedinţelor, Comitetul Geologic, 39 (1951-1952), 48-54.

Edelstein O, Iştvan D, Kovacs M, Bernad A, Stan D, Iştvan E, Gabor M, Balint B, Haranth G, Vârşescu I, 1992. Preliminary data regarding the K-Ar ages of some eruptive rocks from Baia Mare Neogene volcanic zone. Rev. Roum. Geol. 36, 45-60.

Einaudi MT, Hedenquist JW, Inan EE, 2003. Sulfidation state of fluids in active and extinct hydrothermal systems: transition from porphyry to epithermal environments. Society of Economic Geologists Special publication Series, 10, 283-313.

Fülöp A, 2003. The beginning of the volcanism in the Oaş Mountains. Paleovulcanology and paleosedimentology reconstituitions. Ed. Dacia, 134 p., Cluj Napoca.

Hedenquist JW, Matsuhisa Y, Izawa E, White NC, Giggenbach WF, Aoki M, 1994. Geology, geochemistry, and origin of high sulfidation Cu-Au mineralization in the Nansatsu district, Japan. Economic Geology, 89, 1-30.

Ianovici V, Stiopol V, Constantinescu E, 1979. Mineralogy. Ed. Did. si Ped. Bucharest, 827 p. (in Romanian).

Iştvan D, Vârşescu I, Halga S, Grancea L, 1995. Gold-silver epithermal levels and associations in the eastern area of the Gutai Mts. and in the Văratec Mts. (Firiza- Botiza area), East Carpathians, Romania. Studia Universitatis Babes-Bolyai, Geologia, 40 (1), 195-210.

Kovacs M, Fülöp A, 2003. Neogene volcanism in Gutâi Mts. (Eastern Carpathians): a review. Studia Universitatis Babeş-Bolyai, Geologia, Cluj Napoca, 48 (1), 3-16.

Kovacs M, Fülöp A, 2010. Stop 4: Laleaua Albă quarry: a composite igneous body. In: Iancu, O.G., Kovacs, M., (Eds): Ore deposits and other classic localities in the Eastern Carpathians: from metamorphics to volcanics. Acta Mineralogica Petrographica, Szeged, Hungary, Field guide series, 19, 32-35.

Mandarino JA, 1999. Fleischer's Glossary of Mineral Species 1999. The Mineralogical Record Inc., Tucson, 225 p.

Manilici V, Kalmár I, 1973. Certains observations sur la genese de la mineralizations de Baiut, Varatec et Cisma - Coasta Ursului (district Baia Mare, Roumanie). Simposion international de volcanism et de metallogenese associee, Bucharest, 16-21.

Mariaş ZF, 2005. Metallogeny of the Baia Mare mining district. An approach based on the Cavnic hydrothermal system, comparision with other epithermal systems in the world. Editura Cornelius, 450 p. (in Romanian).

Moelo Y, Makovicky E, Mozgova NN, Jambor JL, Cook N, Pring A, Paar W, Nickel EH, Graeser S, Karup-Moller S, 2008. Sulfosalts systematics: a review report of the sulfosalt sub – committee of the IMA commission on ore mineralogy. Eur. J. Miner., 20 (1), 7-46.

Pécskay Z, Edelstein O, Seghedi I, Szakács A, Kovacs M, Crihan M, Bernad A, 1995. K-Ar datings of Neogene – Quaternary calc–alcaline volcanic rocks in Romania. Acta Vulcanica, 7 (2), 53-61.

Plotinskaya OY, Prokofiev VY, Damian G, Damian F, Lehmann B, 2012. The Cisma deposit, Băiuţ district, Eastern Carpathians, Romania: sphalerite composition and formation conditions. Carpathian Journal of Earth and Environmental Sciences, May 2012, 7 (2), 265-273.

Sack RO, Lichtner PC, 2009. Constraining compositions of hydrothermal fluids in equilibrium with polymetallic ore-forming sulfide assemblages. Economic Geology, 104, 1249-1264.

Săndulescu M, 1984. Geotectonics of Romania. Ed. Tehnică, Bucharest, 336 p. (in Romanian).

Stoicovici E, 1947. Cristalografie morfologică: caiet de lucrări practice la mineralogie. Cluj, 73p.

Uytenbogaardt W, Burke EAJ, 1971. Tables for microscopic identification of ore minerals. Second revised edition. Elsevier, Amsterdam, 390p.

New data concerning structural elements and lithology in the eastern part of Meseș Massif

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Key words: reverse fault, lithology

New samples and datasets collected from the field provide new important information about the structure and lithology of the contact between Meseș Massif and sedimentary formations of the Transilvanyan Basin.

One of the most important results is the confirmation that the Meseș fault located at the contact of the Meseș Massif and the Transylvanian Basin is a reverse one. This fault was mentioned before as a reverse fault on the Mezeș sheet of the Geological Map of Romania, scale 1:25 000 (Rusu et al., 1977), but in order of recently interest in infrastructure projects in the area, checking of this fault and other major structural elements has become important.

The Meseș Fault was observed in recent drilling, which first penetrated a soil cover and slope deluvial material (mixture of soil and fragment of crystalline schists), followed by 45 m of metamorphic rocks. Next 15 m consist of fault breccia which is continued with 30 m of red clays, brown clays and sandstones wich belong to the sedimentary deposits of Moigrad and Curtuiuș formations (Oligocene). A similar lithology was observed in two other drillings, made right at the contact of the massif with the Transylvanian Basin: soil cover on the top, delluvial material with crystalline fragments, marls, sandstones and clays.

Reference

Rusu A, Popescu B, Moisescu V, Ignat V, Marinescu F, Popescu A, 1977. Harta geologică a României, scara 1:50000, foaia 29C Mezeş, Institutul de Geologie şi Geofizică, Republica Socialistă România.

The clays from the Cetăţuia - Hoia Hill: mineralogical and physico-mechanical characteristics

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Key words: clay geotechnical properties, clay mineralogy, slope stability, Moigrad Formation, Cluj-Napoca, Romania

Clay mineral composition plays an important role in the physico-mechanical behaviour of soils. Both the type and amount of clay minerals determine the way in which soils act in regard to deformations. Clay minerals lower soil resistance, increase soil plasticity and facilitate failure. As a result, flows and/or landslides can develop.

