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LITHOLOGY, SEQUENCES AND GEOCHEMICAL BACKGROUND IN UPPER OLIGOCENE OUTCROPS FROM RÂPA MALULUI – ROGOZ (MARAMUREŞ COUNTY, ROMANIA)

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Abstract: In right side of Lăpuş valley, the Râpa Malului, large outcrops of Upper Oligocene–Lover Miocene Valea Lăpuşului Formation were described and sampled for mineralogical and geochemical analyses. The results of these analyses evidenced, that (i) the origin of clastic grains are Preluca-type mesometamorphic basement (with presumed green schist mantle), basic rocks of Transylvanian Ophiolitic Belt and Palaeogene carbonatic and clastic sedimentary rocks; (ii) in outcropping succession, as major sequences, three sedimentary cycles (from coarse grained to fine grained sandstone, sandy and sand-free marl) can be separated; (ii) each cycle can be characterized by mineralogical and geochemical composition which differ significantly each another; (iv) the geochemical composition including the toxic heavy metal contents may be considered as background values for further environmental studies in Lăpuş valley. The sampled Valea Lăpuşului Formation which belongs to the Autochthonous Unit of Botiza Nappe System sedimented in a shallow, oligohaline gulf of Maramureş Flysch Trough.

Keywords: Valea Lăpuşului Fm., background values, sedimentary cycles, grain history, Botiza Nappe

1. INTRODUCTION

The Lăpuş River which flows from the Neogene volcanic belt of NW Transylvania transports in his alluvia the abandoned dumps' material of the nearby polymetallic ore mines. In the stream sediment of Lăpuş the fragments of toxic, heavy metal bearing rocks are mixed with the clastics of the rocks from the riverbed. Because the riverbed of Lăpuş and its main affluent rivers are carved in so called Valea Lăpuşului Formation, it is important to know the petrographical and geochemical background of the middle segment of hydrographical basin. The Râpa Malului is one of the most extended outcrops on which a large sequence of Valea Lăpuşului can be studied and sampled.

The stratigraphic description and the sampling of Râpa Malului were executed between June–September 2004. The microscopic, X-ray and ICP-MS analyses were performed in the laboratories of Budapest, Debrecen and Baia Mare (2005-2007) and the synthesis of the field and laboratory data is presented in this study.

2. PREVIOUS REGIONAL AND LOCAL STUDIES

Before the middle of the 20th century (Hofman, 1878) the sandstone and marl deposits from this area were mentioned in the reports and publications representing Early Miocene age. Pătruț (1952) considered the Borşa Sandtone as Helvetian (correlating with Minget Sandstone), while Mutihac (1955) brought palaeonthological arguments for their Late Oligocene age.

Dumitrescu (1957) in the epicontinental Buzaş Levels has separated a western, Buzaş sandstone facies, an intermediary Baba sandstone-marl facies and an eastern, marly Vima facies. Marinescu & Marinescu (1962) describe „the marly facies of Upper Stampian, Aquitanian to Lover Burdigalian". The ingressive character of these deposits appears at South of Preluca (Marinescu & Marinescu 1962).

In published papers, „Stratele de Valea Lăpuşului" as Autochtonous Unit of Botiza Nappe system is presented by Bombița (1966). After the revision of the stratigraphic terms of Parathetys (Bombiță, 1972), the Late Oligocene sediments (Buzaş, Vima, Valea Lăpuşului, Minget Formations) are considered of Egerian – Eggenburgian age, accepted and documented by Mészáros & Ghergari in Rohia area (1979), Macovei (1994), Macovei & Moldovan (1994) and by Macovei (1995) in the Copalnic Basin.

3. LOCATION

Rogoz is located at the confluence of Lăpuş and Libotin rivers, at 10 km N from Tg. Lăpuş town, in the Eastern part of Maramureş County, Romania. The studied Râpa Malului forms a 220 m long and 45 m high barren rock outcrop which represents the ruptured surface of a huge sliding body (Pl. I). We presume that the Lăpuş river washed away the steep right riverside, and not a long (geological) time ago the whole Eastern side of Malul hill molded down, pushing eastward the riverbed more, than 150 m.

4. GEOLOGICAL BACKGROUND

The studied outcrops are located in NW Transylvania, in the convergence area of three geological units: the Someş Platform, the Transylvanian Basin and the Inner Flysch Zone of the Eastern Carpathians.

The Someş Platform represents the easternmost part of Tisia Realm, a micro-plate from the basement of the Pannonian Basin and of Apuseni Mts. In NW Transylvania, the medium stage metamorphic basement emerges as island-like crystalline mountains („*insule cristaline*"), e.g. Preluca and Inău (Fig. 1), forming asymmetric, southward deepened blocks of metamorphic rocks (para- and orthogneisses, mica-schists, quartzites, amphibolic rocks, carbonatic rocks) with 5-30 m thick pre-Eocene weathering crust and shreds of Priabonian aged covering sediments. Northward, in Copalnic Basin and in Lăpuş – Strâmbu zone, the basement continues with the same lithology under Paleogene and Miocene cover (Macovei, 1994 and 2000).

