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the 50th Anniversary of
S.C. PROSPECTIUNI S.A.
20-21 October 2000
Bucharest

ABSTRACTS VOLUME



Institutul Geologic al României
București - 2000

GEOLOGICAL INSTITUTE OF ROMANIA

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The authors are responsible for the contents of the papers

FOREWORD

I'm really very happy to find out that such an interest on the different problems involving the scientific research exists. The 55 papers elaborated for this symposium, with a various content, for a certainty that will stimulate the future geological research and will constitute a valuable source for the genetic processes.

Now, there is a multitude of new experimental data and conceptions concerning the hydrothermal systems and some of these might help to provide us with some solutions to our problems. In these situations, any investigation can be seen as a study involving a multidisciplinary effort.

Our intention was that this symposium to contribute to promotion of the new hydrothermal concepts and to the construction of mineral deposit models. We see that this is a necessity for the future scientific research.

Many of the members of this Society have contributed significantly to the knowledge of the hydrothermal deposits. But many details of the genetic processes remain unknown.

The last 5 decades have brought major progress in the understanding of the hydrothermal systems, i.e. origin and composition of the hydrothermal fluids; temperature, pressure and depth of the mineral deposits formation; source of the elements; physical-chemical conditions of mobilization and deposition of the metals in the various hydrothermal systems; metasomatic processes; origin and evolution of the magmas that give rise to the hydrothermal fluids. These information are of great importance in order to understand the hydrothermal metallogeny of a certain area. They can be obtained through detailed studies of individual deposits or groups of ore bodies as a multidisciplinary effort.

Finally, appreciating these information mentioned above, I would like to thank to all participants at this symposium, especially to the authors of the papers.

Prof. Dr. **Gratian Cioflica**
President of the Society of the
Economic Geology of Romania

Ladies and Gentlemen,

Please let me wish a warm welcome and thanks to all the participants in this scientific symposium, organized by S.C. PROSPECTIUNI S.A., together with the Economic Geology Society and the Mineralogy Department within the Faculty of Geology and Geophysics, that celebrates 50 years of activity of the S.C. PROSPECTIUNI S.A. - Bucharest.

I do not propose myself to present you a detailed history of the present S.C. PROSPECTIUNI S.A., but I consider it necessary to mention some reference aspects of this company's evolution, following that, further on, my colleagues will give details about some significant aspects of the complex prospecting activity carried on during the last half of the XX-th century.

At the beginning, in 1950, the Geological and Geophysical Prospecting Office was set up, subordinated to the Ministry of Petroleum, having as object of activity hydrocarbon research, and, a year later, the Enterprise for Prospecting and Laboratories was set up, subordinated to the Geological Committee, for investigation of the other mineral resources, solid or fluid.

The two companies developed simultaneously, each of them operating in the initially established domain. Thus, in 1956, the Geological Prospecting Office changed into Enterprise for Geological and Geophysical Prospecting, which, in 1971, became Enterprise for Geological and Geophysical Prospecting for Hydrocarbons, subordinated to the Ministry of Petroleum and Chemistry Industry.

On the other hand, the Enterprise for Prospecting and Laboratories became, in 1966, Geological Enterprise for Prospecting, subordinated to the Geology State Committee, changing in 1971, into the Geological Enterprise for Prospecting for Solid Mineral Resources, subordinated to the Ministry of Mining Industry and Geology.

Another reference year in this evolution is represented by the year 1980, when, by merging of the two companies which operated separately in the fields of hydrocarbon and solid mineral resources, the Enterprise for Geological and Geophysical Prospecting, subordinated by the Ministry of Geology was set up.

In 1991, this company became S.C. PROSPECTIUNI S.A., so being denominated also at present. Another very important event in the company evolution took place this year, by taking over the majority stock of the firm by S.C. TENDER S.A. in Timisoara.

In the last half of the XX-th century, the company object of activity was continuously enriched and enlarged, depending on each stage requirements, succeeding to cover the whole range of survey works, through all the usual methods and, practically, for the entire range of mineral resources. Thus, there was and is ensured, as the case may be, a complex geological, geophysical (seismic, gravity, magnetic, radioactivity, electrical, well logging), geochemical, hydrogeological, geotechnical, physical-chemical analyses research for hydrocarbon, coal, ferrous ore and base-metal, aluminum, precious metals, rare and disperse earth ore, non-metallics, useful, rocks, peat, therapeutic muds, bituminous rocks, non-inflammable gas, underground water a.s.o., being the only company in our country adequately endowed professionally and technically for such a diverse and with high qualitative exigencies activity.

From the institution setting up and until the present, through the performed activity, major contributions were brought to the pointing out and capitalization of mineral resources potential throughout the Romanian territory, both by discovering some important structures, proved by drillings to be oil and natural gas accumulations bearers, exploited on shore and on the Black Sea continental platform, and by essential contributions to the pointing out of some important deposits of coal, base-metal, gold-silver ore, bauxite, salt, nonmetallics and diverse useful rocks, underground water and so on. Also, it is worth mentioning the numerous technical assistance and expertise activities, geological and geophysical survey for hydrocarbon, coal, ore, underground water and others, carried on in some countries from Asia, Africa and South America.

Although, during the years, the extremely complex and intense prospecting activity performed did not always benefit of the most adequate organizational background, or the technical endowment was not at all times at international exigencies level, the very good results obtained, in fact recognized in the geological world, were possible due to the technical personnel and staff's quality, who, by professional training, self-exigency and passion, made from S.C. PROSPECTIUNI S.A., a real-school in geological sciences practice. Please let me consider, as a debt of honour, this anniversary, first of all a homage for these special people, from the past but also from present, who contributed to the prestige of S.C. PROSPECTIUNI S.A.

Of course, the Romanian economy evolution from the last decade determined the permanent organization and adjustment of S.C. PROSPECTIUNI S.A. to the present requirements, its basic activities being maintained and properly dimensioned. Likewise, by own financial efforts, which will also continue in the future, S.C. PROSPECTIUNI S.A. improved and modernized its technical endowment, this activity being essential for coping with the competitors, especially from some foreign firms, on the geological workings market, where offer decreased a lot and it continues to decrease.

At present, S.C. PROSPECTIUNI S.A. includes two main activity sectors, for hydrocarbon and for solid mineral resources and water, that benefit of an important logistic support.

The activity for hydrocarbons mainly comprises seismic survey crews, but also designing, studies and processing-interpretation groups, endowed with modern equipment for data acquisition, analysis, processing, storing and plotting.

The activity for solid mineral resources and water has departments for geological, mineralogical, geochemical, hydrogeological, geotechnical, electrical, gravity, magnetic, radioactivity studies and prospecting for geophysical investigation of underground mining workings and drillings, laboratories for complex physical-chemical analyses, all these taking advantage of permanently modernized equipment for data acquisition, analysis, processing, storing and plotting.

Finally, please let me thank again those present for their participation in this scientific symposium and wish success to its debates.

Traian Gubandru
General Manager
S.C. PROSPECTIUNI S.A.

GEOFYSICAL CONSIDERATIONS ABOUT A POSSIBLE ROMANIAN CARLIN

J. ANDREI

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Introduction. The gold ores disseminated by substitution in carbonated rocks, of Carlin type, present specific features. They are formed by magmatic, tectonic and lithologic controlling factors action, as follows: the approximately stratiform aspect; an advanced degree of sulfidation; the ore association with silicifications; the pronounced fracturation of the host rocks and the high permeability; the closest neighborhood of porphyry rocks and less closer of an acid plutonite; the presence of a dense fractured field; the presence of some structural traps, retaining the mineralization, and of some host rocks with carbonates and organic-carbonaceous or bituminous substances, favouring silica, sulfides and gold precipitation, at 150-200°C (Berbelec, 1985, 1998).

Objective and premises of the study. During the last 6 years, the author was concerned with the possibility of the identification of Carlin-type gold mineralizations in Romania. After a detailed analysis, based on the geological and geophysical knowledge of the Tertiary magmatites with metallogenous potential, some optimal possibilities for the existence of such mineralizations in the concealed acid banatitic plutonic area, from Ilidia - Moldova Noua, and especially from Stinapari - Carunari section, have been identified. In conformity with the magnetometric data, the peak of this pluton is placed in the vicinity of the Oravita line.

In Stinapari - Carunari area, the geological data show the following favourable factors:

- the presence of a suite of hypabyssal banatitic bodies, consisting of granodiorites and quartzdiorite and their porphyry varieties too, often with a pronounced western fall, settled in predominantly carbonated formations of Neojurassic - Eocretaceous age, strongly affected by thermal and hydrothermal metamorphism (see the plate);
- under these conditions the banatitic intrusions are accompanied by an important metallogenetic activity of skarn copper $\pm$ magnetite and porphyry copper; in its western extremity, the Getic Nappe cover is overthrust by the Sasca - Gornjak Nappe, constituted of Permian, Triassic and Jurassic formations, strongly scaled here and there;
- the Spathian - Anisian formations of these nappes are constituted of carbonated rocks (dolomites, limestones and bituminous limestones) able to warrant an excellent lithologic control of some eventual mineralizations of Carlin type.

The aero- and ground magnetometric images as well as the geoelectric ones (IP and r_a) are suggesting a series of structural-magmatic and metallogenetic information, able to complete the direct geological data (see the plate). This information presents a high confidence degree, due to some favourable contrasts of physical properties. So, the magnetometry shows the spatial disposition of the hypabyssal banatitic bodies and also the presence of some dykes probably constituted of porphyry banatitic rocks. The IP maximum evidences the dissemination of sulfides, and also their spatial distribution (Stoica et al., 1972, unpublished data, in GIR archives). Taking into account that in the Carlin-type mineralizations, the sulfidation processes are closely correlated with the silicification ones, in the investigated area 21 anomalous couples M_a maximal - r_a maximal have been selected, which can reflect some possible mineralizations of the above-mentioned type, some of them characterized by a special degree of sulfidation.

ȘTINĂPARI-CĂRBUNARI AREA-LOCVA MOUNTAINS STRUCTURAL-METALLOGENETIC MAP AS INFERRED FROM GEOLOGICAL, GEOPHYSICAL AND GEOCHEMICAL DATA

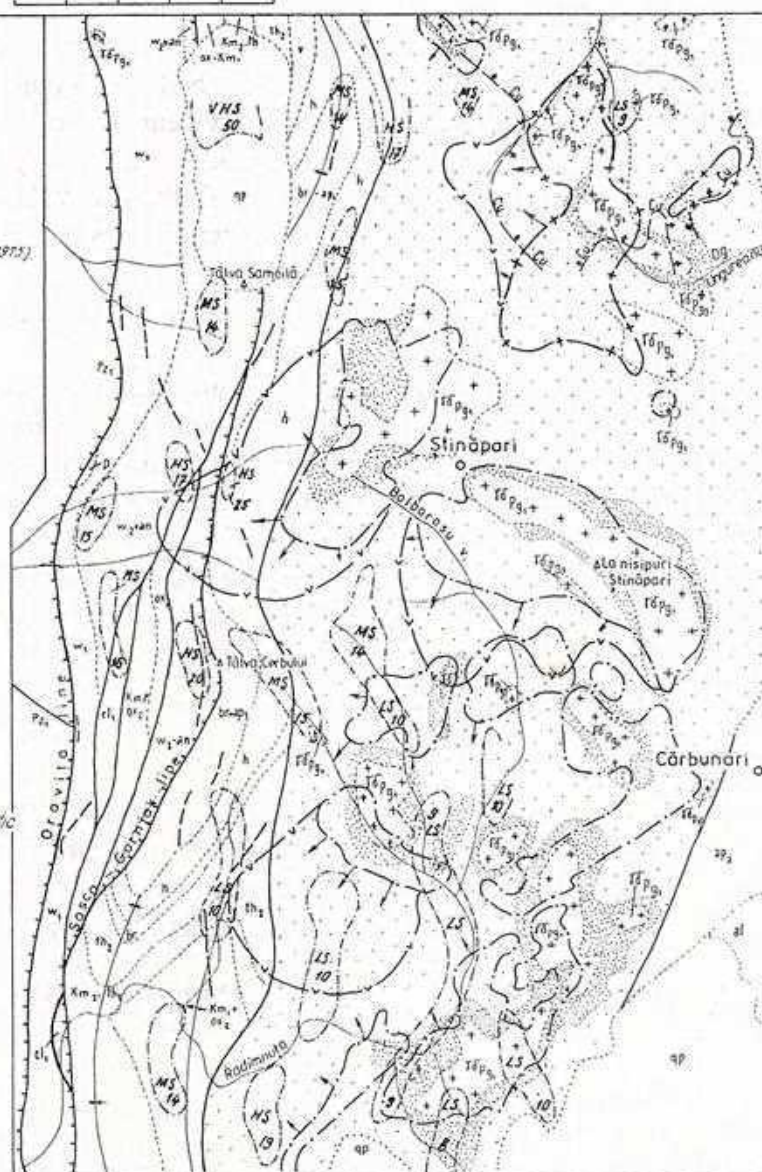
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LEGEND

A. Geological data

Geological map compiled after Codreanu et al. (1964),
Năstăsescu, Mayer (1972), Mayer et al. (1972), Andrei et al. (1975).

PLEISTOCENE	qp	Deluvial deposits
ALBIAN	al	Radimna sandstone
LATE APTIAN	ap ₁	Minis limestones
EARLY APTIAN-BARREMIAN	br + ap ₁	Plapa limestones
HAUTERIVIAN	h	Limestones with chert
VALANGINIAN	v	Crivina marls
BERRIASIAN-LATE TITHONIAN	th ₁	Marila limestones
EARLY TITHONIAN-LATE APTIAN-RIGIAN	km ₂ - th ₁	Bădel limestones
LATE OXFORDIAN- EARLY KIMMERIDGIAN	km ₁ + ox ₂	Valca Aninei limestones (with chert)
LATE OXFORDIAN	ox ₁	Tămaș marls
BATHONIAN- EARLY CALLOVIAN	cl ₁	Sandstones and marly limestones
LATE WERFENIAN- ANISIAN	w ₂ + an	Limestones, bituminous limestones, dolomites
EARLY WERFENIAN	w ₁	Conglomerates and quartzitic sandstones
EARLY PALAEZOIC	pe ₁	Locva series
MAGMATIC ROCKS		
PALEOCENE	td p ₂ +	Granodiorites, quartzites and their porphyric facies
THERMAL METAMORPHISM		
PALEOCENE		Marbles, hornfels
		Skarnes



B. Elements inferred from geophysical and geochemical data interpretation. Geophysical and geochemical raw data according to Geological Institute of Romania and S.C. Prospechumi S.A.