We present the results of lithological, geomorphological, physico-mechanical and mineralogical analyses of the clayey, fluvial deposits from the Moigrad Formation (Rusu, 1970). The studied area is located in Cluj-Napoca, on the south-facing slope of Cetăţuia-Hoia Hill, east of the Tăietura Turcului street. The area covers about 2 hectares and has been known in the past as having stability problems (Poszet, 2011; Vîjdea & Cociuba, 2013).

Lithological descriptions were obtained from two outcrops and four continuous core drillings, conducted at depths of 20-30 m. Surface geomorphological data, slope declivity measurements, as well as strike-dip measurements were also acquired. Geotechnical analyses (grain-size analysis, moisture content, liquid and plastic limits, swelling capacity, drained shear tests) were performed in order to assess the physico-mechanical behaviour of the clays and their effect on slope stability. X-ray powder diffraction analyses on bulk samples were carried out to determine the mineralogical composition of the clays. Diffraction analyses on oriented samples of clay size particles (<2 µm), ethylene-glycol treated samples and thermally treated samples were used to determine the clay minerals and their relation to the geotechnical properties.

Lithologically, the investigated deposits are red, brown, grey and bluish-grey clays, silts, silty clays and clayey silts, grey clayey sands and silty sands and white sandstones. The only sedimentary structures noticed are parallel laminations. Friction breccias and slickensides were found at depths of 18 to 20 m. Strike-dip measurements give a general NW-SE bedding direction and dips of ~13-15º towards NE. Tension gashes, landslide scarps and lobes, a fracture, a suffosion sinkhole, gullies and a flow deposit shape the landscape. Anthropic interventions include fillings, excavations and terracing. Slope declivity varies across the perimeter. Inclinations on scarps and lobes range from 27 to 55º, with values of 50-55º in anthropic excavations and 7-13º on terraces.

The analysed samples consist of quartz, feldspar, clay minerals, chlorite, muscovite, calcite and scarce dolomite, while the clay fraction (<2 µm) is made up of montmorillonite, illite, kaolinite and/or chlorite. Moisture content (w) varies from 11.4 to 26.9 %. Samples plot within the range of medium ($30<Ip<50$) and high ($Ip>50$) plasticity on Casagrande's chart. The relative consistency (Ic) is generally higher than 1, with some exceptions. Six samples investigated reached the moisture content at which they behave in a plastic manner ($w \geq w_P$; $Ic<1$) and are already prone to plastic deformations. The plasticity index plotted against clay-size fraction yielded three activity lines, indicating that plasticity is influenced not only by the amount of clay size particles, but also by their composition. The overall swelling capacity of the clays is very high (170-550%), yet some samples have high (105-120%), medium (90-

100%) or small (10%) swelling capacity. Swelling capacity generally increases with the amount of clay particles. Deviation from the linear trend does exist and the sample with the highest swelling capacity (550%) did not follow the general trend. Effective friction angles range from 6.7 to 33.7º and clay cohesion strength ranges from 7 to 73 kPa. Effective friction angles decrease with the increase of clay size particles. The small value of 6.7º might be due to previous shearing.

Lithological correlations between the borehole investigations and the two outcrops on the general N-S direction were problematic. The strata seem to correlate only if general dipping was towards S, which is impossible when compared to outcrop measurements (NE dipping). This is further complicated by variations typical of fluvial depositional environments. Pre-existent slip surfaces could explain the apparent southward dipping of the strata. Geomorphological traits and the presence of failure structures (friction breccias, slickensides) support this theory. The strata correlation in the W-E direction and the depth at which the failure structures were encountered indicates the presence of a large landslide. Based on the spatial distribution of scarps and lobes, it might be assumed that the landslide is rotational and probably has two or more steps.

The geotechnical results indicate that the studied deposits are active, susceptible to plastic deformatios and volume changes. Such properties decrease the clays' strength and alongside tension gashes, fractures and high slope angles compromise slope stability. Moreover, pre-sheared clays represent minimum resistance surfaces where increases in shear forces could provoke landslide reactivation. The deposits probably exhibit both transitional and sliding shearing behaviour, so one should expect either flows or slides if/when slope instability develops.

The general increase in plasticity, activity, swelling capacity and decrease of effective friction angles with the amount of clay size particles underline the influence that clay minerals have over the geotechnical properties. Based on present data, we can assume that montmorillonite is the dominant clay mineral from the Moigrad Formation deposits. The clay minerals determined in the <2 μm fraction present increasing plasticity, activity, swelling capacity and decreasing shear strength in the following order: chlorite, kaolinite, illite and montmorillonite. Variations within mineral species can occur due to differences in specific surface, cation exchange capacity, electrical charges of the exchangeable cations and pore water chemistry. Most of our samples have activity values >1, plastic index >50 and swelling capacity >100%, indicating that montmorillonite has the strongest influence on the physico-mechanical properties. Variations between samples could be explained by different proportions of montmorillonite-illite-kaolinite-chlorite, the presence of interstratified clay minerals or changes due to chemical differences in illites and montmorillonites, in which respect further investigations are required.

References

Poszet SL, 2011. Studiu de geomorfologie aplicată în zona urbană Cluj-Napoca. Teză de doctorat, Universitatea Babeş-Bolyai, Facultatea de Geografie, Catedra de Geografie Fizică și Tehnică, Cluj-Napoca, 157 p.

Rusu A, 1970. Corelarea faciesurilor Oligocenului din regiunea Treznea - Bizuşa (NV Bazinului Transilvaniei). Studii şi Cercetări Geologice, Geofizice, Geografice, Seria Geologie, 15(2), 513-525.

Vîjdea A, Cociuba I, 2013. Descrierea geohazardelor pentru Cluj-Napoca. PanGeo D7.1.33, 126 p.

Cyclic sedimentation of the Uppermost Jurassic-Lowermost Cretaceous limestones from the central part of the Piatra Craiului Massif (Vlăduşca Section)

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Piatra Craiului Massif is located in the easternmost part of the Southern Carpathians, Romania. The carbonate succession from this area forms a 20 km long, NE-SW oriented calcareous ridge which has an average thickness of 800 m. Vlăduşca Section is located in the central part of the Piatra Craiului Massif.