The Transylvanian Basin, with basic igneous rocks as basement (the end of Vardar-Mureş Ophiolitic Belt) and Neogene sedimentary filling, penetrates as a narrow plume between Rodna and Ţibleş Mts, i.e. not to far from Lăpuş Area (Soroiu et al., 1985). The Inner Flysch Zone of Eastern Carpathians, with Upper Cretaceous and Paleogene formations of nappe structure, overlaps the Upper Oligocene Valea Lăpuşului Formation which forms the autochtonous unit of Botiza and of Wildflysch Nappes (Bombiţă, 1966).

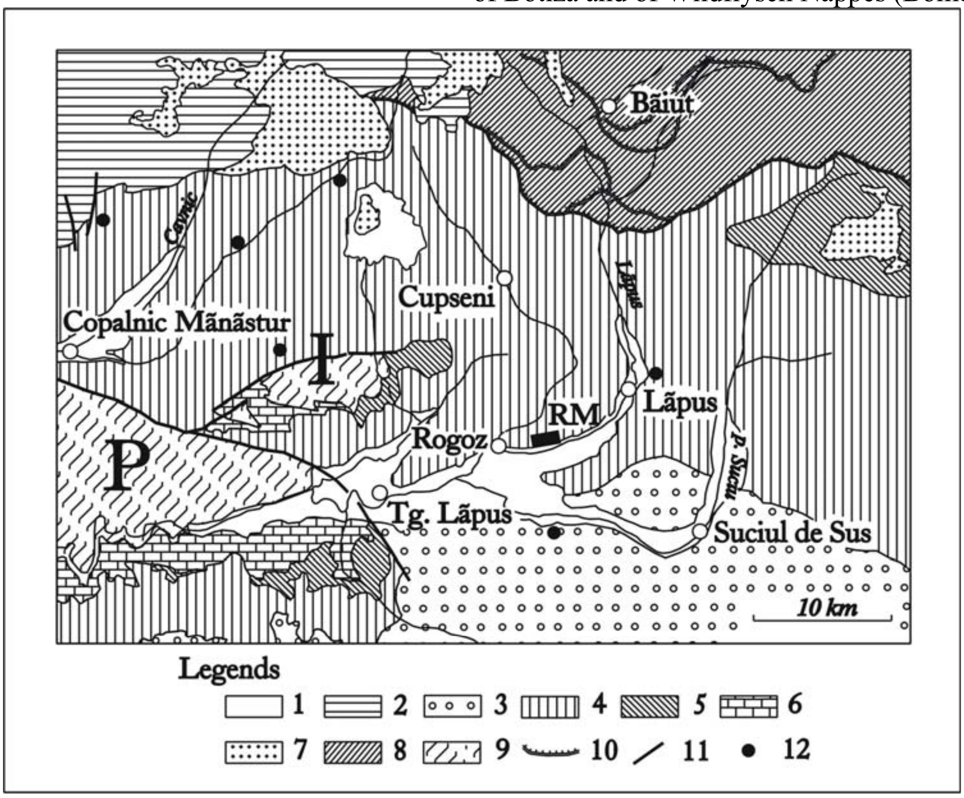


Figure 1. Geological sketch of Copalnic Mănăştur – Lăpuş – Băiuț Area, after Geologic Map of Romania, sheets No. 3 and 4. 1. Quaternary; 2. Neogene of Baia Mare Basin; 3. Carpathian (Hida Formation); 4. Egerian (Vima Group, Valea Lăpuşului Fm, Minget Sandstone Fm.); 5. Ottnangian—Eggenburgian clastic and lime sediments; 6. Priabonian (Valea Nadăşului and Piatra Cozlei Fm.); 7. Neogene igneous rocks; 8. Inner Flisch Zone; 9. Ourcropping Crystalline Basement (P, Preluca; I. Inău); 9. Nappe line; 10, faults; 11. Bboreholes; 12. RM, Râpa Malului outcrops.

The Flysch Zone is traversed by intermediary igneous plugs, by base metal hydrothermal veins and supports Neogene clastic, carbonatic sediments and volcanic products (lava and pyroclastics). Eastward to the Neogene Baia Mare Basin and North of Preluca– Inău blocks, Oligocene clastic deposits outcrop. The metamorphic basement and the few m thick Priabonian limy sandstones are covered by Ottnangian-Eggenburgian aged sandstones, slightly bituminous marls and claystones (Copalnic, Stoiceni) and by Egerian aged Vima Group (Mészáros & Ghergari, 1979). This lithostratigraphic unit, which covers the older stratigraphic units by a slight unconformity (Mészáros & Ghergari, 1979; Popescu, 1994) eastward from fine marls passes gradually to sandy marls and sandstones („Vale Lăpuşului Formation") until pelite free sandstone banks („Minget Sandstones") which reach lower Miocene. At SE, in Suciu Depression it is covered by sandy-gravelly Hida Formation (Ottnangian–Carpathian) by a sharp unconformity surface (Pauca, 1965).

5. PETROGRAPHY

The Valea Lăpuşului Formation of Râpa Malului is formed by a succession of sandstone and marl levels. From these lithologic units 43 samples were taken.

Sandstones. From mineralogical and sedimentological viewpoint, the sandstone levels are fairly homogenous, showing small differences in grain size and mineralogical composition.

The main classic mineral which forms 45-60% of this rocks is the quartz in angular-polygonal, mainly monocrystalline grains with undulating extinction. In coarser sandstone samples, there are subrounded, polycrystalline grains with interlaced suture lines, containing small inclusion of muscovite, biotite, hornblende, staurolite, zircon, apatite and dark minerals

The feldspars, (5-15%). form angular, thinly cleaved grains. The K-feldspars are represented by fresh microcline and by slightly sericitized orthoclase, a few ones with myrmekitic separations (Pl. II, photo 2). Among the plagioclases, albite, oligoclase and basic plagioclase appear.