Symbol	Primary information	Possible geological meaning
	1. Residual aeromagnetic anomaly and/or major ground geomagnetic anomaly	1. Hypabyssal barathite body including skarns (+ magnetite) effect a) shallow hidden body outline, arrow show the deep direction of the body b) deep hidden body outline
	2. Linear ground geomagnetic anomaly	2. Dyke of barathite age porphyric rocks
	3. Ditto 1.	3. Hypabyssal barathite (gasu Ungureanu) body with porphyry copper ore deposit
	4. Geochemical soil anomaly Cu = 100 ppm	4. Shallow hidden porphyry copper ore deposit outline
	5. IP maximum (time domain gradient; injection time = 2 sec) correlated with S _a maximum	5. Sulfidation area accompanied by sulfidation (possibly Carlin type occurrence) a) low sulfidation; b) medium sulfidation; c) high sulfidation; d) very high sulfidation
	a) M _a < 11 m sec; b) 13 < M _a < 17 m sec; c) 18 < M _a < 26 m sec; d) M _a = 51 m sec	

Geological-geophysical correlation. The elaborated structural-metallogenetic map renders evident a series of control factors in the mentioned objectives:

- **The lithologic control:** on the Anisian formations of the Sasca - Gornjak Nappe - 6 objectives with high degree of sulfidation (1 VHS, 2 HS, 3 MS); on the inner scale of the Getic Nappe cover - 7 objectives (2 HS, 4 MS, 1 LS), out of which four, the most intensively mineralized ones, are on limestone with cherts; on the second scale of the Getic Nappe cover (with pyrometamorphic products and banatitic bodies) - 8 objectives (2 HS, 2 MS, 4 LS).
- **The structural-magmatic control** is evident, 16 objectives being disposed, as follows: a) at the periphery of the fallen segment of the Stinapari body (9), b) in the roof and the periphery of the buried body in the western part of Bolborosu Valley (5), c) in the neighbourhood of the Ogasu Ungureanu porphyry copper mineralized body (2). In both cases a dike control can be observed.
- **Tectonic control:** 7 objectives on overthrust lines and 2 objectives in the neighbourhood of an anticline axis.

Verifying ways and other possible mineralized areas. The surest modality to verify the outlined situations is to carry out geochemical investigations, especially for Au, Ag, As, Sb, Hg, Ba, Pb, Zn. In the area of the Cioaca Inalta banatitic structure, especially in the western part, some similar objectives have been identified. Although the major magmatic and tectonic control is obvious (the neighbourhood of an anticline axis), we cannot attribute to these mineralization interesting perspectives, the IP data suggesting a LS mineralization. Another interesting situation for Carlin-type mineralizations could appear for the Supragetic Nappe of Locva, west of Florimunda, also associated with the Spathian-Anisian formations. Unfortunately here the electrometric data are missing.

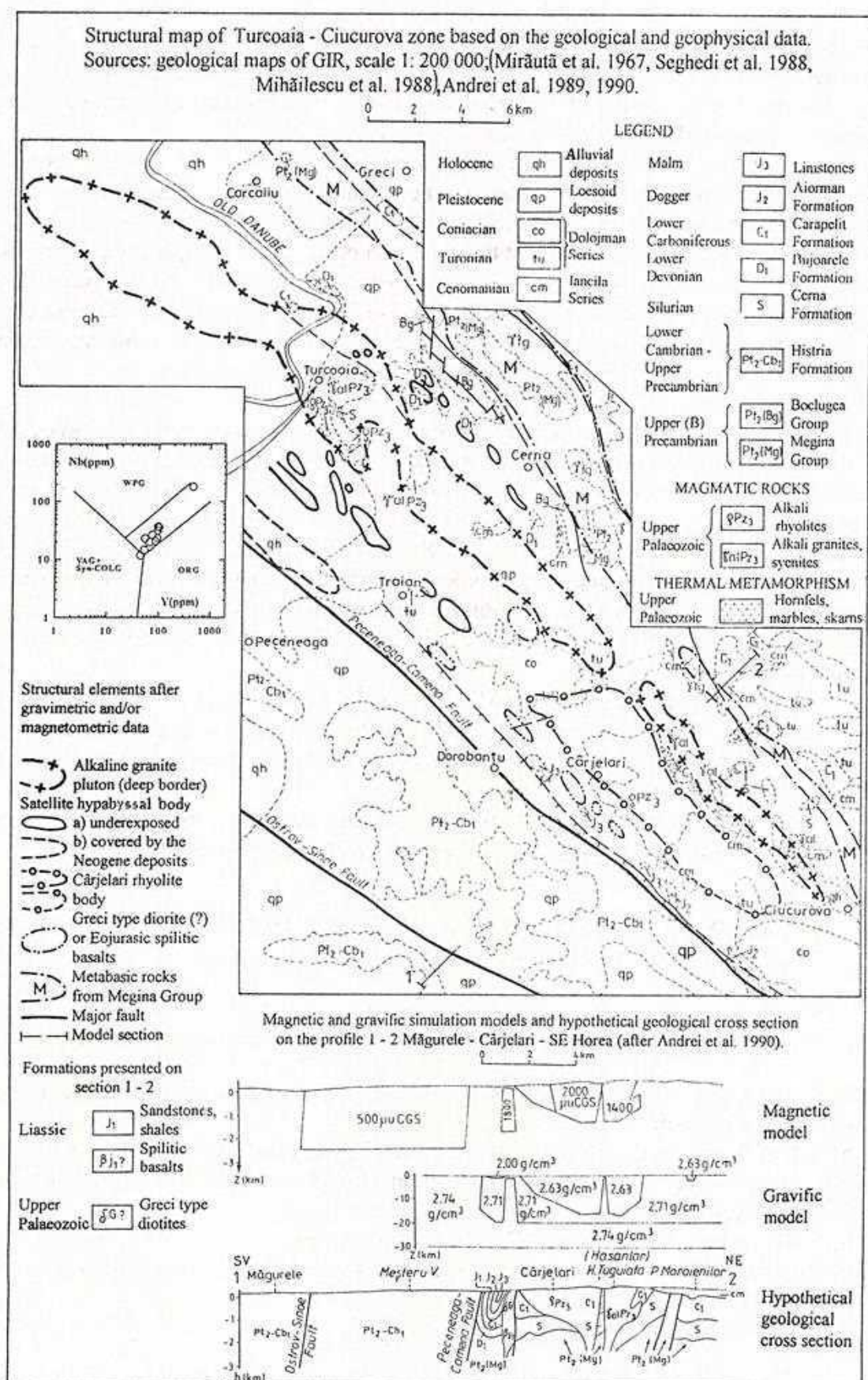
THE PROSPECT OF GOLD MINERALIZATIONS RELATED TO TURCOAIA - PIATRA ROSIE - SACAR BAIR - CIUCUROVA ALKALINE GRANITES ALIGNMENT (NORTH DOBROGEA, ROMANIA) DEDUCED FROM GEOLOGICAL AND GEOPHYSICAL DATA

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Geological setting

As part of the Carpathian foreland, the North Dobrogean territory is located between the Moesian Platform to the south and the Scythian Platform to the north. This domain is composed of four major Alpine tectonic units: Macin, Consul, Niculitel and Tulcea. Each of them includes the pre-Triassic basements (Precambrian and Paleozoic series), as well as the Mesozoic covers. Situated in the south-western part of the Măcin Unit the alkaline within-plate Hercynian magmatism is emplaced in the Paleozoic deposits (Silurian Cerna Formation, Early Devonian Bujoarele Formation and Early Carboniferous Carapelite Formation) and is present in the Turcoaia - Cuciurova alignment. This magmatism is made up of two distinct plutonic and hypabyssal associations intruded in a short range of time. The Turcoaia massif has a concentric structure in which, from the core to the periphery, quartz-syenites, monzogranites, alkali-granites and alkali-rhyolites occur. The plutonic complex is cut by doleritic and rhyolitic dykes of the bimodal Triassic dyke-swarms.



The presence of rare metal concentrations in the pegmatitic pockets show that the mineralized granites are late in the magmatic stage. Pegmatitic pockets, very different in shapes and dimensions, occur in the alkaline granites; their content in REE mineral phases (xenotime, allanite and perrierite-chevkinite) is relatively high. The greisen associations (fluorine, tourmaline, Li-micas and cassiterite) are scarce in alkali - granites.

The Iglicioara - Carjelari rhyolitic alignment is coeval with the plutonic assemblage. Related to this hypabyssal facies, the scarce Cu-Fe sulphides $\pm$ Au mineralisations, as veins and disseminations at Iglicioara Mică, Dealu lui Manole and Hasanlar (Sacarbair), occur.

The geochemical data suggest that the evolution of the alkali complex is characterised by two tendencies: on the one hand, low- evolved syenitic magma and, on the other hand, an evolved granitic trend. The Nb- and Y- enriched peralkaline rocks suggest a within-plate (Fig. 1).

Geochemical and mineralogical data suggest a direct evolution from mantle-derived magmas for the syenitic member and a deep crustal source for the granitic rocks.

Metallogenetic and magmatic-geostuctural considerations deduced from geophysical data

Favourable physical contrasts permit a good gravimetric and/or electrometric mapping of the major intrusive body of Turcoaia - Atmagea alkaline granite, also of related porphyry apophyse train. Figure 1 points out, first of all, the extension of the mentioned alignment, hidden by recent deposits up to 90%, more than 45 Km, from north of once Serban Lake nearby Ciucurova. Moreover, the ground magnetometry data show that the acid alkaline porphyric apophyse, cropping out at Iglicioara and Bujorul Bulgarese, are very extended, like two flanking strips NE and much more SW of the plutonic alignment. The chance of identifying hydrothermal gold deposits can be related with:

- ⑩ alkaline porphyric apophyse (Iglicioara Mica - Dealu lui Manole type)
- ⑩ upper part of plutonic body consisting of alkaline microgranites (Hasanlar - Sacarbair type)
- ⑩ contact area of plutonic alignment and Carjelari-type rhyolite body (see the gravimetric-magnetometric model in Fig.1)

It is possible to identify and investigate this type of mineralizations by geochemical methods followed by IP electrometric investigations for the geochemical anomalous area.

A REVIEW OF MINERALOGICAL AND GEOCHEMICAL PECULIARITIES OF ALLUVIAL DEPOSITS IN ROMANIA

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Alluvial deposits were studied as a part of the research for heavy mineral distribution in the main Romanian river basins.

The aim of the study is to characterise the mineralogical composition of alluvial deposits, to investigate variations in geochemical composition (for different fractions) and to interpret relationships between the gold content and the spatial distribution.

The total number of samples was 210 (26 from ballast-pits).

Representative samples were selected and analysed by different methods: optical, X-ray fluorescence (XRF) and chemical.

Table 1

Sampling area	TiO ₂ (%)	ZrO ₂ (%)	Fe (%)	$C_{Au}/C_{Au}+C_{Ag} \cdot 100$ Ratio Variation (from - to)
Olt basin Sinca Hârseni Porumbacu Prundu Fiscalia	0.5-0.8 0.2-0.5	0.02-0.05 0.02-0.1	1-1.5 1.5-2	530-580 780 575-780
Motru basin Alunul				800-820
Jiu basin Rosia	0.2-0.4	0.0-0.1		
Argeş basin Rm. Vâlcea Fusea	0.2-0.3	0.01-0.02		
Ialomiţa basin Comisani	0.1-0.3	0.01-0.02	0.5-1	
Dâmboviţa basin Viişoara	0.4-0.9	0.01-0.05	4-4.5	780-800
Timis basin Lugojel Jupa	0.5-2.7 0.4-0.5	0.1-0.4 0.01-0.02	4-5	780-920
Topolnita basin Halânga	0.2-2.5	0.1-0.3	6-7	780-800
Nera basin Dalboset Naidas Zlatita	0.3-0.4	0.01-0.02	2-2.8	750-920 800-920
Arieş basin Mihai Viteazu Unirea	0.4-0.9 0.3-0.9	0.01-0.02 0.01-0.03	3-3.3	570-850 570-800
Mureş basin Bârzava	0.7-0.8	0.01-0.03		800-850
Crişul Alb basin Rapsig	0.6-0.7	0.01	3-4	

The mineralogical composition of recent alluvial deposits consists of various assemblages; the means of correlations are limited. Generally, the mineral assemblages consist of: ilmenite, rutile, anatase, magnetite, martite, hematite, zircon, monazite, garnets, amphiboles, pyroxenes, gold, quartz, feldspar, micas and others.

The titanium oxides and gold presence are the most important discriminant for the typology of the alluvial deposits (Table).

The gold particles from older terraces or from alluvium after long transport in river water are characterized by relatively high purity (fineness between 850-950) spongy surfaces and absence of crystallized forms (Mures, Nera, Olt basins).

The "younger" alluvial gold particles (with short transport in river water) as well as the gold from the present river channels show various morphological typology (grains, wires, leaflets, spheres, fine threads) and contains sulphides, quartz and carbonates as inclusions (Cris, Somes, Jiu, Olt basins). Its fineness ranges between 570 and 920.

The gold source (as isolated grains or included in quartz) is hydrothermal (Neogene volcanic rocks) for alluvial gold of Mures, Somes and Aries basins.

For Nera and upper Olt basins, the gold sources are unknown. The gold content in alluvial deposits of these rivers is between 0 - and several g/t.

The minor elements (Cu, Pb, Zn, As, Te, Fe, Sb) contained by gold particles show different levels of concentration, variable for each occurrence. Different localities of alluvial gold were investigated. They show a relatively weak correlation between the mineralogical compositions, the geochemical particularities and the morphological aspects.

For a long time, the alluvial gold was exploited from rivers in the western and north-western part of the Apuseni Mountains. Today, this activity is reduced. The gold particles presence, as isolated or associated grains with quartz, calcite, hematite in alluvial deposit, is considered a very important indicator in gold, base metal or copper geological prospecting/exploration.

SAWING GRANITE – A TECHNICAL AND ECONOMIC PROBLEM

M. BALINT, M. FECIORU, E. JIANU, G. BĂLUȚĂ

Dacia Synthetic Diamond Factory, Bucharest, 77350, Romania

The use of natural stone for decoration of buildings is increased around the world. This is due, in part, to the excellent properties of the material, such as resistance to environmental influences, its hardness and decorative qualities.

In the last years, the architects all over the world realised that granite is a better building material than marble, mainly due to their improved wear and weather resistance.

But sawing granite was not an easy to solve problem. In order to attain the economically best saw tools selection, the following criteria are considered to be of the utmost importance:

- ◆ metal bond and diamond grit characteristics
- ◆ segment manufacturing method and parameters
- ◆ quality of "segment-to-metal core" joint
- ◆ blade tensioning
- ◆ sawing conditions

- ♦ machine conditions
- ♦ workpiece properties
- ♦ operator's skills.