The carbonate beds are forming decimeter thick banks with high dip. In terms of facies, the following types of lithologies are common: intraclastic peloidal grainstone with *Rivularia* type cyanobacteria, ooidic grainstone, alternating peloidal grainstone and laminoid fenestral wackestone, oncoidic wackestone with *Rivularia* type cyanobacteria, fenestral laminoid wackestone, fenestral wackestone with *Rivularia* type cyanobacteria, intraclastic mudstone/wackestone with rare foraminifera [*Anchispirocyclina lusitanica* (Egger)], non-fossiliferous homogeneous mudstone, microbial-cyanobacteria mats (cyanobacteria bindstone) and mudstones with calcrete features. Intraclastic coarse peloidal grainstones characterise high energy upper subtidal/intertidal environments, fenestral wackestones characterise restricted intertidal environments while non-fossiliferous mudstones define supratidal depositional settings.

In terms of vertical stacking patterns, the entire succession is characterised by the repetition of distinct sets of parasequences. Each parasequence commonly shows a shallowing upward trend. This trend is defined by a vertical scale transition from high energy, upper subtidal/intertidal channels to intertidal beaches and supratidal swamps and ponds. Normally, high energy subtidal or intertidal surfaces are capping the shallowest facies of the corresponding parasequence.

Mineralogo- petrographical studies on Dragsani terrain greenshists in the Baru Mare area (Retezat Mountains)

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Key words: Retezat, Dragsani terrain, epidote geothermometry

The Retezat Mts consist of a complex tectonic structure with Alpine and Variscan nappes (Fig. 1), followed by Tertiary transcurrent events.

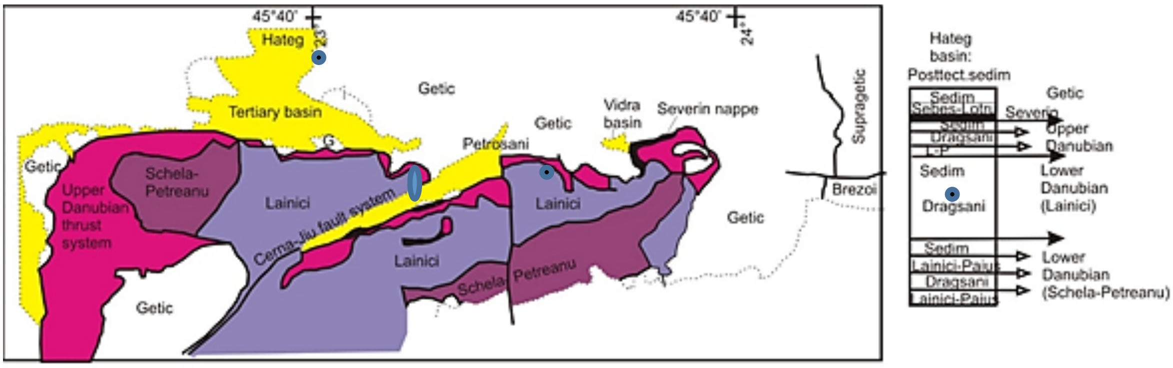

Fig. 1. Tectonic sketch of Retezat Mts, beside the Hateg basin basement section: Variscan nappes composed by Lainici- Paius and Dragsani terrain rocks in the Danubian Unit; Austrian Getic nappe, which is consists of Sebes-Lotru terrain rocks, thrusted over the Danubian autochton unit; Laramian nappes, due to remobilization of older tectonic contacts from Danubian autochton unit (Lower Danubian nappes: Schela- Petreanu and Lainici, overthrusted by Upper Danubian nappes) and simultaneously all Alpine sequences were detached and moved over the Moesian platform. (Ratschbacher et al, 1993, modified). It is marked by blue ellipse the sampling profile along the Barusoru Creek.

The topic of our study was to establish the Dragsani terrain mineral- petrographic evolution, which take part both in the autochton unit of Alpine Getic nappe, and in the Varistic Lainici nappe, along the Barusoru Creek. Along this creek is outcropping a thick Alpine brittle- ductile shear zone of Getic nappe, associated with an intensive dynamic retrogressive process which transformed the Dragsani terrain rocks (metamorphosed in amphibolite up to granulitic facies conitions) into a greenschists. Could be observed the relative high frequency of epidote- clinozoisite group minerals in the rocks mineral assemblages, which appear to memorize by its compositions the metamorphic evolution of host rocks. (Grapes & Hoskin, 2004).

The evidenced mylonitic schists were: sericite- chloritic schists with feldspar porphyroblasts (albite, relic plagioclase), epidote-bearing retromorphosed banded amphibolites, augen gneisses, chlorite- carbonate schists and retromorphosed granulites.

Our researches comprised: mesoscale field observations and sampling, completed by petrographical, microstructural and paleopiezometrical observations in thin section, mineral identifications by XRD and microprobe methods.

The petrographic studies evidenced two mineral assemblages: first, peak metamorphic relics (sillimanite, hedenbergite, magneziohornblende, labradorite) and the second, a retrogressive mineral assemplage in greenschist facies conditions (epidote group minerals, albite, chlorite, actinolite, titanite, phengitic white mica, wollastonite and chalcopyrite. In these rocks was evidenced wollastonite (by optical microscopy, XRD and microprobing) as upper greenschist facies condition mineral (400-500°C, after Hawley & Wobus, 1977).

Were studied compositional zonality by microprobing two epidote grains (of 300μm and 100μm sizes) along two transversal sections and were evidenced: a large core zone, characterized by X_{Fe} > 39 (it could mean a higher metamorphic grade or a relic magmatic protolith), surrounded by a thin (~20 μm) rim zone with X_{Fe} = 25–30, specific for greenschist facies conditions (Grapes and Hoskin, 2004). Beside the zoned epidote porphyroblasts, there are another generation of very fine grained epidote group minerals, which appear to be resulted by dynamic recrystallisation of porphyroblasts rim zone. The paleopiezometrical determinations on dynamically recrystallised quartz and feldspars (Passchierre & Trouw, 2005) evidenced a flow stress of 1-2 kbar. Dynamic recrystallysation mechanism, observed in thin sections (subgrain rotation - for quartz and bulging - for feldspars) revealed 400- 450°C as possible temperature for the Getic nappe shear zone in the Baru Mare area.

References

Grapes RH, Hoskin PWO, 2004. Epidote Group Minerals in Low–Medium Pressure Metamorphic Terrains, Reviews in Mineralogy and Geochemistry 56 (1), 301-345.

Passchier CW, Trouw RAJ, 2005. Microtectonics. (Springer), 300 pp.