Other rock forming minerals of these sandstone samples are the micas, which form 5-10% of rock. Muscovite appears as euhedral (Pl. II., photo 1) and anhedral, straight and gently curved, fresh sheets, the largest ones with thin, leached, low birefringent border. Biotite is rather altered (chloritized, limonitized). The product of biotite transformation is the fine cleaved, partly opacitized, pale green chlorite. In a few slides green, slightly pleochroous and fibrous amphibole (actinolitic hornblende, tremolite) were identified.

The sampled sandstones are poor in accessory minerals: apatite, zircon, tourmaline and titanite. In the sample 411 a few glauconite grains appear. The clastic dark minerals are represented by magnetite, hematite and well rounded, fibrous limonite grains (sample 311).

The sandstone samples contain a rich collection of lithic grains: carbonatic rocks as microsparitic limestone, bioclastic limestone, limy marl, sparry limestone and dolomite, limy and siliceous sandstone and siltstone fragments. Various igneous rock fragments: weathered basic and acid glass (Pl. II., photo 4) diabase and basalt grains (Pl. II., photo 3) were identified. The metamorphic rock fragments are represented by mica bearing quartzite, quartzose mica-schist, gneiss and chloritic-sericitic quartzites The metamorphic rock fragments are angular and mainly fresh, while the igneous ones are rounded and weathered.

In the sandstone samples rare bioclasts are present. The fragments of a macro-foraminifer (sample No. 130), of some milliolids? (sample No. 231) mollusks (samples No. 151 and 261) and echinodermata (sample No. 411) are surely reworked from older limestones, while the algal pellets of sample No. 231, the *Globigerina*-like sphaerules (samples 411 and 415) as well as the small copropellet bodies (samples No. 261 and 411) seems to be allochtonous. Carbonized, platty plant fragments are present in almost all of the samples, which are visible with free eyes in same samples as dark coal films on the stratification surface.

The cement is carbonatic, with basical and void filling character, forming 15-35 % of rock. Two generation of cement may be recognized: the first one as micritic, marly rims around of grains or void fillings between them; the second generation as sparry calcite void fillings in pores. The last cement seems to be formed by recrystallization of the first, marly cement, e.g. in sample No. 291. Secondary minerals of sandstone samples are represented by rare calcite veinlets (samples 121 and 419) and by colloidal limonite.

Knowing the morphology and the composition of the clastics, we can reconstitute the 'grain history' (Pettijohn et al., 1973). Thus, as for the sand grains, three kind of original rocks can be defined:

- Medium stage metamorphic rocks as mica bearing quartzite, mica-schist, gneiss, amphibolitic rocks and crystalline limestone and dolomite. The undulating quartz grains, the feldspars, the K-feldspars and the oligoclase grains, the micas, the inclusions in quartz grains, a part of rock fragments belong to these rocks. On the other hand, the small amount of sericitic and chloritic rock grains and the graphitic quartzite proves the presence of low metamorphic, greenschist type rocks in the source area.

- Acid and basic igneous rocks (rhyolite, diabase, basalt). They indicates the presence of a volcanic belt in the source area during many million years before the Neogene igneous activity. Similar rock fragments were mentioned in some conglomerate outcrops from valea Baicului – Țibleş, by Mutihac (1955).

- Sedimentary, mainly limy, bioclastic rocks and different kinds of sandstones.

Except a few carbonatic grains, the shape of the clastics are polygonal, with sharp edges. The grains are barren. The feldspats are slightly weathered or fresh. Only the biotite shows advanced weathering. Therefore the fragmentation of the original rocks and the transport of clastics happened in short time.

Marls. The fine grained, clayey-carbonatic rocks of Râpa Malului outcrops are less homogenous than the sandstone levels. Clayey marl, silty marl, sandy marl and marly siltstone as few cm or dm thick beds alternate often in the same level, so its petrographic character may be defined as „average" of several rock types and the transition between the beds is sharp.

Macroscopically, the marl samples appear as fine, thin layered rocks with silky, thin micaferous stratification surfaces, with or without carbonized plant (grass or sedge?) fragments. In slides, the clastic grains (the same ones like sandstones) float in silty-clayey-carbonatic groundmass in which only thin mica sheets and limy grains may be recognized (Pl. II., photo 5). The carbonate form fine, micron sized grains in clayey mass and 0.02-0.1 mm lens-like or irregular, micritic nodules probably with algal origin.

By X-ray diffractometry, four < 0,064 mm fraction of marl samples were analyzed (Table 1). The main clay mineral of these samples is illite followed by montmorillonite. Tthe ordered state of illite is high, as well the montmorillonite shows sharp reflexes which evidences ordered lattice structure. In the fine grain size fraction of marls the quartz plays important role, while the feldspars appear subordinately.

The marly character of these rocks is evidenced by high amount of carbonates, mainly the pure, Mg-free calcite. The dolomite may be detrital and as well biogenetic and diagenetic, neomorphous mineral.

Small quantities or traces of other minerals and 1-3% amorphous phases was measured.