Depending on the mineral composition of the stone, the wear of diamond crystals and of the tool matrix is different. One mechanism which directly affects the diamond is the abrasive effect of the swarf generated by desintegrating the stone material, which causes the crystals to wear. The properties of the abrasive swarf depend on the composition of the stone. For example, swarf consisting of particles of metamorphic and deep-seated rock has smaller grains than the tool material. During the cutting process, sedimentary rock fractures mainly along its grain boundaries because of the low strength of its binding material. This results in swarf consisting of small and hard grains, which determines the erosion of the matrix.

Because of the extreme hardness of granite, diamonds must be of very high quality, very strong and sharp. The harder the stone to cut, the stronger the diamond grit type to be selected. Furthermore, diamond crystals must wear in a controlled manner during cutting. All these requirements were possible to satisfy only when developments in synthetic diamonds industry had led to the manufacture of a high quality diamond range of products, called saw grits. The properties of saw grits which make them useful in sawing granite are detailed in the paper.

The introduction of saw grits, as well as the application of modern powder metallurgy methods to segment fabrication and laser-welding of segments to the steel core have substantially improved productivity in granite sawing. This fact had consequences detailed in the paper:

- ♦ development of new quarries all over the world
- ♦ modernization of sawing technique
- ♦ reduction of granite cost and price.

The decrease of granite blocks and tiles prices and the better properties of granite than of the marble in the cladding and flooring have determined the development of granite production. For example, granite production had an increase of nearly four times between 1976 (1.26 millions m³) and 1991 (4.28 millions m³), whilst marble production had an increase of only 40%.

The applications of granite were consequently diversified. In 1993, about 70% of produced granite was used in construction – including interior decorations – 25% for tombstones and 5% for technical stone and sculptures. The modern techniques permit sawing of well-shaped blocks, grinding to very small dimensional tolerances, manufacturing of tiles for interior decorations by gluing very thin granite tiles (3-6 mm) onto a backing which reduces the weight per square meter.

In conclusion, a technical development like industrial fabrication of high quality diamonds has led to the opening of new possibilities and to the development of dimensional stone industry.

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GOLD ORES AND GOLD RECOVERIES

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From ancient times up to the present gold losses to tailings from world mines, exclusive of placer mining, probably represent more than hundreds of tones. For this reason mining companies make now a greater effort to improve gold recoveries through detailed mineralogical studies and metallurgical test work.

The traditional method for the extraction of the gold includes the following stages: crashing and grinding, concentration, dissolution, precipitation and smelting. For most gold ores, recoveries in the ninety per cent range can be solved by one or more of the conventional techniques, such as gravity, flotation and cyanidation. It is known that the refractory-type ores are not amenable to direct cyanidation; additional treatment, such as flotation with smelting or oxidation of the concentrate and cyanidation, is required.

The extraction of metal from its ore and the processing of the metal are known as "primary and secondary metallurgy".

The aim of this paper is to review the nature of the gold in deposits, to choose the most suitable extraction methods, and to discuss some mineralogical factors that can result in poorer recoveries. These factors are six (Harris, 1990): 1. gold minerals; 2. grain size of the gold minerals; 3. nature of the gangue minerals; 4. associated sulfide minerals; 5. coatings on gold and 6. chemical bound or "invisible" gold.

Gold minerals

In 1990 twenty-six accepted gold-containing minerals (10 native metals, alloys, intermetallic compounds, 9 tellurides and tellurites, 7 sulfides and selenides), three unpublished new mineral species, one doubtful species and thirteen unnamed species have been inventoried (Harris, 1990).

The native gold and its varieties as a result of metals substitution are the most important gold minerals. Pure gold is very rare in nature. The most common metal substitution is silver. These two metals form a continuous solid-solution series with electrum as minimal component (20 wt. % Ag). The compositional range for electrum is 20~40 wt. % Ag. Beyond 40 wt. % the mineral should be named to as aurian silver (Harris, 1990). Electrum is the variety of gold found in epithermal or mesothermal genetic-type deposits. In these deposits the gold alloy shows a wide range of silver contents. The variation of Ag in native gold is defined by the term fineness. Some workers used the relation between fineness of gold and the genesis of gold deposits. Thus, Ross (1988, in Harris, 1990) concludes: 1. Archean greenstone hosted deposits are characterized by restricted range of high fineness values (890-960); 2. epithermal deposits show a wide range of fineness values (450-900); 3. intermediate values between these two extremes are granite related gold deposits, porphyries, porphyry related breccias and porphyry related skarns. Other less common varieties of gold are: cuprian gold (Au, Cu), palladian gold (Au, Pd), mercurian gold (Au, Hg), goldamalgam (Au_2Hg_3) and a new mineral ($\text{Au}_{0.75}\text{Hg}_{0.25}$). Gold takes mercury up to 16.5 wt. % at 90 °C. Other important gold minerals are aurostibite (AuSb_2) and the most common gold bearing tellurides as calaverite (AuTe_2), krennerite (Au, Ag Te_2) and petzite (Ag_3AuTe_2). Aurostibite is virtually unattacked by cyanidation thus the ore is refractory. Gold tellurides are

dissolved slowly in cyanide solutions and require very fine grinding, intense aeration and long agitation.

Grain size

Grain sizes for gold-bearing minerals range (Haycock, 1937, in Harris, 1990) from macroscopic (10.000-100 μ m), microscopic (100-0.1 μ m) and sub-microscopic (0.1-0.0001 μ m) ranges and the size ranges for effective amalgamation (1000-10 μ m), effective cyanidation (60-1 μ m) and ineffective cyanidation (refractory gold, 0.1-0.001 μ m). Haycock (1937, in Harris, 1990) has examined gold grains in fifty Canadian ores. His data have shown: 1. relative proportions of gold in common milling ores with respect to grain size, colloidal gold and gold in solid solution; 2. grain size of native gold varies with the mode of origin of the mineral. Thus most of the gold deposited contemporaneously with gangue and ore minerals is generally very finely divided, while the gold deposited later than the associated minerals has a tendency to occupy small fissures and to have a coarser grain size. Unfortunately, at present the gold ores from the majority of deposits tend to be lower-grade, which makes them difficult to treat. This lower-grade ore normally contains micrometre sizes to the invisible category of gold. In this case the result of effective cyanidation means fine grinding, higher treatment costs and lower recoveries.

Gangue minerals

The gangue minerals have effect on the grinding characteristics and in defining the effectiveness of cyanidation. Thus, the talcose minerals give grinding and filtering problems, certain carbonates cause high alkali consumption and foul the cyanide solutions, the silicates, carbonates and oxides of the base metals in cyanide solutions have a significant solubility, whereas all the normal gangue minerals are generally unreactive. More troubles render graphite and carbonaceous matter occurred in the form of "active" carbon which reprecipitates dissolved gold in cyanide solutions. The highly siliceous (Suior, Romania) or cherty-type gold ores are characterized as poor recoveries. These ores consist of very fine gold or auriferous pyrite within microcrystalline quartz or chert. For some of these ores, even a fine grinding has little effect on gold recoveries.

Associated sulfide minerals

The sulfide minerals are important for gold recovery because: 1. they are frequently the host minerals for gold; 2. pyrrhothite and marcasite are attacked by and have the effect of fouling the cyanide solutions; 3. chalcopryrite and other copper sulfide require abnormally high cyanide consumption; 4. pyrite and arsenopyrite are the most common host minerals, in order following galena, sphalerite, chalcopryrite, pyrrhotite and tetrahedrite-tennantite; 5. with sulfides native gold occurs either as totally enclose microscopic inclusions, to inclusion fractions, to grains in contact with sulfides. For gold-bearing sulfides, metallurgical treatment yields good recoveries with proper grinding and direct cyanidation or by selective flotation and treatment of the concentrates. If in some gold ores the gold inclusions are either submicroscopic or chemically bound gold in sulfides, the ore is considered refractory.

Coatings of gold

Coatings on gold are the result of supergene alteration of the deposit or the processing of the ores. The coatings can be iron oxides, silver chlorides and antimony, manganese and lead compounds. Silver bearing gold from the ores is easily attached by sulfide ions, whereas pure gold is inert.

Invisible gold

According with Harris (1990) "invisible gold is that which occurs either as submicroscopic inclusions within host mineral or as a solid solution or chemically bound gold thus rendering the gold refractory to conventional cyanidation". Multidisciplinary studies with new analytical techniques (electron microprobe, scanning electron microscope, TEM, PIXE, SIMS, laser microprobe) are required to solve the problem of "invisible" gold. SIMS is the most promising in situ method for quantification of "invisible" gold concentration in common sulfides and metallurgical products. The results of these studies demonstrated that gold may coprecipitate together with Fe, As and S during the pyrite and arsenopyrite crystallization. The high activity of As and Au complexes control coprecipitation.

The gold-rich pyrite and or arsenopyrite ores are refractories. The extraction of the gold includes crushing and grinding, dissolution with bacterial or aqueous and heaps leaching by cyanidation.

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ELECTRON MICROPROBE ANALYSES ON SOME GOLD GRAINS FROM DEVA AND BOLCANA NEOGENE PORPHYRY COPPER-GOLD DEPOSITS, POIANA RUSCA AND METALIFERI MOUNTAINS, ROMANIA

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Introduction

The Deva (DD) and Bolcana (BD) Neogene porphyry copper-gold deposits are situated in the north-eastern part of the Poiana Rusca Mts. (PRM), South Carpathians, and in southern part of the Metaliferi Mts (MM), respectively. The first deposit is now almost exhausted. The second one is already explored. The study focuses especially on the electron microscope (EMA) and quantitative electron microprobe (QEMA) analyses of the free gold grains, less other metal minerals from ore of these two deposits. These investigations were performed on two representative polished sections of ores, one from DD (no.1) and another one from BD (no.1). The results come to complete the mineralogical studies achieved by many workers (Superceanu, 1958; Bostinescu, 1984; Maties, Match, 1997).

Geological setting

The DD and BD porphyry copper-gold deposits are located at the joint points of regional and local NE-SW, E-W and NW-SE faults. The basement consists of Paleozoic crystalline schists (DD) or Jurassic ophiolites (BD). It is covered by Cretaceous sediments (DD) and Miocene volcanics and detrital rocks (BD). Both porphyry copper-gold deposits, like others from MM, are spatially and genetically related to Sarmatian-Pannonian calc-alkaline andesite-microdiorite subvolcanic bodies. Highly mineralized rocks occur in the potassic and propylitic zone (inner zone) consisting especially of quartz $\pm$ chlorite, biotite, sulfide $\pm$ magnetite veinlets and less abundant disseminated sulfides and magnetite.

Analytical techniques

High accuracy mineral analyses were carried out with electron microscope and electron microprobe (wavelength dispersive mode) at USGS Laboratory, Denver, CO, USA. Operating conditions were 15 kV, 15 nA and beam diameter < 1 mm. Synthetic ZnSe was used as standard. Corrections were applied using a computer program. QEMA were carried out on grains > 5 μ m in diameter. Each mineral was tested for Fe, Te, As, S, Hg, Cu, Sb, Se, Bi, Pb, Ag, Zn, Au and Cd. The QEMA were carried out on 4 grains of free gold (20 points (pts), Table 1), 3 grains of chalcopyrite (cp, 3pts) and 2 grains of bornite (bo, 2 pts) from sample 1 and 1 grain of bo (1pt.), 4 grains of cp (4pts.), 1 grain of covellite (cv, 1pt.), 1 grain of galena (gn, 1pt.), 1 grain sphalerite (sph, 1pt.), 3 grains of pyrite (py, 3pts.), 2 grains of molybdenite (mo, 2pts.) and 4 grains of magnetite (mt, 4pts.) from sample 2.

Results

The ore consists of two main types of metal mineral assemblages: chalcopyrite (cp)-bornite (bo)-magnetite (mt) in DD and cp-pyrite (py)-mt in BD. As accessory metal minerals have been identified native gold (au) and copper and gn in DD (sample no.1) and, bo, cv, sph, gn, mo, native gold, unidentified Au and Ag tellurides and a Sn mineral in BD (sample no.2). Unidentified Ag Te and Au Te tellurides (BT) appear as very fine idiomorphic grains (2-10 μ m) in bo-cp-gn assemblage, usually associated with gn inclusions from bo. In some grains the Ag Te telluride is commonly intergrown with Au Te telluride. The bo, cp, mt and less py are prevailing in both deposits. They appear as finely disseminated μ m to mm-sized aggregates. The py and mt aggregates are generally idiomorphic, but occasionally deformed or even crushed down to microclastic grains. In contrast, the cp and bo aggregates are usually xenomorphic. They filled the microfissures and veinlets (widths of μ m to mm). Bornite replaces and includes cp grains but in some cases it is replaced and included by cp. The both minerals seem to be contemporaneous. The observed textures can be interpreted as the result of a multi-stage repetitive cataclasis with associated hydrothermal influx.

Native gold is present in both polished sections, more frequently in no.1 (four grains). Its grain size varies from <1 μ m to 25 μ m. It occurs in cp-bo (DD), less cp-py (BT) assemblages, but differs in Fe (0.1-1.04 wt. %), S (0.1-1.5 wt. %), Hg (0.0-0.2 wt. %), Cu (1.5-6 w. %), Bi (0.0-0.67wt. %), Ag (1.3-6.8 wt %) and Zn (0.0-0.1 wt. %) contents (Table 1). In sample no.1 the native gold tends to be associated with massive cp and bo from bo-cp-mt assemblage, where it appears especially as minute inclusion blebs, usual of 1 to 5 μ m. The QEMA and element mapping of gold revealed the distribution patterns of major and trace elements within individual grains. The spot analyses across some gold grains show that the

contents of these elements varied from below detection limits to 6.8 wt % in different grains (Table.1). Silver, Cu and Fe seem to be a constant presence in gold grains, in order following S, Zn, Hg and Bi (Table1). However marginal rims with Ag and partial Cu have been observed (Sample 1, grains 1 pt. 10, sample 1, grains 2, pts.3, 4, sample 1, grains 3, pts. 2-4, Table 1). The average Au : Ag ratio (out of total of 14 analyses) is 31.44. The average of Cu and Ag contents for both silver-poor (grain 1, 2) and silver-rich gold (grains 3, 4) grains are 2.23 wt. % and 2.04 wt. %, 3.04 wt. % and 4.66 wt. %, respectively. The gold as minor constituent of Au-bearing metal minerals has been detected by spot analyses using Au L α line. Its content ranges as follows: 0-0.1 wt. % in cp, bo and py, 0.14 wt % in cv, 0-0.06 wt % in mt, 0.389 wt % in sph and 0.479 wt % in mo.