Hawley CC, Wobus RA, 1977. General Geology and Petrology of the Precambrian Crystalline Rocks, Park and Jefferson Counties, Colorado. Geological Survey Professional Paper, 608-B.

Ratschbacher L, Linzer H-G., Moser F, Strusievicz RO, Bedelean H, Har N, Mogos PA, 1993. Cretaceous to Miocene thrusting and wrenching along the Central South Carpathians due to a corner effect during collision and orocline formation, Tectonics, 12 (4), 855-873.

Micropalaeontological data analysis using open-source tools: a case study

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Key words: palaeontology, data processing, statistical analysis, free and open-source software, Python

As fields of science, palaeontology and especially micropalaeontology often yield a significant amount of data, whether ecological, morphological or phyllogenetic in nature, which require statistical methods in order to be fully capitalized. While there are already several applications enabling such studies, none are open-source (providing the source code freely in order to be modified or adapted).

Our newly developed application has included so far a number of commonly used univariate indices, such as: the Fisher alpha (Fisher et al. 1943), Shannon (Shannon, 1948), Simpson (Simpson 1949) and Hurlbert (Hurlbert, 1971) diversity indices, Pielou's equitability (Pielou, 1977), relative abundances for chosen species, P/B ratio, morphogroup contributions, BFOI (Benthic Foraminifera Oxygen Index - Kaiho, 1994) and the SHE index (Buzas & Hayek 1998). The further versions are supposed to include multivariate indices, including K-means clustering, hierarchical clustering in the form of dendrograms and multi-dimensional scaling.

The proof-of-work shows the current status of our efforts - a program written in the Python 3 programming language, which uses .xlsx spreadsheets as input and returns an image in the .svg format containing the processed data. Examples on multiple datasets is shown for each function.

Our aim is to offer a program dedicated to micropalaeontology which is fast, easy and simple to use while providing advanced features. Proper documentation will be added, together with the possibility to be adapted to the user's needs or to be integrated in other applications.

References

Buzas MA, Hayek LC, 1998. SHE analysis for biofacies identification. Journal of Foraminiferal Research, 28 (3), 233-239.

Fisher RA, Corbet AS, Williams CB, 1943. The relation between the number of species and the number of individuals in a random sample of an animal population. Journal of Animal Ecology, 12, 42-58.

Hurlbert SH, 1971. The Nonconcept of Species Diversity: A Critique and Alternative Parameters. Ecology, 52 (4), 577-586.

Kaiho K, 1994. Benthic foraminiferal dissolved-oxygen index and dissolved-oxygen levels in the modern ocean. Geology 22, 719-722.

Pielou EC, 1977. Mathematical ecology. Willey, 385 p.

Shannon, C.E.. 1948. A Mathematical Theory of Communication. The Bell System Technical Journal, 27 (3), 379-423.

Simpson EH, 1949. Measurement of diversity. Nature, 163, 688.

Microfacies and microfossils in Mesozoic limestone from "Piatra Ciorii" area, Pui-Bănița zone (Hunedoara county) – preliminary data

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Key words: carbonates, microfacies, microfossils, Barremian – lower Aptian.

The purpose of this study is to identify and describe the main microfacies and microfossil assemblages from one outcrop (near Piatra Ciorii) located in Hunedoara county, on the left side of the road towards Petroșani city (approx. 8 km from Petroșani).

For the present study, 28 limestone samples were collected for thin-section analysis. Thirty-five thin sections were made in order to describe the most important microfacies traits.

The outcrop of carbonate deposits from Piatra Ciorii area belongs to the Getic Domain, more precisely to the Pui Zone sedimentary area described by Stilla (1971), containing mostly Jurassic, Lower Cretaceous, and Upper Cretaceous (Cenomanian) formations. Within Pui-Bănița sedimentation area, the sedimentary sequence starts with Lower Jurassic deposits, followed by the Mid-Jurassic represented mostly by siliciclastic deposits and carbonates (in the uppermost part). The Upper Jurassic and Lower Cretaceous are characterized mainly by shallow-water carbonate deposits (Stilla, 1971; Stilla et al., 1971; Balintoni, 1997). They are covered by Cenomanian breccia and conglomerates containing Upper Jurassic and Lower Cretaceous elements.

The Cenomanian conglomerates and breccia from Piatra Ciorii area contain numerous limestone components generally developed in Urgonian facies. They are similar in terms of microfossil associations with many carbonates from other areas of the Romanian Carpathians (Bucur, 2006).

Thin section analysis permitted the identification and assignment of the following microfacies types: *peloidal-bioclastic grainstone, peloidal-bioclastic, grainstone/rudstone* (with cracks and fissures filled with spar-calcite and sometimes red-micritic cement), *bio-peloidal packstone with rare ooids* (with irregular shapes and thick micritic cortices surrounding the main bioclasts), *bioclastic wackestone* (with rare textulariid and miliolid foraminifera) and *carbonate micro-breccia* (with packstone-grainstone intraclasts with ferrous oxyhydroxides rims between the main components).

The following microfossils were identified within the limestone samples of the conglomerates from Piatra Ciorii area: dasycladalean algae [*Salpingoporella muehlbergi* (Lorenz), *Salpingoporella pygmaea* (Gümbel), *Zittelina hispanica* (Masse et al.), *Cylindroporella ivanovici* (Sokač), *Montiella elitzae* (Bakalova), *Pseudoactinoporella fragilis* (Conrad)], udoteacean algae [*Boueina hochtetteri* (Toula)], foraminifera [*Banatia aninensis* (Schlagintweit & Bucur), *Derventina filipescui* (Neagu), *Paracoskinolina maynci* (Chevalier), orbitolinid foraminifera, corals, calcified sclerosponges, gastropods, bivalve fragments and microbial crusts and microstructures. This microfossil association assign a late Barremian–early Aptian age to the limestones pebbles and cobbles in the conglomerates from Piatra Ciorii area.

Concerning the depositional environment, the main microfacies types were assigned to the platform margin (peloidal-bioclastic grainstone, peloidal-bioclastic, grainstone/rudstone) and to more internal environments (bio-peloidal packstone with rare ooids and bioclastic wackestone) of an eroded carbonate platform. Regarding the identified platform margin carbonates, the shape of the grains (sub-angular to sub-rounded) and their low to moderate sorting of the grains, indicates that these limestones were formed in an environment with different hydrodynamic regime (mainly upper slope and bioclastic shoals with dasycladalean algae and benthic foraminifera). The inner-platform limestones are characterized by microbial activity (cyanobacteria oncoids, micritic rims) and scarce biota. Moreover, the presence of numerous ferrous oxy-hydroxides within fractures may indicate a possible subaerial exposure of the carbonate platform.