5.3. The source area

Knowing the actual geological framework, the presence of grains of metamorphic origin rises two problems:

- On the outcropping crystalline rocks, thick weathering crust and rests of red (clayey, sandy) cover are present (Turbuța Formation, Marinescu & Marinescu, 1962; Valea Nadăşului Formation, Bombița, 1972). At the same time in the sandstones the reworked metamorphic rock fragments are fresh; red colored inbeddings, as they were mentioned in Oligocene beds around Cluj are missing here. It is probable that the source area is situated southward to Vima Mare and Măgoaja line, where in boreholes, the Oligocene lies directly on fresh mica-schists.

- A few greenschist fragments appear in the sandstone on slides. Such rocks are missing in the NW Transilvanian islands, except Meseş Mts. It is probable that there was a low stage metamorphic mantle in the past, covering the medium stage crystalline series.

The presence of the igneous, basic rock fragments and the chert grains as well make probable an extended outcropping area of the ophiolitic basement as source area of these rocks. It is probable, that the bioclastic limestone fragments in sandstones come from Priabonian aged rocks, while the well ordered, reworked clay ninerals (and a part of the fine grained carbonate) were washed out from marly Vima Group.

Table 1. X-ray analyses of < 0,064 mm fraction of some marl samples

Occurences	Samples	Laboratory number	montmorillo nite	illite	kaolinite	chlorite	quartz	K-felspar	plagioclase	calcite	dolomite	rutile	siderite	goethite	pyrite	gypsum	amorphous
Rogoz	142	107-09er	10	20	2	4	25	7	5	18	tr	tr		2	3	2	2
Rogoz	262	108-09er	15	15	4	5	14	2	12	20	5		tr	3	2	tr	3
Rogoz	327	109-09er	8	15	3	15	18	3	7	18	5	tr	tr	3		3	2
Rogoz	424	110-09er	12	17	5	8	32	5	7	10	tr			2		tr	2

Analyzed by dr. Péter Kovács-Pálffy and Péter Kónya, MÁFI Budapest

6. SEDIMENTOLOGY

6.1. Outcrops

Râpa Malului shows an apparently chaotic succession of marly - sandy levels (Fig. 2). Here 31 sandstone banks of 5-60 cm thickness are imbedded in a few m thick marl beds (Fig. 3).

The lower limit between the sandstone and marl beds is sharp, while the upper boundary to the marl may be gradual or sharp as well. No unconformity surfaces in the examined profile were observed.

The sandstone banks thicker, that ~ 10 cm may be followed in 150 m N-S, through the whole outcrops, while the thinner ones form 15-40 m long, platty lens like bodies or a string of decimetric lenses. The grain size of sandstone banks from the bottom and top do not present notable variations. No correlation between the grain size and thickness was found.

Tendency of regular distribution of coarse, respectively gravelly sandstone banks may be recognized. From the bottom to the top of outcrops, the coarser beds (gravelly sandstone, respectively coarse grained sandstone with insulated quartz gravels) appear in three sites: at 2.5, at 12.5 and at 26.5 m. They are followed by finer sandstone beds (12.5 – 26.5 m) or by thicker and thicker marl ones (26.5-44.0 m). It seems that the three coarser sandstone beds mark the beginning of three sedimentary cycles (Fig. 2.).

It is important to know that small, but significant differences are depicted in the mineralogical composition of these levels (Table 2). Differences between these cycles in chemical – geochemical composition appear, too (Fig. 4).

The presence of convolute structure on the top of the sandstone bed (m. 10.75; sample No. 241) and carbonized plant fragments (samples 142 and 151) are the other macroscopic observations which signify the shallow water, respectively the close situated grassland seashore.

Horizontal friction mirrors were observed on the top of sandstone beds in samples No. 130 and 413.

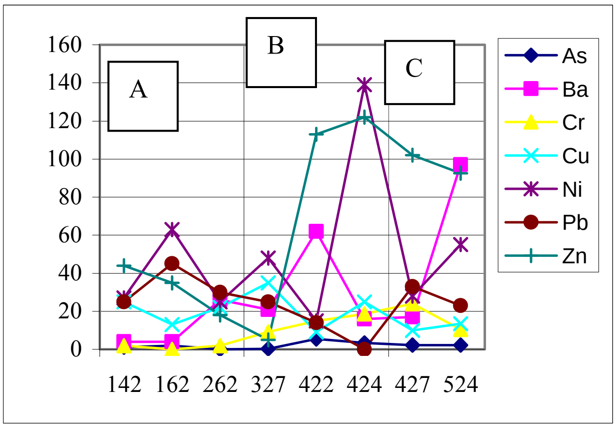


Figure 4. Distribution of some heavy, toxic elements in the samples of cycle A, B and C (concentration, ppm).

6.2. Microstructural and textural observations

Both by macroscopic observations and in thin sections, the fine, the medium and the coarse, respectively the gravelly sandstones were recognized. The packing of grains is advanced for coarser sandstones, while in finer ones the matrix supported structure is preferred.