Table 1. QEMA on gold grains (wt. %)

Sample	Fe	S	Hg	Cu	Bi	Ag	Zn	Au	Total
1,1pt.8	0.9	0.09	0	2.848	0.67	1.654	0	94.686	100.848
1,1pt.10	1.04	0.22	0	2.458	0.56	4.244	0	93.774	102.296
1,1pt.2	0.7	0.1	0	2.5	0.6	1.6	0	96	101.5
1,2pt.1	0.9	0.1	0	2.5	0.6	1.9	0	95.3	101.4
1,2pt.1	0.2	0	0	1.9	0	1.4	0.1	96.1	99.7
1,2pt.2	0.2	0	0.1	1.8	0	1.7	0.1	95.1	99
1,2pt.3	0.8	0	0	2.1	0	2.4	0.1	97	102.4
1,2pt.4	0.6	0.1	0	2.4	0	2.2	0.1	96.8	102.2
1,2pt.5	0.3	0.1	0.2	1.6	0	1.3	0.1	93.8	97.4
1,3pt.1	0.1	0.1	0	1.5	0	3.8	0.1	95	100.7
1,3pt.2	0.5	0.3	0.1	1.5	0	4	0.1	87	93.5
1,3pt.3	0.8	0.5	0.2	4	0	4.9	0.1	90.4	100.9
1,3pt.4	1.2	1.5	0.1	6	0	6.8	0.1	84.3	100
1,4pt.1	0.5	0.2	0	2.2	0	3.8	0.1	96	102.8

GAS-CHROMATOGRAPHY AND GEOLOGICAL LABORATORY CORRELATED WITH PETROPHYSICAL ANALYSIS

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Summary of features

1. Gas — Chromatograph:

- Continue qualitative hydrocarbon analyses from C₁ to nC₄ and also parasite gases as H₂, CO₂ using mud trap;
- Quantitative and qualitative contents of hydrocarbons (C₁ to nC₄) in mud samples using vacuum method (V.M.S.);
- Theoretical estimation of potential and gas saturation of the formation;
- Lag — time method for accurate interpretation;
- Connection / Trip gas.

2. Geological Laboratory:

- Sample collection and processing at prescribed intervals;
- Zoom microscope;
- Sample description / chemicals and geological analysis;
- Shale density determination;
- Quantity fluorescence technique.

WELLSITE SERVICES

- Interpretation reporting to Client's wellsite geologist;
- Interpretation of all gas information;
- Sample handling, packing, recording and description as required;
- Daily reports to Client's specification.

POST WELLSITE SERVICES

Final interpretation made by ATLAS G.J.P. provides End Of Well Report together with the final Geological Evaluation Log and especially with all interpretation results obtained by Petrophysical Analysis Department using logging data acquisition.

GEOLOGICAL AND CHEMICAL ANALYSIS

INTERVAL: 2550.0 m — 2630.0 m

SAMPLE DESCRIPTION:

2560m - 100% green-gray shale;

2570m - 80% fine grained sandstone, dark gray;
20% green gray shale;

2576m - 40% green-gray shale;
60% fine grained sandstone, traces of mica, gray, yellow in color, with benzene reagent;

2580m - 80% green-gray shale;
10% sandstone with calcite cement, gray, traces mica, pale yellow-colored, with benzene reagent,
10% gray micaceous sandstone,

2590m - 40% micaceous sandstone, gray, pale yellow in color, with benzene reagent
60% green gray shale;

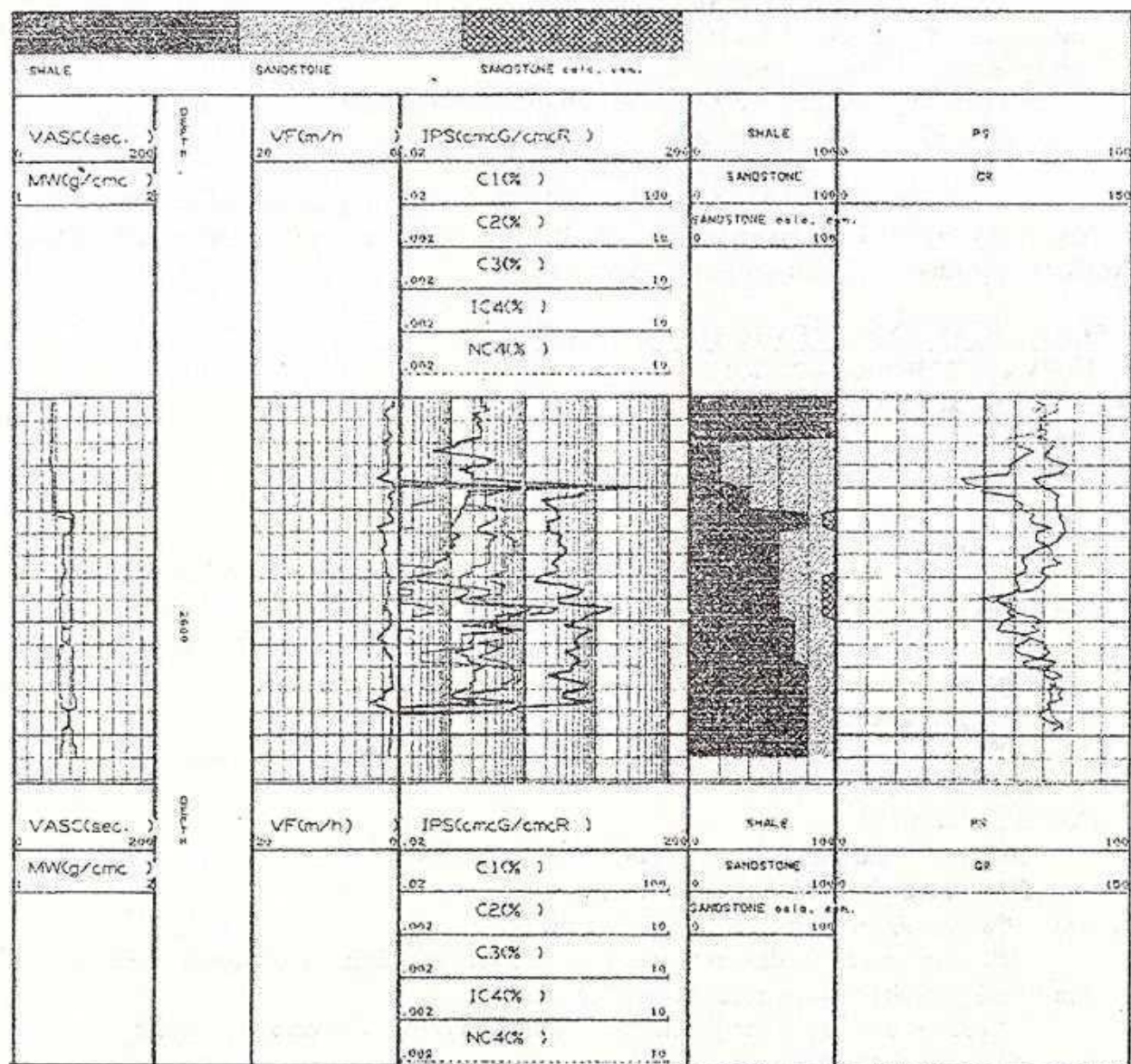
2600m - 60% brown-gray shale;
10% sandstone with calcite cement, gray, mica traces;
30% fine-grained micaceous sandstone;

2610m - 70% gray shale, mica traces, fossil fragments;
30% fine-grained sandstone, micaceous, pale yellow in color, with benzene reagent;

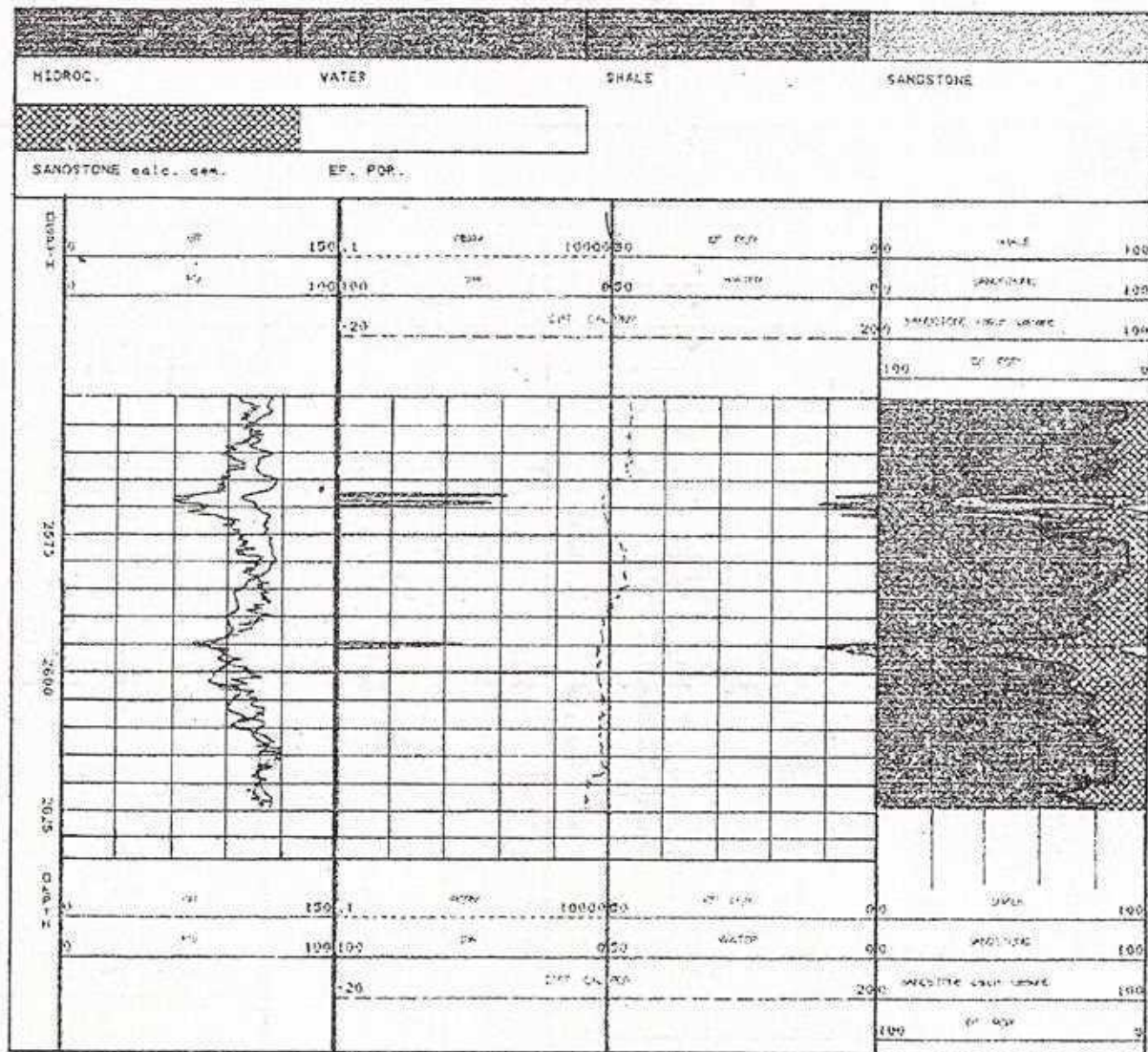
2620m - 80% gray shale, mica traces, fossil fragments;
20% sandstone, gray, fine-grained, pale yellow in color, with benzene reagent

2630m - 80% gray shale, fragments fossil;
20% sandstone, poor micaceous, gray, fine-grained, no show

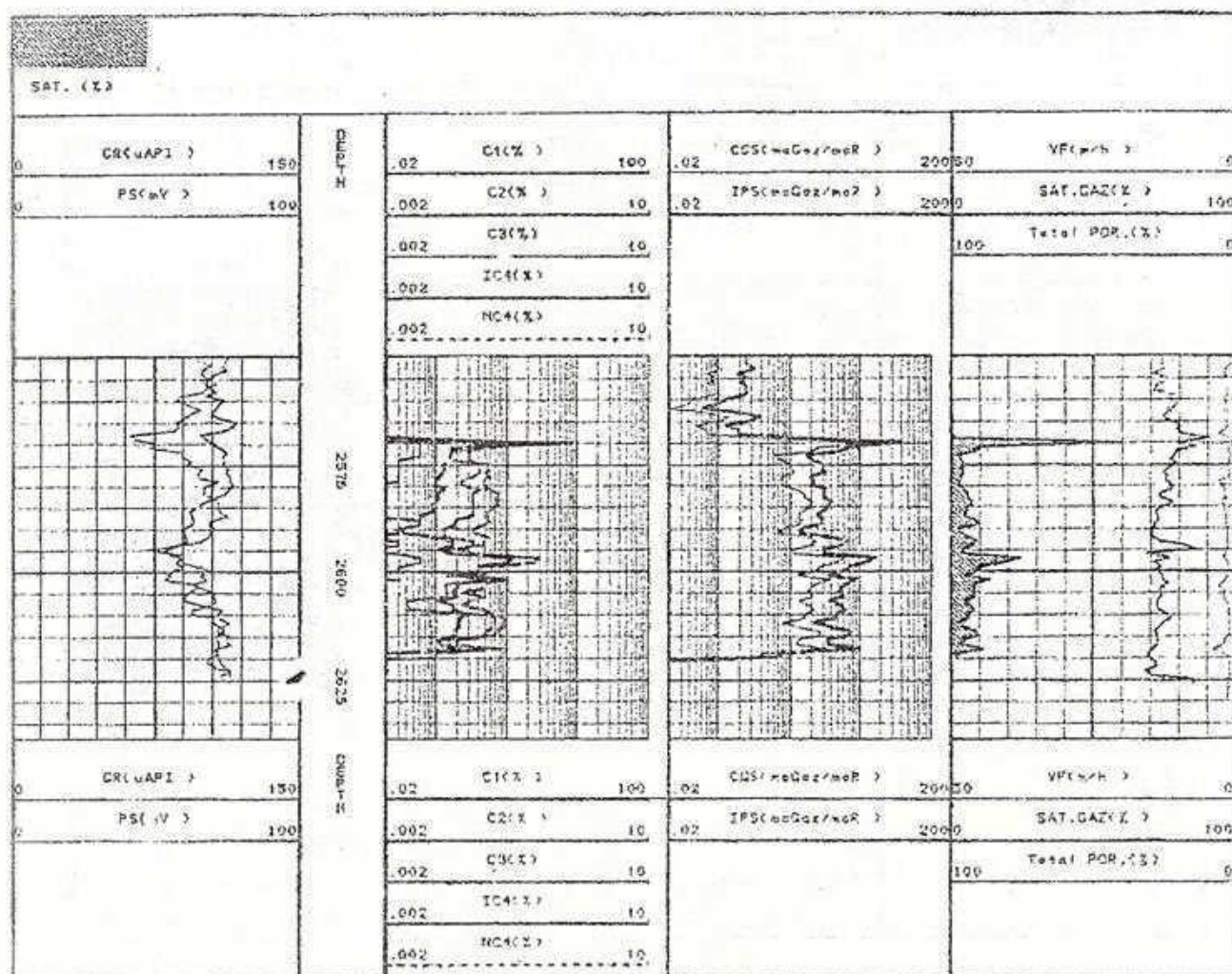
GAS - CHROMATOGRAPHY AND GEOLOGICAL ANALYSIS



Complex Reservoir Analysis (CRA)



INTERPRETATION REPORT of GAS-CHROMATOGRAPHY



GEOLOGICAL, GEOCHEMICAL AND GEOPHYSICAL RESEARCH CONTRIBUTIONS TO OUTLINING BASE METAL MINERALIZATION IN DEALUL MARE - PODELE STRUCTURE (METALIFERI MOUNTAINS)

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The integrated interpretation of the complex prospects results (1980-1995 Prospectiuni S.A.) emphasised new geological, structural and metallogenetic aspects in the Dealul Mare - Podele zone, located in SW of the Metaliferi Mountains.