References

Balintoni I, 1997. Geotectonica Terenurilor Metamorfice din România. Editura CARPATICA, Cluj-Napoca, 176 p.

Bucur II, 2006. Urgonian limestones from Romania: An overview. Proceedings XVIIIth Congress of the Carpathian-Balkan Geological Association September 3-6, 2006, Belgrade, Serbia, 49-52.

Stilla A, 1971. Zona Pui şi Bazinul Haţeg – unităţi structurale distincte în Carpaţii Meridionali. D. S. Inst. Geol. Rom., 58 (5), 173-176.

Stilla A, Dragastan O, Dumitru I, 1971. Consideraţii stratigrafice asupra faciesului carbonatat recifal din zona Pui (Carpaţii Meridionali). D. S. ale Sedinţelor, 58, 123-135.

Mid-Holocene sedimentology of aeolian particles from Rodna Mountains

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Key words: geochemistry, storminess, magnetics, radiocarbon, multiproxy.

Aeolian particles deposited in ombrogenous bogs come from different sources from regional (e.g. dust) to more local sources (sand). Their formation, transport and deposition can vary over time, mainly by climatic characteristics (e.g., precipitation, wind speed, the movement of air masses). Ombrogenous bogs are formed above ground water and therefore all the mineral inputs come from the atmosphere, which makes them suitable for reconstructing past aeolian fluxes.

Here, we have applied three different methods (geochemical-XRF, manual and laser-based particle size analysis and magnetics parameters) to an ombrotrophic peat profile from Rodna Mountains to determine changes in aeolian deposition, and wind / storm activity in the mid Holocene period (8000-4500 cal. years BP).

In this period, the studied peat usually contains less than 4% of inorganic sediment. The clastic particles contained in the peat vary in size from clay to coarse sand. The main part is consisted of silt (85%), varying from fine to coarse. The average particle size varies from 7 µm to 52 µm. In terms of mineralogical composition, the sand particles consist of mainly quartz (92%), calcite (1%) and rarely feldspar, sulphur, mica (biotite and muscovite), magnetite. The shape of the sand particles varies from well-rounded to sub-angular and angular shape, indicating different source areas.

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Intraspecific variations in *Plagioptychus* genus (rudists bivalves) from the Late Cretaceous deposits of the Apuseni Mountains, Romania

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Key words: *Plagioptychus*, taxonomy, Late Cretaceous, Apuseni Mountains.

Genus *Plagioptychus* (Matheron, 1842) belongs to the family Plagioptychidae (Douvillé, 1888) being characterized by a shell with both valves differing in form and size. The shape of right valve (RV) is gyropleuriform or low conical, with attachment surface at the posteriordorsal margin. Left valve (LV) is convex with a wide umbo only slightly coiled anteriorly, projected dorsally, and covering parts of the right valve. The myocardinal organization essentially includes two subequal teeth and myophores in LV, and one, robust, central tooth in RV. The most important character of the *Plagioptychus* genus consists in the presence of pallial canals in the inner, originally aragonitic layer of the left valve (LV) because the pattern of pallial canals around anterior, ventral and posterior margins of the LV is traditionally considered to be diagnostic at the species level. *Plagioptychus* genus currently contains 29 species described both from American (9 species) and European Tethys (20 species) being identified only from the Upper Cretaceous deposits. First European representatives of the genus, *Plagioptyhcus haueri* (Teller, 1877) appeared in early Turonian (Czech Republic, Austria), while *Pl. aguilloni* (d'Orbigny, 1840) represents the last European plagioptychid that occurs in the late Campanian; in Maastrichian *Plagioptychus* genus is relativ rare in Europe and Mediteranean Tethys then became extinct.

The main aim of this study is the identification and description of the plagioptychid rudist species from the Upper Cretaceous deposits of the Apuseni Mountains, based mainly on the specimens collected by the author, but also on the revision of fossil material described by Lupu (1976) and taking into account the recent taxonomic and biostratigraphic advances on the knowledge of the Late Cretaceous Plagioptychids.

From the Upper Cretaceous deposits of the Apuseni Mountains, five species of *Plagioptychus* genus have been identified by Lupu (1976) from localities ranging from the Coniacian to the upper Santonian: *Pl. arnaudi* Douville, 1888 from Coniacian deposits (Southern Apuseni - Drocea Mts.) and *Pl. paradoxus* Matheron, 1842; *Pl. toucasi* Matheron, 1842; *Pl. maestrei* Lupu, 1976; *Pl. borodense* Lupu, 1976 described from upper Santonian deposits (Northern Apuseni Mts.-Borod Basin). The two new plagioptychids species, *Pl. maestrei* and *Pl. borodense* described by Lupu (1976) are based on records of single specimens and occurrences. The study of these specimens, and comparison with new collected specimens, reveals that *Pl. maestrei* and *Pl. borodense* show an internal intraspecific variation of the characters and thus, can be considered as junior synonyms of the other well knows plagioptychids species.

References

Douvillé H, 1888. Etudes sur les Caprines. Bull. Soc. Géol. France. 3/XVI, 699-734.

d'Orbigny A, 1840. Note sur le genre Caprine: Revue Zoologique de la Société Cuvierienne, v. 1839, 168-170.

Lupu D, 1976. Contributions a l'etude des rudistes senoniens des Monts Apuseni. Memoires l'Institut de Geologie et de Geophysique, 24, 83-152.

Matheron P, 1842. Catalogue méthodique et descriptif des Corps organisés fossiles du département des Bouches-du-Rhône et lieux circunvoisins; précedé d'un Mémoire sur les terrains supérieurs au grès bigarré du S.E. de la France: Répertoire des travaux de la Société de Statistique de Marseille, 6, 81-341.

Teller F, 1877. Über neue Rudisten aus der böhmischen Kreideformation. Sitzungsberichte der kaiserlichen Akademie der Wissenschaften, Mathematisch-naturwissenschaftliche Klasse, 75, 97-112.