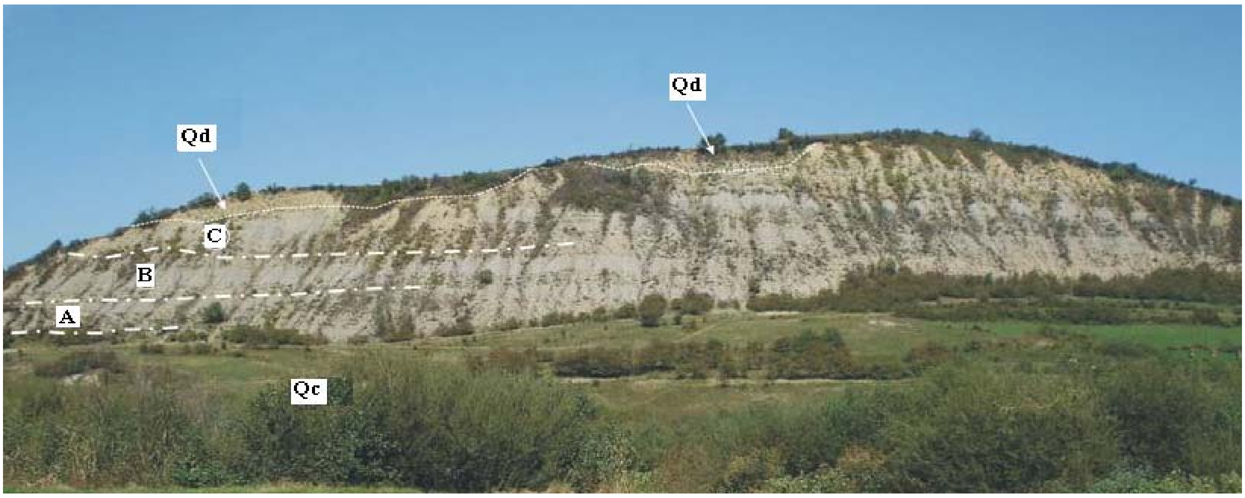
In almost all of the samples the oriented texture is present. It is evidenced by the position of micas and as well the elongated grains, by the orientation of lamellar minerals and of carbonate-rich zones of the marls. In some muscovite slightly curved sheets or kink type deformations appear (Pl. II., photo 1). The mica sheets may be curved (Pl. II., photo 6). and the deformed micas „wear” larger quartz grain groups.

In the sample No. 291, the (presumed) algal pellets are intruded between clastic grains. In a few slides, the inflow of marly groundmass in joints and cleavages of quartz and feldspar grains was observed (Pl. II., photo 4).

Table 2. Characteristic minerals, rock fragments and fossil rests in samples of cycles A, B and C.

Cycles	Feldspars	Main rock fragments	Accessories	Fossils
A	Microcline, plagioclase	Limestone, basic igneous rock	Hornblende, chlorite	Algal pellets? in marl
B	Plagioclase, microcline	Gneiss, mica bearing quartzites		Copropellets in marl
C	Microcline, plagioclase, albite, orthoclase	Basic igneous rock,limestone, sericite-chlorite schists	Biotite, chlorite, tourmaline	Small globigerinides

PLATE I



Râpa Malului outcrops. Od, deluvial deposits; Oc, colluvial prism; A,B,C, sedimentation cycles of Lăpuş Formation.