The island-arc rocks (Upper Jurassic - Lower Cretaceous) form the geological composition of the location, while sedimentary rocks (Upper Jurassic - Lower Cretaceous), Neogene and Quaternary are subordinated.

Within the island arc Mesozoic igneous rocks two complexes have been separated: basic and intermediate acid, represented by an alternance of basic and andesite lava with the respective pyroclastics. These rocks are arranged in an E-W syncline, slightly tilted toward the north. The relation between the two complexes is a discordant and tectonic one, the last being along two major E-W fractures (the inverse fracture Valea Mare-Podele and the southern fracture Razleu Valley - Cucui Brook).

The two rock complexes are pierced by Eocretaceous igneous rocks (granite, tonallite, granodiorite and diorite), displayed along two alignments: North: Valea Mare -Podele, and South: Cucui Brook - Valea Oanei.

This structural pattern is very well represented by the complex geophysical image. Thus, the gravity maximum and the magnetic minimum overlapped the Eocretaceous intrusive rocks, suggesting their evolution in depth (gravity maximum), the hydrothermal process expansion and development (magnetic minimum, radiometric and maximum). The same data indicate for the Eocretaceous body in Valea Mare an approximately vertical southern flank with slight southward tilting and a northern flank, northward tilted.

In the area two mineralization types appear: syngenetical (manganese and pyrite + calcopyrite), without economic importance; epigenetic, of hydrometasomatic and hydrothermal type, which formed accumulations of economic interest and were generated by Eocretaceous magmatites. Within the last mineralization type, a hydrometasomatic mineralization (with pyrometasomatic beginning) was separated, developed in Valea Mare sector, that formed porphyry-copper mineralizations +/- Mo and continued with a hydrothermal phase that generated a copper +/- Mo and gold-base metal mineralization, developed in the Valea Mare basin - Zapoti Brook - Cucui Brook.

The complex research data indicate the overlap of the syngenetic mineralization location with the epigenetic ones, within the (Vorta - Dealul Mare - Valisoara) metallogenic alignment. Within Dealul Mare - Valisoara area two sub-alignments are individualised: northern, Valea Mare and southern, Zapoti Brook - Cucui Brook. The mineralizations concentration was made along some prevailing directions: NE-SW, NW-SE, N-S and is associated with a breccia formation.

The same data also indicate a block structure of the location that can be followed from north to south and east to west. There was ascertained that the eastern compartment - springs-Cucui Brook is the best preserved, in comparison with the ones in the south-west.

The research data obtained allowed us an acquisition of the sectors from their economic prospects point of view: 1. Cucui Brook - springs sector; 2. Trecatorii-Zmeului Brook; 3. Stânii Brook sector; 4. Valea Mare sector; 5. Valisoara sector.

The sector with the maximum metallogenetic potential is springs-Cucui Brook one, where, through drilling (1,2,10,25,26,27,28) and mining (outcropping, wells, Speranta gallery) workings a vein mineralization *was identified (5 veins: 1,2,3,4,5), of stockwork and impregnation, in which the contents vary, as follows: 0.5-16.62% Pb, 0.5-24% Zn, 0.1-6 g/t Au. The mineral parageneses identified in veins: galena, blende (cleophasical), calcopyrite, pyrite, tetraedite, marcasite, native gold; gangue: calcite, quartz and clay minerals).

The veins have a NW-SE/60-80 NE trending and were investigated on a length of 300 meters, and on the vertical on 345 meters. The electrometrical, radiometric, geochemical and geological data indicate the possibility of the veins continuation toward NW and SE on about 500 meters.

The metallic elements associations established by geochemical data processing: Pb, Zn, Cu, Ag, Ni, Sb, Ni/Co = 8, at the upper part and the geochemical association Pb, Zn, Cu, Ag, Cd, Sb, Bi, Mo, Ni/Co = 2 at the lower part of the drillings, at which the anomalies image of Pb, Zn, Cu, Ag, Cd can be added, show that the drillings intercepted the upper part of a hydrothermal vein mineralization, generated by Eocretaceous magmatite, overlain by the syngenetic mineralization pointed out.

The investigation of other sectors mineralizations (including springs- Cucui Brook sector) was stopped for the moment.

Each investigation method has its opportunity in the identification and outlining of the mineralizations at Dealul Mare - Podari.

NEOGENE GOLD MINERALIZATION IN ROMANIA

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The Neogene gold mineralizations from Romania are pretty well known as an important mining resource for gold extraction. They are of interest to the mineralogical community because of the various assemblages and of the famous free gold hand specimens. Information on gold mineralization is presented by detailed studies or synthesis papers.

Types of gold mineralizations

The Neogene gold mineralizations may be divided according to different characteristics: mineralization form, gold/sulfide ratios, Ag/Au ratios, characteristic associations of elements, nature of host rocks and composition of associated volcanics. These mineralizations of Sarmatian-Pannonian age may be classified into two main groups including gold mineralizations in which gold is the main component and gold-bearing sulfide mineralizations where gold is a by-product (Table 1).

According to gold /sulfide ratios two types of gold mineralization can be defined: sulfide-rich gold mineralizations as Muncaceasca, Hanes, Valea Morii, Cavnic, Ilba, Nistru, Herja; sulfide-poor gold mineralizations as Musariu, Rosia Montana, Sasar, Valea Rosie, Caraciu.

The Neogene gold mineralizations are connected to shallow intrusions (andesites, quartz andesites, dacites, porphyry micromonzodiorite, porphyry microdiorite, porphyry microgranodiorite) and are mainly hosted by Sarmatian-Pannonian volcanics; less are hosted by sedimentary rocks.

Table 1: Types of Neogene gold mineralizations.

Main groups	Types of mineralizations		Characteristic associations of elements	Host rocks	Mineralization form	Ore deposits
Gold mineralizations	Sarmatian-Pannonian volcanics-hosted gold mineralizations	a) High-sulfidation type	Cu + Au + As	Quartz andesites, andesites	Veins	Coasta Mare – Geamana - Voia, Bucium, Roşia Poieni.
		b) Low-sulfidation type	Au, Au + Ag, Te + Au + Ag, Au + As	Quartz andesites, andesites, dacites	Veins, breccia pipes	Musariu, Rosia Montana, Baia de Aries, Săcărâmb, Sasar, Dealul Crucii, Valea Rosie
Gold-bearing sulfide mineralizations	Sarmatian-Pannonian volcanics-hosted gold-bearing sulfide mineralizations		Pb + Zn + Cu (Au, Ag)	Quartz andesites, andesites	Veins	Herja, Baia Sprie, Şuor, Cavnic, Muncăceasca, Hanes
			py + Au	Andesitic breccia	Breccia columns	Vălişoara
	Mesozoic-Tertiary sedimentary rocks-hosted gold-bearing sulfide mineralizations		Pb + Zn (Au)	Lower Cretaceous sedimentary rocks and Tertiary molasse	Impregnations, veinlets, pockets	Coranda-Hondol
			py + Au (Pb, Zn)	Tertiary molasse	Impregnations, veinlets	Larga
			py + Au	Upper Cretaceous Negruleasa conglomerates	Stockwork	Fericeana-Stăniţa
	Sarmatian subvolcanic intrusions related porphyry-type mineralizations		Cu + Au (Mo)	Quartz andesites, andesites	Stockwork	Deva, Bolcana, Valea Morii, Musariu, Voia, Bucium-Târniţa, Roşia Poieni

Mode of gold occurrence

The investigations of the gold mineralization point out the following gold occurrences: free gold, gold grains included in various minerals and invisible gold supposed in the lattice of the As-minerals.

Free gold is significant in the gold-rich deposits, at their upper levels. It appears as crystals, in some mineralizations forming dendrites, plates, lamellae, filaments, etc., in places up

to 5 cm long; free gold has been recognized in intergranular spaces and cavities. This type of gold with different morphologies has been sampled from Rosia Montana, Musariu, Ruda Barza, Valea Morii, Caraciu, Baita Craciunesti, Hondol, Dealul Neagra from the Southern Apuseni Mts. or Dealul Crucii, Valea Rosie and Valea Borcutului in the Gutai Mts. The free gold occurrences are very rare in the gold-bearing base metal mineralizations. The gold grains are included in pyrite, chalcopyrite, sphalerite, galena, arsenopyrite, löllingite, bornite, tetrahedrite, alabandite, quartz, carbonates and even in native arsenic with crustiform textures. The association of native gold with quartz, sulfides, sulfosalts and tellurides is very characteristic. An affinity of the native gold for bismuth minerals in the copper sequences from Nistru has been pointed out (Damian, 1998). The microscopic investigations show different sizes for gold grains ($< 1 \mu\text{m}$ - 0.2 mm). The invisible gold may be fixed in the lattice of the arsenian pyrite, arsenopyrite and löllingite or fixed by absorption onto the sulfides surface during the crystal growth.

Some chemical data

Ag content. The Ag content in the gold grains points out a large variation from 2.7 to 93.16 atomic % (74 analyses) and of course the Ag/Au ratios display the same range of variation (0.032 – 14.009). The lowest Ag content (2.724 – 6.759 atomic %) is recognized in the gold grains from porphyry copper deposits and the Ag/Au ratio varies from 0.032 to 0.083 (3 analyses). Opposite, the highest Ag content (90.62 – 93.16 atomic %) is shown by the gold grains from base metal mineralizations from Suior and the Ag/Au ratio is 9.661 to 14.009 (8 analyses). Generally, the silver content in the Sarmatian and Pannonian gold mineralizations varies widely (9.5 – 61.76 atomic %) and the Ag/Au ratio is between 0.105 and 1.619; frequently the values include 20 – 40 atomic % (45 analyses). The Ag content of the gold grains from gold-bearing base-metal mineralizations from Herja and Căvnic varies between 36.28 and 53.74 (16 analyses) and of the gold grains with an affinity for bismuth minerals from Cu veins (Nistru) indicates 24.82 atomic % Ag (Damian, 1998).

Compositional zoning in gold grains. This particularity has been investigated for the gold grains from Au-Ag mineralizations from Sasar and for the gold grains from gold-bearing base metal mineralizations from Suior. An increase of Ag content from the core (43.20 atomic % at Sasar; 91.5 atomic % at Suior) toward the rim (48.72 – 61.76 atomic % at Sasar; 92.58 atomic % at Suior) is recorded.

Gold fineness. There is a large variation of the gold fineness from 983 to 122 ‰. The highest fineness is generally characteristic of the gold grains from the porphyry system (983 – 957 ‰) and for some Au and telluride deposits (986 – 900 ‰) as Breaza, Rosia Montana, Sacaramb, Fata Baii and Stanija.

A particular feature is shown by the gold in the Rosia Montana and Suior deposits. Both deposits contain Ag-sulfosalts; the Suior deposit has the highest Ag content. We determined the gold fineness from Rosia Montana 952 – 840 ‰. Certain data from the literature show 500 ‰. There is the possibility of two generations of gold at Rosia Montana. The latter could be paragenetically associated to Ag-sulfosalts explaining the low value (500 ‰) of gold fineness. Two gold generations have been recognized at Sasar (Petrulian et al., 1961). It is possible that the two values might represent both generations.

Conclusions

The Neogene gold mineralizations are genetically related to subvolcanic intrusions of intermediate composition. They are mainly hosted by Sarmatian and Pannonian volcanics; always these intrusions are younger than the extrusive activity which generated the volcanic structures. Less gold mineralizations are located in areas composed of sedimentary rocks.

In the various types of gold mineralizations gold is present as free gold, gold grains as inclusions and invisible gold; sometimes in the same ore deposit all the three types of gold occurrences have been found (e.g. Baia de Aries in the Apuseni Mts.).

Concerning the invisible gold, our data point out a significant correlation between Au and As in arsenian pyrite and arsenopyrite from different types of gold mineralizations. Available evidence suggests that these sulfides (arsenian pyrite, arsenopyrite) are a very important host for the invisible gold. Presently available information does not allow to specify the species of gold and the position of gold in these sulfides.

The compositional variation of the gold grains displays the following features: a) the gold grains from the porphyry systems and some epithermal gold and telluride mineralizations have the lowest Ag content and therefore the highest fineness; b) the gold grains from some gold-bearing base metal mineralizations (e.g. Suir deposit) have the highest Ag content and therefore the lowest fineness; c) a large spectrum of Ag contents is known between these two categories. In fact, the Ag content varies also in the same gold grain; the Ag content increases from the core towards the grain rim.

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GEOLOGICAL AND ENVIRONMENTAL IMPACT ASPECTS OF MINING WASTES IN THE BAIJA MARE REGION

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Hydrothermal activity in Baia Mare metallogenetic area occurs along some major tectonic E-W alignments between Ilba and Baiut. On the basis of their metallogenetic particularities, three districts have been recognized: (1) Ilba- Baita, (2) Sasar-Valea Rosie and (3) Dealul Crucii-Baiut (Borcos and Vlad, 1994).

Ore deposits in the Baia Mare region are of low sulphidation epithermal type related to volcanic and sedimentary rocks.

Over the entire Baia Mare region Borcos and Vlad, (1994) have identified five paragenetic mineralization sequences: (1) Fe-W; (2) Cu-Bi; (3) Pb-Zn-Cu; (4) Sb; (5) As-Au-Ag.

The metallogenetic activities have been generated in three stages associated to the second magmatic activities, associated to the Sarmatian, Pannonian and Pontian age.