Analogue (physical) modelling: an invaluable research and educational tool

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Key words: analogue modeling, physical modelling, structural geology, education.

Short introduction to Analogue Modelling

Analogue modelling began with Sir James Hall, in 1815, when he shortened pieces of cloth, placed under a load, in order to model folding. The topic of tectonic/structural modelling progressed to scaled analogue modelling after the key contributions of Marion King Hubbert, who introduced the theory of scaling (Hubbert, 1937). Along with tectonic/structural modelling, there are two other types of analogue modelling: stratigraphic and geomorphic modelling (for more details on the history of analogue modelling, see Koyi, 1997; Paola et al., 2009; Graveleau et al., 2012).

Structural geology and tectonics are some of the key topics in geosciences. Gaining understanding of these processes is of the upmost importance for any geoscientist. By using simple materials like quartz sand or kaolin clay, one can model brittle behavior in a variety of tectonic settings (extension, compression, strike-slip). Detachment levels can be introduced by using e.g. glass microspheres. The ductile behavior of salt in geological time can be modeled in the laboratory using materials like silicone (among others). In order to create a model which can be considered qualitatively and quantitatively representative, the analogue models have to be geometrically, kinematically and dynamically scaled (Hubbert, 1937; Ramberg, 1981; Weijermars et al., 1993).

The driving force needed to create such models can be either mechanical (manual of motor driven), gravitational (change in angle of experiment), or due to differential loading (sedimentation and/or erosion). The other two types of analogue models imply the use of water as a main driving force.

The interaction between erosion, sedimentation and tectonic processes can also be studied by combining these types of experiments with the tectonic/structural ones. The use of a sprinkler systems above an "erosion box" (a box made out of a silica powder and water paste), can be used to understand the response of landscape geomorphology to climate change and tectonic uplift (e.g. Bonnet & Crave, 2006). The tectonics-erosion-sedimentation interactions can also be modeled, providing valuable insights into the morphological dynamics of topography evolution in different tectonic settings (e.g. Graveleau et al., 2015).

Stratigraphic analogue models can be used to better understand the development of rivers, deltas and deep marine systems. One other important topic is understanding how sedimentation reacts to different features (i.e. the geometry of the basin floor or the presence of salt diapirs). Stratigraphic analogue models are also used to understand the climate control on river and delta architecture (e.g. Van Heijst & Postma, 2001; Bijkerk et al., 2014) or the effects of vegetation on channel morphodynamics (Tal & Paola, 2010).

Another experimental technique that can be used while teaching structural geology and rock mechanics is based on the property called photoelasticity. Photoelastic stress analysis can be used as a visual aid when discussing about stress, strain and stress concentration. This can be achieved simply by visualizing a material made out of e.g. food gelatin that you subject to strain under polarized light.

The Analogue Modelling Lab in Babeş-Bolyai University

The laboratory in the Geology Department, Babeş-Bolyai University, Cluj-Napoca, focuses mainly on the modelling of structural/tectonic processes. Interests and applications of this lab lie both in education and research. Some of the key educational experiences that the modelling procedures offer are the understanding of stress, strain, fault development and geometry.

In order to achieve deformation like compression, extension, strike-slip, transpression and transtension, several modelling devices are used. They are either powered manually or by motors (i.e. Nema 34 stepper motor with a 7.7 Nm holding torque). All of the modelling devices and the codes driving these devices are self-built. Most of the coding is done in Arduino and Python, and it is used both for driving the motors and in the monitoring procedures (e.g. logging the data from the force sensors). The materials that are usually used for experiments are dry colored sand, glass microspheres, kaolin clay (for modelling the brittle behavior) and PDMS Silicone (to model the ductile behavior).

Deformation monitoring is achieved with the used of DSLR cameras and an Xbox Kinect 360 (using its IR projector and camera). The time-lapse top- and side-view photos are processed using a digital image correlation technique called Particle Image Velocimetry (PIV) in a MATLAB based application. With the use of PIVlab software and MATLAB (Thielicke and Stramhuis, 2014) displacement vectors are created and several attributes can be extracted (velocity magnitude, strain rate, shear rate, divergence, etc.). The ARSandbox software (Reed et al., 2014) is used together with the Xbox Kinect 360 to extract real-time Digital Elevation Models (DEM) during the experiments.

After the models are finalized, they are wetted using a water-gelatin mixture. Closely spaced serial sections are cut and photographed. The section photographs, together with the PIV and DEM are used to better interpret and understand model deformation (in software like: Move, Petrel, OpendTect, ArcGIS, etc.). In some cases, 3D voxel models are reconstructed from the serial cut sections with the scope of visualizing other section orientations (e.g. horizontal) within the model (achieved using a medical image processing and scientific visualization software – MeVisLab).

Conclusions

Analogue modelling can bring invaluable insights into the understanding of structural/tectonic, stratigraphic and geomorphic processes. These tools can and should be used both for the validation and better understanding of these processes and as an aid in the educational program.

The analogue modelling laboratory in the Babeş-Bolyai University, Cluj-Napoca is capable of performing experiments that can bring an educational aid in fields like structural geology, rock mechanics, hydrocarbon geology, salt tectonics, seismic interpretation, field mapping, etc. In addition, analogue modelling for research or industry-specific topics can be conducted as well in the laboratory.

References

Bijkerk JF, ten Veen J, Postma G, Mikes D, van Strien W, de Vries J, 2014. The role of climate variation in delta architecture: lessons from analogue modelling. Basin Research 26, 351-368.

Bonnet S, Crave A, 2006. Macroscale dynamics of experimental landscapes. Geological Society, London, Special Publications, 253, 327-339.

Graveleau F, Malavieille J, Dominguez S, 2012. Experimental modelling of orogenic wedges: A review. Tectonophysics, 538-540, 1-66.