PLATE II

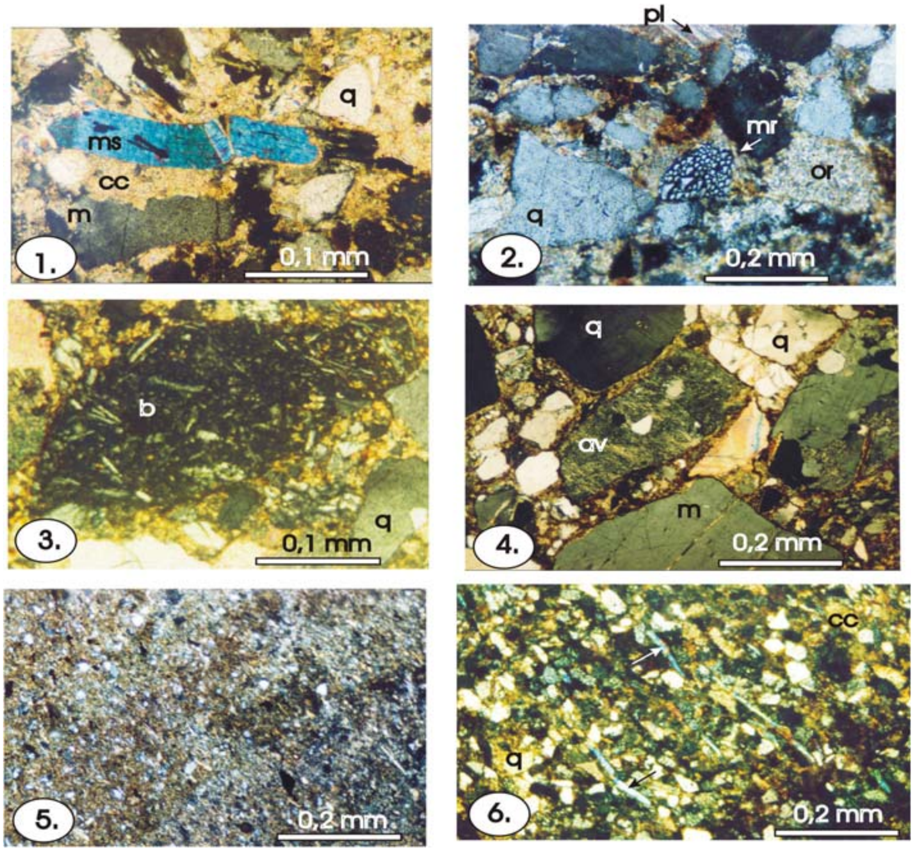


Photo 1. Fine-medium grained sandstone with angular quartz (q) and microcline (m) grains, deformed (kinked) muscovite sheet (ms), basal microsparitic calcite cement (c). Sample no. 211, + nichols.
Photo 2. Coarse grained sandstone with angular quartz grains (q), slightly sericitized, twinned plagioclase (pl), orthoclase (or) and myrmekite fragment (mr). Sample No. 418b, + nichols.
Photo 3. Angular quartz grain (q) and basalt fragment (b). Sample No. 311a, + nichols.
Photo 4. Coarse, gravelly sandstone: rounded and angular quartz with undulant extinction (q) and acid vitreous rock fragment (av). In cleavage of microcline (m), carbonate cement has penetrated. Sample No. 130. + nichols.
Photo 5. Fine grained, silty marl with muscovite sheets. Sample No. 424, II nichols.
Photo 6. Fine grained, marly sandstone with gently curved muscovite sheets and slightly lenticular texture; q, quartz grains; cc, carbonatic basal cement. Sample No. 512, + nichols.

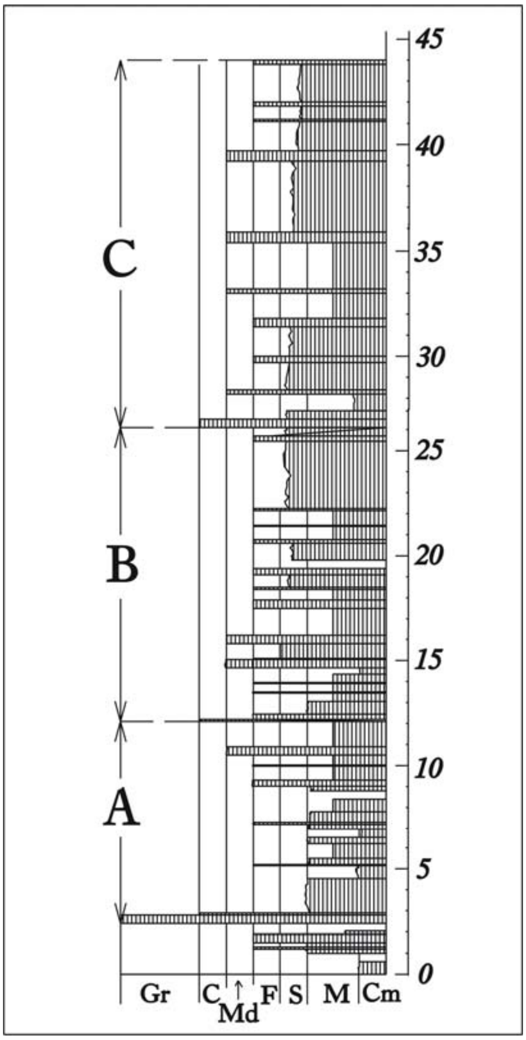


Figure 2. Sketch of lithological column: Gr, gravelly sandstone; C, coarse grained sandstone; Md, medium grained sandstone; F, fine grained sandstone; S, siltstone; M, silty-sandy marl; Cm, clayey marl; A,B,C, sedimentation cycles.

A few mm extended shearing lenses were identified in the samples No. 311 and 130 (sandstones) and in the sample No. 142 (sandy marl). In the samples No. 121 and 419 the veinlets crosscutting the oriented texture evidenced slightly, brittle deformation of sandstone.

6.3. Marls and sandstones: the 'rock history'

The above mentioned observations permit to reconstitute the processes which lead from soft, plastic sediment to the present aspect of the analyzed rocks. The granulometric study of recent estuary sediments (Anithamary, 2011) evidenced the seasonal variation of such textural peculiarities of deposits. After presence of algal carbonate production, the depth of sedimentary basin may be appreciated as shallow, far up to aphotic zone.

A part of the bioclasts, mainly the algal pellets, the small, underfed, „smurf" globigerinae and the copropellets evidenced scarce biologic activity in oligohaline conditions of a sub-horizontal foredelta plain, at the border of the flysch trough

In the sediment the compaction under proper load is the first (locomorphic, syn-sedimentary) process: i.e. the alineation of clay minerals in marls, mica and carbonate deformation in sandstones. In both sediments the compaction is accomplished by recrystallization of carbonates: firstly by coating and void filling of marly cement and finally by filling of free pores with sparry calcite.

In hard, lithified rocks the effect of lateral tectonic forces (overlapping Botiza nappe system?) as friction mirrors and as sheared structures were mentioned, as well as scarce brittle deformation and sparry calcite filling of veins, as distal manifestation of Neogene hydrothermal events.