The first stage is of $Pb+Zn+Cu > Au$, Ag type related to the Sarmatian andezitic structures in Ilba – Baita district.

The second stage is characterized by an accentuated gold-silver tendency (sulphosalts; local concentrations of Pb and Zn, $Au+Ag \gg Pb+Zn$) related to the Pannonian quartz andesite bodies. The third metallogenetical stage has a polymetallic character containing frequently copper sequences Pb-Zn and locally rich concentrations of Au, Ag and sulphosalts ($Pb+Zn+Cu > Au+Ag+Sb$).

This metallogenesis is developed in various structural settings of the central – eastern parts of the metallogenetic zone of the Gutai Mountains related to the sedimentary and volcanic (pyroxene andesites, Pontian age) rocks.

The geochemical signature is characterized by the presence of major elements, such as: Pb, Zn, Cu, Au, Ag, S and trace elements, such as: As, Cd, Co, Bi, Mn, Sb, Fe, W, Tl, Te, Ni, Ga, In.

The mineralogical composition in the entire Baia Mare zone is characterized by sulphur and sulphosalts minerals, such as: hematite, magnetite, wolframite, scheelyte, pyrite, marcasite, arsenopyrite, tetrahedrite, tennantite, bismuthinite, chalcopyrite, sphalerite, galenite, bournonite, semseite, jamesonite, boulangerite, antimonite. Native As, realgar, orpiment minerals, electrum, Au, Ag native, miargyrite, proustite-pyrargirite, pearceite-polybazite, included in gangue, such as: quartz, adularia, calcite, rhodocrosite, barite.

The alteration phenomena are characteristic of the low sulphidation type, zonally distributed around the ore, such as: propylization, chloritization, adularization, illitization, argillization and local carbonization and silicification.

As a consequence of the mining activity two types of mining wastes result: spoil wastes characterized by a small content of metal elements a coarse granulometry and by dryness; and tailing wastes characterized by important contents of metal, they have a small homogeneous granulometry and they are moist (wet).

Under some circumstances the mining wastes can turn into urban ore deposits (Keller, 1992). Materials (especially metals) that end up in land fill and other waste management facilities are sometimes designated as urban ore because of the useful materials the waste may contain.

The concept of "urban ore" was released when it was discovered that ash from the incineration of sewage sludge in Palo Alto, California, contained large concentrations of gold (30 ppm), silver (660 ppm), copper (8000 ppm) and phosphorus (6,6 %). Each metric ton of the ash contains approximately 1 ounce of gold and 20 ounces of silver (Keller, 1992). The gold is concentrated above natural abundance by a factor of 7500, making the "deposits" double the average grade that is mined of 9400, similar to that of a common ore grade. Commercial phosphorous deposits vary from 2 to 16 %, so ash with 6,6 % P has the potential of a high value resource. The ash in the Palo Alto dump represents a silver and gold deposit with a value of about \$10 million, and gold and silver worth approximately \$2 million are being concentrated and delivered each year.

In Baia Mare region there are two major types of mining waste: (1) spoil waste and (2) tailing waste.

(1) The spoil waste inventory shows a number of hundred occurrences. The surface of the spoil waste vary from 0.01 ha (Baiut Vest, +812 m) to 2.7 ha (12 Cisma, +686 m). The volume of the spoil waste deposition vary from 870 m³ (Tigher, +356 m) to 97660 m³ (Purcuret, +405 m). Ten of the hundred spoil wastes are active (in exploitation) and ninety are inactive. The chemical composition of the major elements is, as follows: Pb vary from 0.02% to 3.2% (Borcut spoil, +925 m and Varatec spoil, +1044 m); Zn vary from 0.01% to 1.85% (Borcut spoil, +925 m and Varatec spoil, +1044 m); and Cu vary from 0.01% to 1.01% (Gheroldy spoil, +455 m).

(2) There are twenty tailing wastes; their surface vary from 1.5 ha to 120 ha (Bozanta tailing); they represent 433.3 ha of the total surface. The quantity of the material deposition vary from 0.151 million ton to 40.968 million ton (Bozanta tailing), having a total value of 112,926 million ton. Six tailings are in exploitation and fourteen are in conservation. After their mode of construction there are seven tailings of field type, four of valley type and nine of coastal type

The urban ore from Baia Mare region is Meda tailing. It has a surface of exploitation of about 16 ha with a quantity of deposition of 4.4 millions ton. The mineralogical composition is given by the presence of quartz, adularia, pyrite, sphalerite, galenite and submicroscopical gold (amount 0.6 g/t). The chemical composition of the Meda tailing is: Au – 0.8 – 1.05 g/t; Ag 13 – 21 g/t; Pb 0.05 – 0.114%; Zn 0.109 – 0.174%; Cu 0.021 – 0.035%; S 1.58 – 2.35%; SiO₂ 58 – 65%; Al₂O₃ 5.91 – 11.147%. Its moisture is 13.1% and the dimension of its particles is 70 – 280 micron.

The impact of these mining wastes upon the environment manifests itself the action of water, air and soil. The causes of the impact are, as follows :

(1) The rains that washed mining waste acidification themselves and transport the metal in suspension or solution up to groundwaters.

(2) The water of the tailing wastes has a chemical composition that is more complex (miscellaneous chemical substances used in mineral processing) that can trickle in groundwaters transporting heavy metals. On the other hand, their physical stability is characterized by the presence of fine dust particles, that after drying rise in the air under the influence or sometime the presence of some favourable conditions that lead to the crackling dam of protection.

The remediation (Bennett and Doyle, 1997) strategy supposes, in function of the mining waste, the following: for the spoil wastes – the material used aims at five goals: as landfill in the engineering project; as aggregate materials; as inert landfill; as landfill for the mine and quarry; as reshape and revegetation.

The problem of the environment toxicity with heavy metals requires a different approach before the environment remediation. The first approach is the adjustment approach. The second approach is the improvement approach and the last approach is the agricultural and forest approach.

The adjustment approach assumes a selection of the vegetal species that adjust to the toxic environment with heavy metals. The improvement approach assumes the neutralization by means of chemical substances of the mining wastes. The agricultural and forest approach assumes the covering with soil for agricultural and forestation utilization (indicated for the Fe and Al mining wastes).

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THE STUDY OF ANOMALOUS SOURCES FROM MAGURICII DISTRICT, MEZES MTS (NW-APUSENI MTS, ROMANIA)

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This paper presents the main results of our research in the south slope of the Mezes Mts, between Maguricii Valley and Corbului Valley, aiming to identify Au-Ag and base-metal ore deposits. At first the research has consisted in electric prospecting, using I.P. and resistivity methods, next detailed measurements have been performed on the interesting zones, using Vertical Electric Soundings. Finally, we have set up a physical model, in the laboratory. That has helped us to find out the anomalous sources and their most probable depth and dip. It also made us to eliminate the relief effect.

From the geological and tectonical points of view, the southern part of Mezes Mountains corresponds to a horst structure. It is constituted of the formations belonging to the mesometamorphic Somes series. This series was created through the metamorphic process (almandine-amphibolite facies) of terigene deposits, clay-sandstone with fine bands of shales, clay-schists, acid lavas and tuffs, rarely basic. Micaschists (+/- amphiboles, +/- garnets) which alternate with paragneiss (+ muscovite, biotite and garnets) are the most widespread. There are many petrographic types, characterized by the presence of the dominant mineral. Quartz schists with muscovite and chlorite (+/- biotite +/- amphiboles), amphibolites and amphibole schists can be noticed.

Leucocratic gneisses exist, too. These have been formed, most probably, through metamorphism of lavas and acid tuffs. Locally, at the contact zone of the eruptive rocks and country rocks (micaschists, paragneis) migmatic rocks occur. These rocks were initially meso - metamorphic crystalline schists, affected by a weaker metamorphic process.

All this geological assemblage is pierced by several small eruptive dykes and apophyses. These have been emplaced during the Paleocene. The mineralogical composition and the relations with the country rocks show that these rocks belong to the banatitic type.

The banatite magmatism is calc-alkaline and consists of two cycles: the first one, represented by pyroclastics, andesite lavas and subvolcanic bodies, andesite sills and dykes, dacites and rhyolites, and the second one, by granites, diorites and granodiorite bodies.

In the fractured zones, the eruptive rocks are often strongly cataclased and hydrothermalised (silicified, calcitied, chloritized, pyritized).

Two fracture systems have been identified in the area. The main one has a NE - SW trend and is almost vertical (70 - 80° W). The second one crosses the former and is responsible for the splitting of the crystalline.

For electric prospecting a longitudinal gradient with the following features has been used: AB = 1200 m, MN = 40 m, step = 20 m. The measured profiles were located at 100 m each other.

An I.P. maximum with a range of 30 - 50 mV/V in the three apexes, a NNE - SSW trending, and dimensions of almost 1200 x 150 m has been outlined between the Corbului Valley and Maguricii Valley. The background values have a range of 10-20 mV/V. The maximum I.P. with the same orientation is associated with a relative resistivity maximum (500 - 1000 Ω m).

The I.P. maximum has been investigated with a vertical electric soundings line. The geoelectric section has shown a possible mineralized fracture in the depth.

In the Corbului Valley, the main known mineralizations have been seen nearby an eruptive body, on a fracture zone. The mineralizations consist of disseminated pyrite in quartz schists. A rich level having an aspect of massive ore has been identified inside the schists. This band has 4 cm width; it is oriented to the N - S and is crossed by an E- W fracture. The rock samples taken from this outcrop have a 90 mV/V maximal I.P. value.

On the Maguricii Valley, the mineralizations occur like weak impregnations, especially as pyrite, inside some quartz schists with amphiboles.

The assay results show interesting contents of Au, Ag, Cu, Pb, Zn.

In order to identify more exactly the anomalous sources, a model has been performed in the laboratory (sc. 1:2000). Using this model, the relief effect could be eliminated. This correction allowed the rigorous localization of the anomalous sources.

Comparing I.P. maps and the I.P. cross-sections, issued from the model of sources and those issued from the survey, the accurate depth and dip have been obtained.

A vein hydrothermal mineralized system was interpreted based on geological and geophysical data.

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THE MINERALISED STRUCTURES IN THE BAIA MARE ORE DISTRICT

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1. Introduction

The Baia Mare metallogenetic district is situated in the Gutâi Mountains and its represents the NW part of the Neogene Volcanic Chain inside the Carpathians. The calc-alkaline Neogene volcanism is related to the subduction processes of the Orogenic Carpathian Chain. This district is the most productive and it includes gold and base-metal mineralisations.

2. Geological setting

The prevolcanic basement is made up of metamorphic rocks and Paleogene and Neogene sedimentary rocks. These formations were deeply dislocated by longitudinal pre-Neogene fault (Cârlibaba-Carei) that controlled the development of the volcanism and of the metallogenesis

(Borcoş et al. 1994). After the geochemical features of the Oaş-Gutâi Mountains volcanism, two types of volcanic rocks are observed: calc-alkaline acid and calc-alkaline intermediate. The volcanic activity began with the explosive acid phase (rhyolite-rhyodacite) of Lower-Badenian-Sarmatian age. The intermediate volcanism occurred in the second (Sarmatian-Pontian) and third cycle (Upper Pliocene) (Giuşcă et al., 1973). The recent K-Ar data (Edelstein et al., 1992; Kovacs et al., 1994; Pécskay et al., 1994) indicate a Late Badenian to Pannonian age for the Oaş-Gutâi Mountains. The intrusive magmatic activity occurred later together with the lava flows of the calc-alkaline intermediate volcanism. The bodies of the intrusive magmatic rocks from the Oaş-Gutâi Mountains have different morphological characters: stocks, dykes, apophyses, sills, microlaccolites. These intrusive bodies play an important role in localising the ore deposit.

3. Metallogenetic Background

The metallogenetic activity corresponds to three distinct phases (Giuşcă et al., 1973) overlapping the calc-alkaline intermediate magmatic activity of the second eruption cycle. According to the K-Ar and Ar-Ar radiometric data (Lang et al., 1994) the metallogenetic activity is restricted to the Pannonian level (11.5-7.9 M.a.). Analyzing this data we consider that there is a single metallogenetic phase in Oaş and Gutâi Mountains. Within this metallogenetic phase, three mineralisation stages can be separated: a copper one, a base-metal one and a gold-silver one. The upper parts of the copper and base-metal mineralisations have important quantities of gold and silver. Within the base-metal veins the polyascendent character is observed, and at the gold veins and the small-sized ones the monoascendent character is predominant. The structural control, the association with magmatic intrusions, the type of ore deposit, the hydrothermal alterations and the mineralogical composition integrate them to the epithermal and mesothermal type.

4. Types of Mineralized Structures

The veins appear in the form of vein systems associated with intrusive or stratovolcanic structures. The gold-silver veins are localized in stratovolcanic structures. In such structures base-metal mineralisations also appear, but they are rich in gold and silver. The most typical stratovolcanic structure occurs at the gold mineralisations at Săsar-Propad. The main veins are very extended on the vertical and pierce the entire stratovolcanic structure. At Văratec Băiut, in the eastern part of the district, the vein mineralisations appear in a stratovolcanic structure. The gold base-metal veins are localized in intrusive bodies, lava flows, pyroclastics and Paleocene sedimentary rocks. The central area includes gold-copper mineralisations, and the marginal areas gold base-metal mineralisations. The vein systems associated with intrusive structures are very frequent in the Baia Mare area. Baia Sprie ore deposit is the most representative. The andesitic dyke constitutes the local geological element with an important role in metallogeny. The Main vein is localized on the northern contact and the New vein at the southern contact of the dyke. The Main vein has a large number of branches at the upper and lower part. Inside the dyke small-size veins are known. The vertical zonality is very clear: silver-gold, lead-zinc and copper.

A similar structure is the one at Şuitor (Borcoş et al., 1973), where the Cremenea vein is situated on the northern contact of the porphyry microdiorite structure. Vein systems associated with intrusive bodies are also to be found in the western part of the Nistru Valley. In this area the veins are zonally disposed around a porphyry micromonzodiorite intrusion. On the flanks of the body copper veins appear and towards the exterior veins with base-metal and gold mineralisations are to be found. There are transitions from structures of stratovolcanic type to the ones of

intrusive bodies, where the lower parts, predominantly cupriferous, are localized within subvolcanic structures. Typical of this model is the Bolduț-Cavnic vein field. A structure associated with an intrusion of laccolite type can be found at Ghezuri-Turț in the Oaș Mountains. The mineralisation is localized on the flanks of a laccolite with intense potassium altered porphyry microdiorites and has a base-metall character. The copper veins are entirely localized in intrusive bodies of quartz-dioritic type in the east of the mining district at Toroioaga or they are disposed in the spreading area of the microdioritic intrusive bodies like the ones at Cisma-Poiana Botizei. The vein systems with base-metal mineralisations are almost entirely situated in intrusive bodies (Herja).