Graveleau F, Strak V, Dominguez S, Malavieille J, Chatton M, Manighetti I, Petit C, 2015. Experimental modelling of tectonics–erosion–sedimentation interactions in compressional, extensional, and strike–slip settings. Geomorphology, 244, 146-168.
Hubbert MK, 1937. Theory of scale models as applied to the study of geologic structures. Geological Society of America Bulletin, 48 (10), 1459-1520.
Koyi H, 1997. Analogue modelling: from qualitative to quantitative technique - a historical outline. Journal of Petroleum Geology, 20 (2), 223-238.
Paola C, Straub K, Mohrig D, Reinhardt L, 2009. The "unreasonable effectiveness" of stratigraphic and geomorphic experiments. Earth-Science Reviews, 97 (1-4), 1-43.
Ramberg H, 1981. Gravity, Deformation and Earth's Crust, (second edition), New York, Academic Press, 452 pp.
Reed S, Kreylos O, Hsi S, Kellogg L, Schladow G, Yikilmaz MB, Segale H, Silverman J, Yalowitz, S, Sato E, 2014. Shaping Watersheds Exhibit: An interactive, augmented reality sandbox for advancing Earth science education, Abstract ED34A-01 Fall Meeting, AGU, San Francisco, Calif., 15-19 Dec.
Tal M, Paola C, 2010. Effects of vegetation on channel morphodynamics: results and insights from laboratory experiments. Earth Surface Processes and Landforms, 35, 1014-1028.
Thielicke W, Stamhuis EJ, 2014. PIVlab - Towards User-friendly, Affordable and Accurate Digital Particle Image Velocimetry in MATLAB. Journal of Open Research Software, 2 (1), p.e. 30
Van Heijst MWIM, Postma G, 2001. Fluvial response to sea-level changes: a quantitative analogue, experimental approach. Basin Research, 13 (3), 269-292.
Weijermars R, Jackson MPA, Vendeville B, 1993. Rheological and tectonic modeling of salt provinces. Tectonophysics, 217 (1-2), 143-174.

Hydrothermal activity in Baia Sprie ore deposit - insights from quartz texture in epithermal veins, breccia types and breccia-vein relationships

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Key words: epithermal ore deposits, quartz textures, phreatomagmatic breccias, hydrothermal breccias, Baia Sprie, Gutâi Mountains

Introduction

The Baia Sprie epithermal ore deposit is located north of Baia Sprie town, in the so-called Dealul Minei (Mine's Hill). The ore deposit belongs to the Baia Mare metallogenetic district from Gutâi Mountains, part of the Neogene-Quaternary volcanic chain of the Eastern Carpathians.

The mining activity in Baia Mare metallogenetic district reached its climax in the mid-late 20th century, during the communist times, but it stopped in 2006. The access in the underground workings is no more possible due to the absence of real maintenance works, but representative ore deposits characteristics can be still observed in the field, *e.g.* outcrops, waste dumps, abandoned open pits. Even if presently the mining activity in Baia Mare area is stopped significant ore reserves still exist in some of the former exploitation sites.

Baia Sprie ore deposit is considered to represent an excellent example of adularia-sericite/low sulfidation deposit with significant vertical zonality in respect with the chemical and mineralogical composition of the ore (Manilici et al., 1965; Mariaş, 2005), *i.e.* the lower part consisting of Cu-rich ore, the central part consisting of massive Pb-Zn ore, and the upper part being mostly Au-Ag. The most important ore bodies from Baia Sprie ore deposit are the so-called Filonul Principal and Filonul Nou (Mariaş, 2005).

Many waste dumps, outcrops and open pits, altogether with countless floats spread all around Dealul Minei allow to examine the textural and the genetic peculiarities of the ores from Baia Sprie ore deposit. A west-east transect across the western half of the Dealul Minei, mostly along the surface trace of the underground stopes that followed the Filonul Principal (Main Vein) allowed to collect tens of significant samples illustrating the epithermal nature of the ore. The present contribution intends to decipher the significance of, *i*) some textural characteristics of the quartz veins, *ii*) some breccia types, and *iii*) breccias-vein relationships.

Material and Methods

The studied material consists in 48 ore samples collected at the surface from the Dealul Minei, along a track that starts at the base of the western slope at an elevation of 450 m ASL and reached an elevation of 680 m ASL, south of the peak of the hill.

The ore samples have been sliced and some of them partially polished. Macroscopic observations and photographic coverage followed by subsequent on-screen examination represented the main methods of study. The observed quartz textures were compared with those reported and interpreted by Dong et al. (1995), while for the breccias were used the general characteristics and the key genetic criteria proposed by Tămaş (2007).

Quartz Textures

Various quartz textures were identified among the epithermal vein fragments from Baia Sprie (Fig. 1) and altogether suggest an extensional structural setting. The most frequent quartz texture is colloform. Additional frequent textures are comb and crustiform, while mosaic, massive, cockade, and ghost sphere occur occasionally. Lattice bladed-like texture has been also observed.