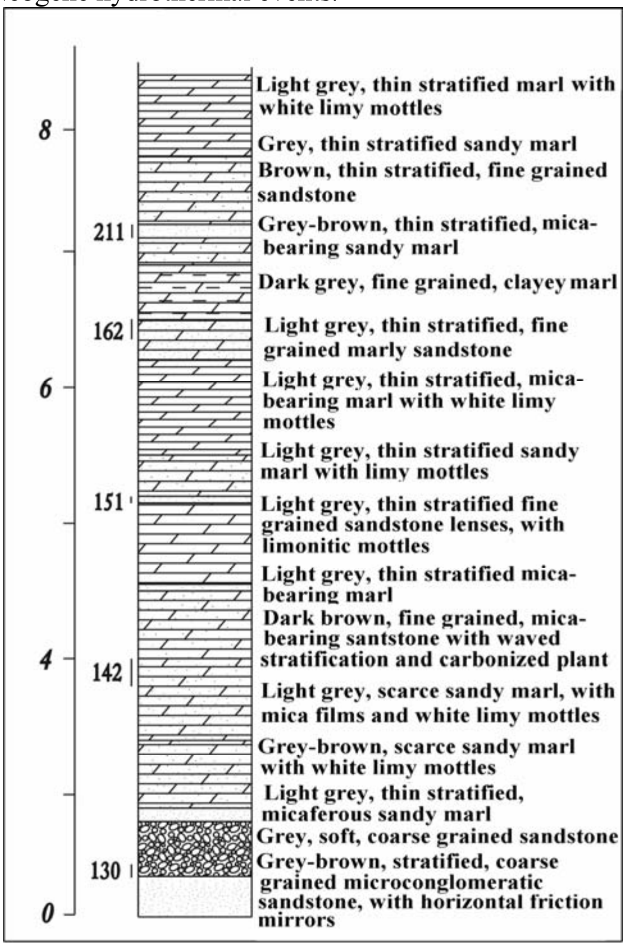


Figure 3. Detailed lithological succession of the lower segment of A cycle.

The mineral phases of these rocks were transported by laminar currents and sedimented as more or less rhythmic levels in subaquatic conditions. Due the thin stratified texture, the sediments were spread on the bottom, below the wave base (except the top of some convoluted sandstone beds, sample No. 241).

Scarce flow channels with coarser (gravelly) sediment were identified in three levels only. They mark the moments of intensified erosion and transport processes. The increased energy of transport may be tied to vertical oscillation (rise) of eroded blocks. At contrary, the fine grained sandstone and the sandy marl imbedding may signify variation of meteorological and hydrologic conditions (stronger rainfalls, floods).

7. GEOCHEMISTRY

The Valea Lăpuşului Formation forms the geological background of hydrographic basin of Lăpuş river between Gura Poienii and Tg. Lăpuş. It is obvious that an important amount of the stream sediment and the sediments of floodplain are originated from the decay of Lăpuş Formation. This natural alluvia is mixed with the grains and colloids having anthropogenic origin, i.e. the eroded dumps and tailings and as well, the mine water of abandoned mining works (Băiuț, Poiana Botizii, Țibleş, see Doroțan et al., 2010). For this reason it is important to know the geochemical composition of these un-polluted rocks.The levels of Râpa Malului dip 2-3°; northward. Therefore they are cut by Lăpuş River up to Lăpuş village. In this segment of Lăpuş valley, in summer of 2010 systematic sampling was performed. Thus, our results may be used for appropriate interpretation of the obtained analytic data.

From Râpa Malului, eight samples for main and trace element analyses were taken (Table 3). The analyses were executed by ANALAB Ltd laboratory (University Debrecen, Hungary) in June 2009, by ICP-OES method for metal components as As, Ba, Cd, Co, Cr, Cu, K, Li, Al, Ca, Fe, K, Mg, Mn, Mo, Na, Ni, P, Pb, S, Sr, Ti, V, Zn. The content of main and trace elements varies between fractions and more, than hundred thousand ppm. Among the randomly distributed values positive correlation with petrographic consequences were evidenced for some elements (Fig. 5), e.g. between Ca–Mg, between Ca–Ba and Ca-Sr (in carbonatic minerals) and between Fe–S). The positive correlation between Al and some heavy metals as of Zn, V, Pb, Cu indicates, that these elements are adsorbed in clay minerals, while Ni which correlate with Mg evidenced the ophiolitic origin of chlorite and of other Fe-Mg minerals.

Table 3. Main and trace elements in some samples from Râpa Malului.

Elements	142	162	262	327	422	424	427	524
Rock name	Sandy mica bearing marl	Fine grained marly sandstone	Mica bearing sandy marl	Fine stratified silty marl	Mica bearing limy marl	Silty clayey marl	Marly silt with plant rests	Thin stratified clayey silt
Al	20618,0	14486,0	150183,0	143271,0	9584,0	13285,0	35260,0	26170,0
Ca	11400,0	8666,0	17016,0	43779,0	73880,0	130570,0	29125,0	9254,0
Fe	709,0	495,0	993,0	483,0	1045,0	3496,0	1912,0	7756,0
K	1104,0	1929,0	872,0	2257,0	2766,0	12511,0	12033,0	902,0
Mg	1163,0	2576,0	3267,0	11632,0	14105,0	18193,0	20159,0	818,0
Mn	26,0	133,0	537,0	425,0	744,0	1555,0	3038,0	513,0
Na	2338,0	3224,0	1122,0	1254,0	3010,0	880,0	1155,0	446,0
P	15,0	31,0	293,0	41,0	459,0	163,0	63,0	72,0
S	549,0	42,0	78,0	106,0	237,0	187,0	125,0	393,0
Ti	152,0	86,0	53,0	222,0	294,0	333,0	408,0	144,0
As	1,2	2,0	<0,3	0,3	5,5	3,4	2,3	2,3
Ba	4,0	4,0	26,0	21,0	62,0	75,0	17,0	97,0
Cd	<0,3	<0,3	<0,3	<0,3	5,3	1,8	0,7	0,6
Co	<0,3	0,6	<0,3	2,3	28,5	1,5	<0,3	65,0
Cr	1,9	<0,3	1,9	9,1	15,0	18,6	24,0	10,4
Cu	25,0	13,0	22,0	35,0	9,2	25,0	18,0	13,5
Li	1,5	1,2	<0,3	0,6	<0,3	1,3	<0,3	5,8
Mo	<1	<1	<1	<1	3,5	<1	<1	<1
Ni	27,0	63,0	25,0	48,0	15,0	139,0	28,0	55,0
Pb	25,0	45,0	30,0	48,0	14,0	21,0	33,0	23,0
Sr	225,0	1125,0	358,0	2626,0	1225,0	1880,0	551,0	233,0
V	7,9	5,0	19,0	60,2	162,0	96,9	24,6	330,0
Zn	44,0	35,0	250,0	138,0	113,0	122,0	102,0	92,5