The stockworks are less known in the Baia Mare area. The reorientation of the prospecting and exploration research in the upper parts of the mineralized structures have emphasized their presence in various areas. In the upper parts of the intensely branched veins predominantly gold stockworks could appear. The most typical body of stockwork type is the one at Borzaș which is followed by a vein system and localized in adularized and brecciated quartz andesites. A similar body localized in adularized pyroxene andesite can be found in the western part of the perimeter, at Racsa. Gold stockworks are localized in the upper branched parts of the mineralized structures at Șuior, Baia Sprie and Aurum-Săsar.

The breccia bodies are the least known in the Baia Mare mining district. The main explosion breccia pipe structure at Kelemen Băiuț is base-metal mineralized. The dyke type breccias are typical of the mineralized shear fault like the very thick veins at Șuior and Baia Sprie. Inside the very thick veins and at the vein intersections mineralized breccia of phreatomagmatic explosion appears. The breccia especially from the upper parts of the mineralized structures will be known much better from the ongoing prospecting and exploration for gold epithermal mineralisations carried out in the Baia Mare area.

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THE EMPHASIS AND CONFIRMATION OF THE GAS PRESENCE IN A TRANSYLVANIAN DEPRESSION STRUCTURE THROUGH THE ADVANCED PROCESSING OF SEISMIC DATA

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Introduction

The emphasis of the traps for oil and gas is the major concern, both for the geologists and the geophysicists who are working in the acquisition, processing and interpretation of the seismic data. If for the structural traps the older methods have worked, the stratigraphical traps need technology and processing adapted to the enlargement of the seismic resolution. Furthermore, in the tectonically complicated areas the data is complicated by random waves, by surface waves without any connection with the acoustic structure of the geological environment, by multiple waves with variable periods, by targeted and diffractive waves. The elimination of these influences is the task of the acquisition and mainly of the processing.

Data Processing

In this work we will give the example of processing of some profiles in the Transylvanian Depression, with a set of programs from the Promax system. In order to emphasize the new structures we have reprocessed the old recorded profiles and some new profiles with a packet of new programs. In areas where the presence of a bright-spot seismic sign type has been spotted we have made seismic attributes and processing of AVO attributes. The study of the seismic waves propagated in the geological environments meets many problems connected to the complexity of those environments and the insufficient knowledge of their composition and physical properties, factors that are of great influence to the propagation establishing the modification of the shape and amplitude of the initial seismic signal.

The improvement brought in the processing and data interpretation field makes possible the achievement of the following major targets:

1) The attenuation of the perturbation waves which leads to an improvement of the signal – noise relation.

2) The removal of the reflections distortion given by the fast variations of the low velocity area parameters (the thickness and velocity) that can lead to the alteration of the subsoil represented by the stacked section, with the refraction static corrections.

3) The processing with keeping the true signal amplitude, which allows the quantity determination of the reflection amplitude variations.

4) The elimination of the influence of the random factors, of multiples, the enrichment of the power spectrum and the removal of differences between seismograms using deconvolution consistent with the surface.

5) The achievement of some continuous analyses regarding the interval velocity variation, the frequency and amplitude of the seismic waves with AVO program.

6) The utilization of special programs for the extraction of other attributes of the seismic signal (envelope, instantaneous frequency, polarity).

7) The best presentation in sections or maps of the seismic processing results so that they can be used as well as possible by the processing geophysicist and geologist.

Starting from the bright-spot signal type at the level of the Sarmatian-Buglovian formations and from the fact that not always the bright-spots are caused by the presence of the gas the AVO attributes have been used for the confirmation or denial of the gas presence. The study of the attributes clearly confirmed that we are in the presence of gas. The confirmation came from the drill designed and drilled which proved to be productive. The following pictures represent: Migrated time section (Fig.1), Zoom bright-spot event (Fig. 2), Reflectivity Strength (Fig. 3), one of AVO Attribute (Intercept*Gradient) on one of the profiles confirmed those showed above.

Seismic Interpretation

The above-mentioned structure is presented like a brachy-anticline with a NNW-SSE trend. The bright-spot signal can be observed at the Buglovian – Sarmatian level formations at 300-900 ms. The Buglovian levels with a thickness of 200-500 m are constituted of alternating grid stones, sand and sandy shale. The Sarmatian formations levels, with a thickness of 600-800 m, are presented as predominant sandy facies with good petrophysical features. These are the main geological objectives in the area. So, the isochrone map drawn up based on the interpretation of profiles emphasizes some structural elements. In the northern part it appears the route of a takeoff fault with E-W route formed through the takeoff deformation on a detached section which is formed in a rock packet with high plasticity, represented by the salt formation (Badenian superior), during or at the end of the Pliocene. South of the fault a high zone appears, with an enclosure of 370 ms, on whose east flank a hole has been drilled. The presence of bright-spot type of signal at the Sarmatian-Buglovian formation level can be noticed, which indicates the hydrocarbons presence. The image is confirmed by the seismic attributes, as well. On this basis, the moving of one particular hole location at 150 meters from the old emplacement has been proposed, which, as shown in the sections, has stopped with the bottom hole in the salt layer at a depth of 1388 meters and where the production samples taken at the Badenian level had lack of afflux. Following these corrections the hole projected and drilled proved to be productive.

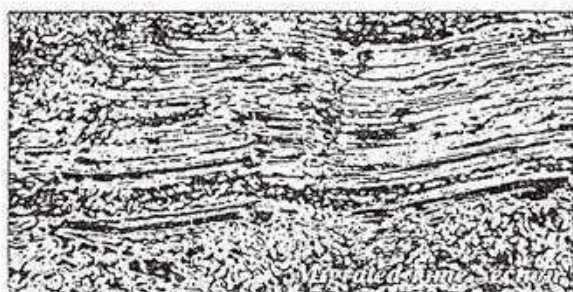


Fig. 1. Migrated time section.

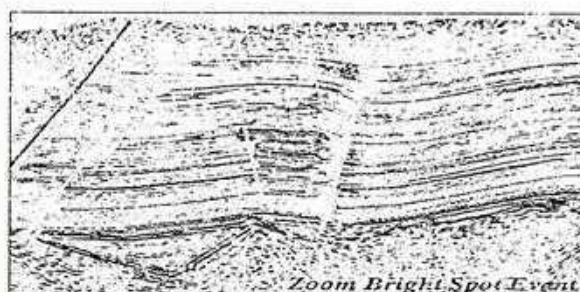


Fig. 2. Zoom bright spot event.

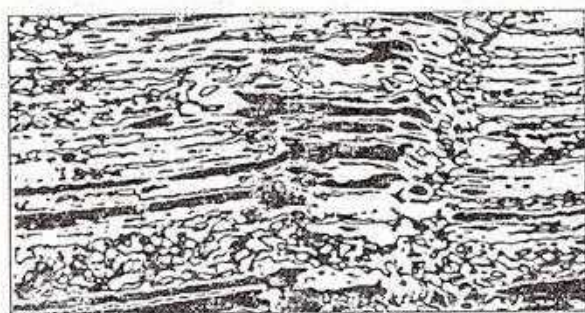


Fig. 3. Reflectivity strength.



Fig. 4. Intercept*Gradient

Conclusion

Concluding, the need to discover hydrocarbons deposits under harder conditions led to the development of more and more programs for data processing and interpretation. The huge jump made by the interactive processing helps you to adopt parameters and programs necessary for every area, every profile or group of seismograms, which leads in the end to the optimal solving of the geological objectives. Taking into account the obtained results, the following conclusions are imposed:

- The primary data quality must be constant (the signal/noise ratio), so that the processing must assure the elimination of all non-geological factors, which can affect the seismic signal amplitude.
- The single interpretation of the analytical signal and AVO is not univocal; in order to obtain success in placing some objectives of interest, the correlation between parameters must be achieved such as the utilization of some geological and geophysical data.

ROMANIA – THE FIRST OIL PRODUCER REGISTERED IN THE WORLD. PAST, PRESENT AND FUTURE

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The first oil production of the world has been officially recorded in Romania in the year 1857 at a rate of 275 tones/year. However, the extraction of crude at Mosoarele, Poieni and Pacuresi, located in the Romanian provinces of Moldova and Muntenia, has already been mentioned by foreign travelers since the first half of the 16th century.

In 1990 Romania was the third largest oil producer in the world with a yearly production of $0.3 \cdot 10^6$ tones/year. In 1953-1955 the oil output of Romania was 9-10.106 tones/year, and in 1976 a maximum of oil output of $14.6 \cdot 10^6$ tones was achieved.

For a better understanding of Romania's geology and for the evaluation of perspective areas, detailed maps and synthesis have been drawn up over the years. All geophysical methods were applied in regional and detailed researches especially seismic ones. On the on shore

prospective areas, the density of available reflection and refraction seismic coverage amounts to about 2 km profile per sq.km, and on the Black Sea offshore to about 2.6 km profile per sq.km.

More than 400 wells deeper than 3500 meters have been drilled, in order to explore the deep structure with hydrocarbon potential of the country. The deepest well in Romania was drilled in the Baicoi oil field to explore the prospective of the Oligocene formation in Mio-Pliocene zone and reached a total depth of 7025 meters, proving the oil shows at 6500 m in Oligocene reservoirs.

Before the Second World War the geological research for hydrocarbon in Romania was performed by the geologists and the geophysicists of the Geological Institute and from the petroleum foreign companies. 8.7 million tones of oil represented the highest output reached in that period.

The first geological map of Romania and detailed regional maps were performed in this period. Gravity, magnetic and electrical maps were carried out in the Mio-Pliocene zone and the Transylvanian Depression. As a result the Moinesti region in the East Carpathians, dyapiric zone from Mio-Pliocene zone and Transylvanian Depression have become well known for their oil and gas fields.

After the Second World War Romania's oil production has drastically diminished down to 3.8×10^6 tones.

Beginning with the fifth decade of the century a prospecting company and a laboratory specialised in geological and geophysical research for oil were founded. At the same time the regional companies for drilling and production began their activity.

In the same period the Geological Committee supervised all geological researches in the country.

More than 250,000 km seismic profiles were recorded with oscillographic, analog and digital recording and more than 70% were multifold coverage. Using the modern equipment for acquisition, processing and interpretation provided a good support for new discoveries.

New producing areas were discovered in the Moesian Platform, Getic Depression, Pannonian Depression, Moldavian Platform, North-Dobrogean Promontory and Black Sea offshore. At the same time new oil and gas fields were discovered in the East Carpathians, Mio-Pliocene zone and Transylvanian Depression. The peak of yearly production was reached in 1976 with 14.6 million tones and 34 billion cubic meters of gas.

After 1976, the crude production in Romania decreased gradually and more rapidly during the eighties, reaching 6.8 mil.tones in 1990. After 1990 the producing level remained more or less at about the same level.

The improvement of field acquisition, processing and interpretation of seismic data has contributed to a much more efficiency of research and discovery of new traps containing hydrocarbon pools.

But during the time classical traps were discovered and all accessible areas were covered with seismic profiles.

A new stage of research has begun both for seismic research and for geological conception about petroleum systems, places and prospects.

For this reason we shall try to mention out the most important areas to be researched in order to discover new prospects.

In the East Carpathians the future prospects have to be discovered in the foreland autochthonous underthrust blocks, in Badenian and Mesozoic formations, and in the Marginal

Folds Nappe both below the Tarcau Nappe and in new scale nappes inside the Tarcau Nappe. Some seismic images regarding the polystage structure of the Marginal Folds Nappe in Bistrita Halfwindow of the Tarcau Nappe and south of Vrancea Halfwindow are very promising results. Likewise, the multistage structure is proved by well-known Carpathian fields as Zemes-Tazlau, Dofteana-Bogata.

The Mio-Pliocene zone represents a good prospect area to discover new traps both in Oligocene formations at depth and between the oil fields in new blocks and pinch-outs.

The Getic Depression is a good prospect area for the Oligocene formations north of the Ticleni-Romanesti-Ursi-Calinesti-Suta Seaca fault and for the stratigraphic traps in Sarmatian and Pliocene formations mainly along the frontal zone of the Pericarpethian Nappe.

The foreland area as Moesian Platform and Moldavian Platform can be taken into consideration for new prospects in Mesozoic and Cenozoic formations. In the Moesian Platform new perspective traps can be delimited in Jurassic and Cretaceous formations as reef build-ups and tectonics blocks, as well as some depositional fans. In Sarmatian and Pliocene formations pinch-out zones and sand fans and bars have to be taken into consideration.

The Transylvanian Depression – the most producing gas from Romania – has good possibilities to discover new traps with gas in Badenian and Sarmatian deposits between the old gas fields and also in fan deposits along the external limits of the basin as proved by new seismic images.

The Pannonian Depression can reveal new subtle traps both in the southern part and the northern part. Also, the turbidites fans along of paleovalleys can be challenge in this area in the future.

The Black Sea offshore was not enough searched for Mesozoic traps up to 200 m depth of water, but good prospects can be taken into consideration for the areas deeper than 200 m.

As a general conclusion, we believe that the Romanian territory can be a good target for new oil and gas discoveries both in classic traps and mainly in subtle traps. We need new concepts, new techniques for research, new investments and certainly a much more favorable climate for investment for such objectives.

SOME MODELS OF PHOTOGEOLOGICAL INTERPRETATION IN ORE DEPOSITS PROSPECTING FROM ROMANIA

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The most representative areas covered by remote sensing experiments, as primary or secondary method, in minerals prospecting projects followed by Prospectiuni SA were: Oas-Gutâi Mts., Călimani Mts. (Călimani Caldera, Colibita-Struniorul area), South Apuseni Mts. (Brad-Vălișoara area), Poiana Ruscă Mts. (Rusca Montană basin), Căpățanii Mts. (Bistrita-Gurui area).

1. Oas-Gutâi Mts.

A photogeological systematic interpretation (sc. 1:100.000) on the area of about 1,200 sq.km, superposed with satellite imageries (SPOT, 1-P 84/254; 84/253) have been performed in Baia Mare area. The criteria that allowed a GIS document elaboration have been used.