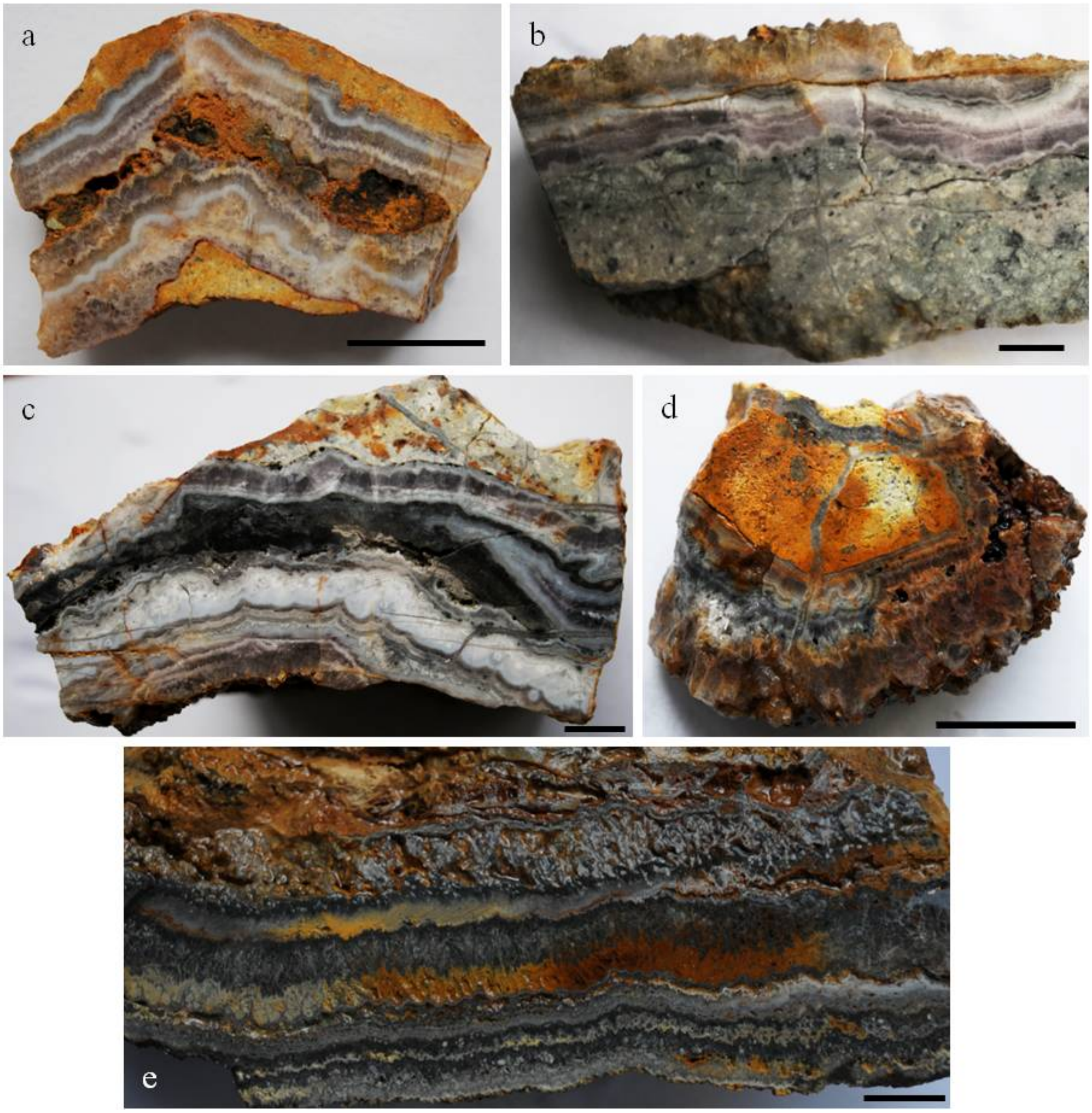

Fig. 1. Quartz textures from Baia Sprie epithermal veins: a) colloform symmetrical; b) colloform grading into final comb; c) colloform, comb and ghost sphere texture in the milky white sequence; d) cockade, with colloform and comb sequences; e) crustiform, ghost lattice sequences and mosaic texture in the central deep grey sequence. The scale bar is 1 cm in each picture.

According to Dong et al. (1995) three possible origins could be invoked for explaining the origin of quartz textures, *i*) primary growth; *ii*) recrystallization, and *iii*) replacement. The Table 1 summarizes the observed quartz textures according to their presumed origin.

Breccia Types

Two genetic types of breccias have been encountered among the studied samples according to the genetic criteria proposed by Tămaș (2007), hydrothermal and phreatomagmatic respectively (Fig. 2). Each genetic breccia type was separated on the basis of specific key genetic features.

Table 1. Quartz textures from Baia Sprie epithermal ore deposit (veins) grouped by their origin according to the classification proposed by Dong et al. (1995).

	quartz texture origin		
	primary growth	recrystallization	replacement
texture types	cockade colloform comb crustiform massive	ghost sphere mosaic	lattice bladed

Fig. 2. Genetic breccias from Baia Sprie ore deposit: a) phreatomagmatic matrix supported breccia overprinted by several quartz veinlets generations; b) hydrothermal breccia with ore clasts and ore cement. The scale bar is 1 cm in both images.

The phreatomagmatic breccias are matrix supported, even matrix dominated, with rounded to angular rock fragments. They are usually barren or they are slightly mineralized, mostly as impregnations. Sometimes these breccias could be hydrothermally rebrecciated and in this case the grades are higher. Both barren and mineralized breccias have been identified.

The hydrothermal breccias are extremely frequent and they suggest a vigorous hydrothermal system. These breccias have more angular clasts, sometimes open spaces and abundant hydrothermal cement that held together the clasts. The mineralizations occur as breccia cement (most frequently), as ore clasts, or as overprinting stockworks and veinlets. The open spaces could be preserved as such among breccia clasts, or they could be filled with hydrothermal cement and/or quartz gangue with various textures, more frequent being colloform and comb.

Breccias - Veining Relationships

The field evidences and the macroscopic examination of sliced ore samples revealed that the phreatomagmatic breccias are systematically cut by later hydrothermal breccias and different generations of quartz veinlets. The hydrothermal brecciations acted recurrently, with hydrothermal breccia fragments present within later hydrothermal breccias. The hydrothermal brecciation was more or less synchronous with at least some of the epithermal veining as indicated by quartz vein fragments attached to their host rock wall which are also present in the hydrothermal breccias which were subsequently overprinted by quartz veining with various textures. In a similar way, some quartz veins were subsequently cut by hydrothermal cement dykes, as well as by later generations of quartz veins as well.

Conclusions

Different types of quartz textures including primary growth textures (cockade, colloform, comb, crustiform, massive), recrystallization textures (ghost sphere, mosaic), and replacement textures (lattice) were identified in the studied ore samples from Baia Sprie ore deposit.

Phreatomagmatic breccias and hydrothermal breccias are ubiquitous in Baia Sprie ore deposit, showing complex spatial and temporal relationships among them and with quartz veining. Overall a transition from early phreatomagmatic breccias to subsequent more or less synchronous and recurrent hydrothermal brecciation and quartz veining was clearly documented. The hydrothermal brecciation ended with steady state hydrothermal fluid flow as confirmed by the infilling of the open spaces with colloform and comb quartz as well as by the overprinting quartz veining with various textures cutting the hydrothermal breccias.

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References

Dong G, Morrison G, Jaireth S, 1995. Quartz textures in epithermal veins, Queensland - classification, origin, and implication. Economic Geology, 90, 1841-1856.

Manilici V, Giușcă D, Stiopol V, 1965. Studiul zăcământului de la Baia Sprie (regiunea Baia Mare). Memorii, 7, 1-95.

Mariaş ZF, 2005. Metalogeneza districtului minier Baia Mare. Model bazat pe sistemul hidrotermal Cavnic (Maramureş). Evaluări comparative cu alte sisteme epitermale din lume. Cornelius Publishing house, 450 p.

Tămaş CG, 2007. Structuri de brecii endogene (*breccia pipe – breccia dyke*) şi petrometalogenia zăcământului Roşia Montană (Munţii Metaliferi, România). Editura Casa Carţii de Ştiinţă, Cluj-Napoca, 230 p.