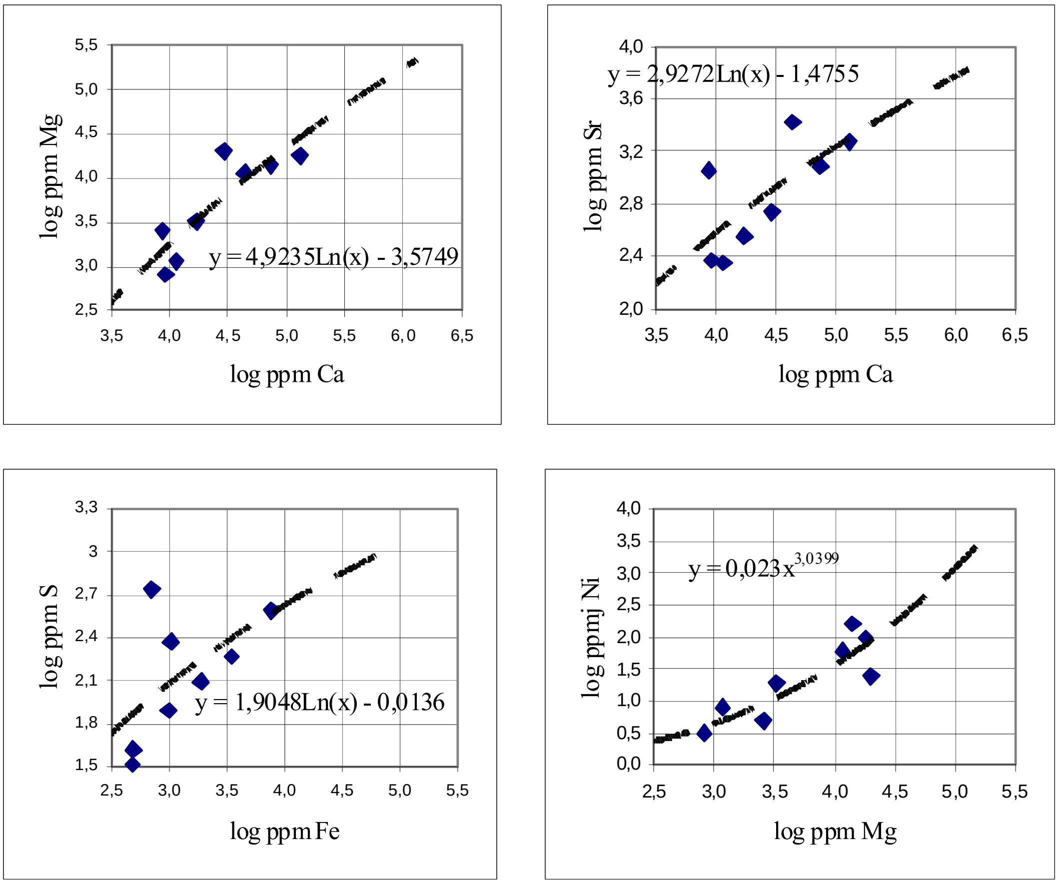


Figure. 5. Correlation diagrams between some elements with equation of trend line

The background values for the main heavy, toxic metals is relatively high for Zn and Ni, and low, close to detection limit for As, Cd, Co and Mo. In distribution of some trace elements, the sedimentary cycles A, B and C may be recognized (Fig. 4)

8. CONCLUSIONS

Close to the locality Rogoz, a large outcrop of Upper Oligocene – Lover Miocene Valea Lăpuşului Formation was sampled and analyzed. The aim of the research was to know the sedimentology of these rocks, the presumed erosion area of the sediments, explaining their geochemical peculiarities, as background for further environmental studies.

The grains of the outcropping formation come from an extended medium stage metamorphic basement (probably southward of Preluca Mts), from basic rocks (ophiolite belt) and from Paleogene limy and marly sedimentary cover, separated to Valea Lăpuşului Formation by a weak unconformity surface.

The clastics sedimented in a shallow, quiet, oligohaline gulf of Maramureş–Szolnok Transcarpathian Flysch trough-and went through on weak diagenetic transformation (compaction, lime-cementation). In the hardened rock horizontal shearing related to close situated Botiza naps and calcite vein filling took place. These rocks constitute the geochemical background for stream and floodplain sediment analyses, in further studies of environmental state of the whole Lăpuş Valley.

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