The results of this program could be grouped, as follows:

- the majority of the contoured volcanic edifices forms: *calderas* with composite structures, mainly stratovolcanic, such as: Ignis, Strâmbu-Hârcea-Berdu, Plesca-Prislop-Măgura Mare (S Jereapăn), Ursoi Peak-Bârloagele (Cămârzana); *composite major cones ± lava domes ± peripheral volcanoclastics*, such as: Satra, Măgura Focului, Higea, Piatra Soimului, Sindilit, Dealu Negru (Orasu Nou), Jeleznic, Gărăsean (Negresti), Măgura Târsolt, Prislop Peak, Plescuta Peak; *minor lava cones or lava domes* such as: Arsita, Măgura (Suior), Ascutitu, Coasta Chinezului, Dealul Minei, Blidaru Peaks, Măgura (Chiuzaiba), Piciorul Herjei, Ostra, Purcăretu, Muntele Mic, Orasu Nou Vii, Gruia Peak (Gherta Mică), – of prevailing rhyolite-andesite composition. The only *cumulodome* we consider in the area is the Gutin edifice, and the typical *lava dome* is the Ignis Peak. The photogeological study contests the previous representation of the Săpânta and Mara calderas. They seem to be southward directed monoclinical stratovolcanic complexes (mainly pyroxene andesite lava flow). Some of their volcanic centers could correspond to the northern zones – eroded without volcanics – Măgura Piatra and Agrisului Peak, Pestilor Peak necks respectively. A lot of *subvolcanic bodies* (most of them dikes and sills) mark tectonic alignments (active after the Mara Pannonian andesite phase), and correspond to intermediate and basic phases correlated with previously determined age and chemical data;
- the regional sinistral strike-slipping WNW-ESE (the conventional Bogdan Vodă name has been adopted), E-W (the conventional Dragos Vodă name has been adopted) and NW-SE (North Gutâi) have been recorded with a post-Jereapăn andesitic lava phase imprint. These main faults and the secondary isoclinal angle faults generated in the extensive and compressive moments (NE-SW, ENE-WSW and E-W respectively), as well as the N-S regional faults (W Gutâi), constitute the Upper Neogene *macrotectonic setting* of the area;
- the Paleogene sedimentary deposits of Băiut-Botiza area show a *suture melange structure* that contests the nappe structure (Botiza and Wildflysh nappes) previously mapped. The design of the «Botiza nappe» shows regular sequences of slides, possible sutured remnants of Paleogene ocean deposits. The «Botiza frontal slide» is a perfect model for all the *Botiza Multislide Unit*;
- the E-W (Dragos Vodă - Jereapăn, Suior, Baia Sprie) and WNW-ESE (Bogdan Vodă - Băiut, Bixad-Corneasa) major fault systems as well as the isoclinal secondary fault systems ENE-WSW (Băiut) and NE-SW (Roata-Oanta, Căvnic-Boldut, Herja, Dealul Crucii, Săsar) prove to have an obvious metallogenetic value, controlling the well-known metallic veins. The western side of the Gutâi Mountains suggests an obstruction of the mentioned faults with the N-S one (Piatra-Ciresului Valea Mare-Cicârlău) and the NNW-SSE fault systems (Turulung Vii-Orasu Nou-Racsa-Piatra Handal; Cămârzana-Vama-Nistru; Târsolt-Alunis). They form the hydrothermal net in Racsa stock, Ilba - Nistru ores, or Wilhelm field and partly Valea Rosie-Săsar metallogenetic districts.

2. Călimani Mts.

2.1. Călimani Caldera. The first systematic photogeological photointerpretation on a major area (>150 sq.km) has been done, with detail tracing of lithocartographic entities, of major or detail fractures, of postvolcanic (Solfatarian) alteration zones, of volcanic edifices. The main mapping novelties could be resumed, as follows:

- disconnection of volcanoclastic entities from upper caldera edifice;
- unravelling of basalt-leucobasalt, as a major development product, generator of independent edifices (Măgura) - foregoing to the great subsequent effusive phenomena (pyroxene andesite);
- separation of the two major andesite pyroxene (lower/upper) categories and of the associated pyroclastite (clearly volumetrically subordinated and prevalingly distant);
- strict outlining of the volcanic - andesite with q+bi+px+ov (Dragus, Pietricelul, Puturosul) last products edifices;
- outlining of main fractures (circulation ways of postvolcanic - mostly solfatarian solutions: Puturosul fracture, Ilva Mare fracture, Pietricelul-Retitis, Bradul Ciont etc., from the radial circumcaldera system;
- detail outlining of solfatarian areas.

2.2. Colibita-Struniorul area. By mapping experiments there were obtained: - the first geotechnical sketches with the delimitation: volcanic edifices, subvolcanic bodies (sills, dikes), areas with postvolcanic alterations, sedimentary/volcanic limits, lava/ volcanoclastite limits.

3. South Apuseni Mts. (Brad-Vălișoara area)

Application of geological photointerpretation was facilitated by:

- alternations of volcanic rocks (ophiolite, Eocretacic, banatite, neogenite), sedimentary (Mesozoic, Neozoic) and crystalline rocks;
- tectonics with various genetic dominants, multiple metallogenesis.

The photogeologic interpretation in the Transylvanides area shows morphographic and drenographic features, as follows:

- possible definition of surface geological-mapping;
- Neogene volcanological clarifications (necks denial, lava domes unravelling, pyroclastite levels unravelling);
- petrogenetic clarifications (volcanoclastics/tectonic breccia);
- tectonic-metallogenetic alignments marking;
- unravelling of structures in scales - as an effect of rhythmic sutures of the ocean floor remnants, which generated, in time, by clear local discordances, the «sheet structure» image;
- pointing out of carbonate and ophiolite «olistolite» alignment, on colinear path, marking suture scales;
- crystalline scales positioning in the same suture series, with possible explanations of their structural position.

4. Căpățâni Mts. (Bistrita Valley-Gurgui Valley area)

Unlike the areas with igneous rocks, the unravelling of the tectonic style, of the geological-lithological limits and of the tectonic detail is extremely difficult to unravel because of homogenization through metamorphism.

Major ruptural discordances were identified, among which «Cornul Caprei» (Gurgui creek) fracture, which brought about the penetration of an ophiolitic melange with a Cyprus-type mineralization.

The development area of pegmatite, or amphibolic/gneiss rocks contrasts can be easily pointed out.

5. Poiana Ruscă Mts. (Rusca Montană Basin)

Essential mapping contribution, resulting in:

- firm tracing of sedimentary Mesozoic/magmatite - basaltic volcanite limits;
- firm tracing of banatite bodies;
- tracing of fractural alignments, difficult to be stratigraphically defined;
- unravelling of volcanoclastics entities, alternatively with the lava flow levels, or sedimentary deposits from the Rusca Montană basin volcano-sedimentary complex.

REMOTE SENSING MAPPING IN THE OAS – GUTÂI MOUNTAINS (NW ROMANIA)

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A specific S.A. Remote Sensing study made by Prospectiuni S.A., focused on the Gutâi Mountains and the eastern part of the Oas Mountains, consists of a systematic photogeological interpretation and a SPOT satellite imageries processing and geologic interpretation (P 84/254, P 84/253). The goal of this study is to bring together new tectonic (including volcanologic), petrologic and metallogenetic data. The Stereo Zoom Transphere Scope™ technique for aerial photographs interpretation and specific softs (ArcInfo 7.02, ERDAS Imagine 8.3 on a SUN Sparc Station 5) for satellite imageries provide GIS products. The final maps take into account field observations and standard maps definitions of the area.

The remote sensing new mapping data could be grouped into:

- *volcanologic categories:*
- the majority of the contoured volcanic edifices forms: *calderas* with composite structures, mainly stratovolcanic, such as: Ignis, Stâmbu-Hârcea-Berdu, Plesca-Prislop-Măgura Mare (S Jereapăn), Ursoi Peak-Bârloagele (Cămârzana); *composite major cones ± lava domes ± peripheral volcanoclastics*, such as: Satra, Măgura Focului, Higea, Piatra Soimului, Sindilit, Dealu Negru (Orasu Nou), Jeleznic, Gârătean (Negresti), Măgura Târsolt, Prislop Peak, Plescuta Peak; *minor lava cones, or lava domes* such as: Arsita, Măgura (Suior), Ascutitu, Coasta Chinezului, Dealul Minei, Blidaru Peaks, Măgura (Chiuzaia), Piciorul Herjei, Ostra, Purcăretu, Muntele Mic, Orasu Nou Vii, Grui Peak (Gherta Mică), – prevailingly of rhyolite-andesite composition. The only *cumulodome* we consider in the area is Gutin edifice, as well the typical *lava dome* of the Ignis Peak. The photogeological study contests the previous representation of the Săpânta and Mara calderas. They seem to be southward-directed monoclinical stratovolcanic complexes (mainly pyroxene andesite lava flow). Some of their volcanic centers could correspond to the northern zones – eroded without volcanics – Măgura (Piatra) or Agrisului Peak, Pestilor Peak necks, respectively. A lot of *subvolcanic bodies* (most of them dikes and sills) mark tectonic alignments (active after the Mara Pannonian

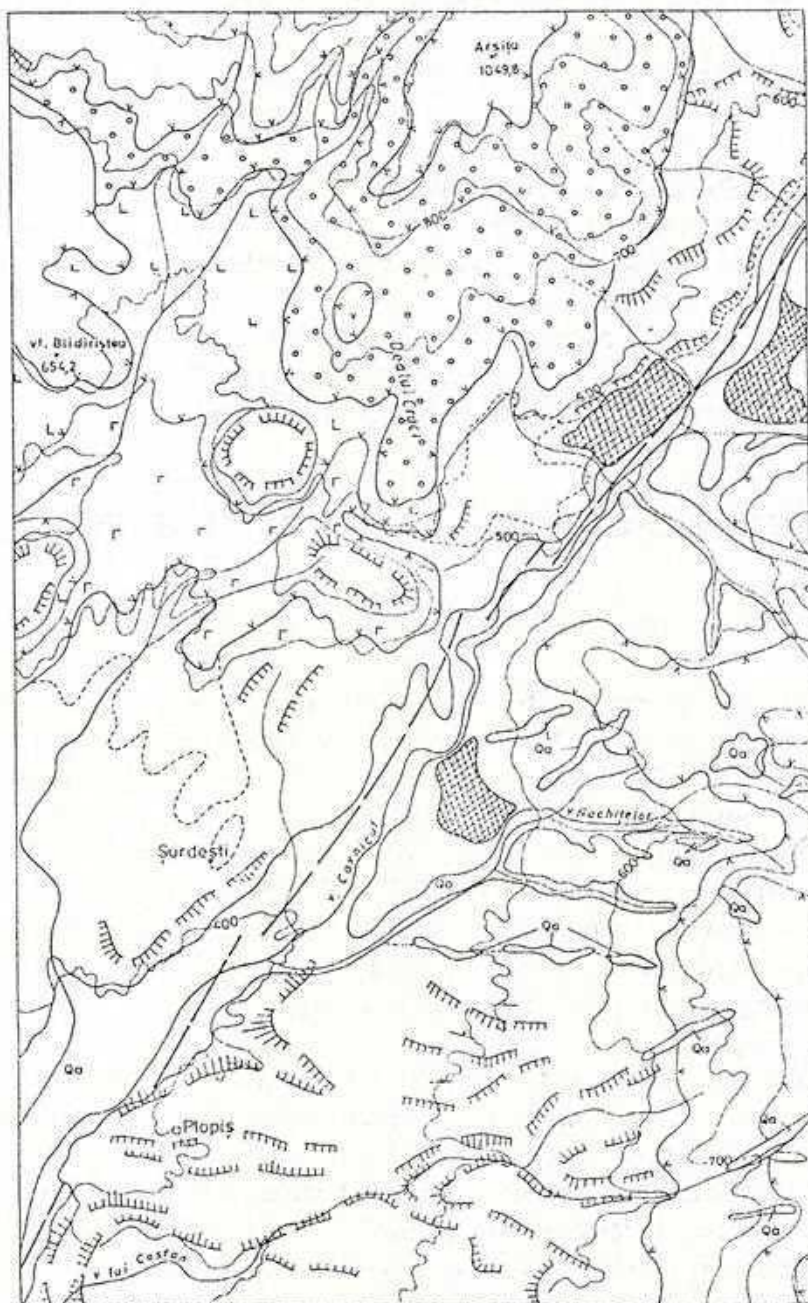


Fig. 1 Sisesti-Danesti photointerpretation mapping proposal

andesite phase), and correspond to intermediate and basic phases correlated with previously determined age and chemical data; the discrimination between lava types, as well as between volcanoclastics and volcano-sedimentary deposits from different volcanic edifices, can be mapped accurately. Locally, the lava/pyroclastic complexes are undifferentiatedly mapped as major effusive/extrusive units (NW Gutâi);

- *tectonic categories:*

- the regional senestral strike-slipping WNW-ESE (the conventional Bogdan Vodă name has been adopted), E-W (the conventional Dragos Vodă name has been adopted) and NW-SE (North Gutâi) have been recorded with a post-Jereapăn andesitic lava phase imprint. These faults and the secondary isoclinal faults generated in the extensive and compressive moments (NE-SW, ENE-WSW and E-W, respectively), as well as the N-S regional faults, form the Upper Neogene macrotectonic setting of the area;
- the Paleogene sedimentary deposits of Băiut-Botiza area show a *suture melange structure* that contests the nappe structure (Botiza and Wildflysh nappes) previously mapped. The design of the "Botiza nappe" shows a continuous sequence of imbricate slides, possible sutured remnants of Paleothetys ocean deposits. The "Botiza frontal slide" is a perfect model for all the Botiza Multislide Unit (Fig.);

- *metallo-genetic categories:*

- The E-W (Dragos Vodă), WNW-ESE (Bogdan Vodă) major fault systems (Jereapăn, Suior, Baia Sprie and Băiut, Bixad-Corneasa, respectively) as well as the isoclinal secondary fault systems (ENE-WSW – Băiut and NE-SW - Roata-Oanta, Căvnic-Boldut, Herja, Dealul Crucii, Săsar, respectively) prove to have an obvious metallogenetic value, controlling the well-known metallic veins. The western side of the Gutâi Mountains suggests an interference of the mentioned faults with the N-S (Piatra-Ciresului V.- Mare-Cicârlău), and the NNW-SSE fault systems (Turulung Vii-Orasu Nou-Racsa-Piatra Handal; Cămârzana-Vama-Nistru; Târsolt-Talna Mare-Alunis). They constitute the hydrothermal net in Racsa stock, Ilba - Nistru ores, or Wilhelm field of Ilba-Băita and partly Valea Rosie-Săsar metallogenetic districts.

PHOSPHATES IN THE BAT GUANO DEPOSIT FROM THE "DRY" CIOCLOVINA CAVE, SUREANU MOUNTAINS, ROMANIA

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The cave at Cioclovina is located in the northern part of the Sureanu Mountains (South Carpathians), at about 16 km east-southeast of Hateg, the major city in the area. The cave, known since 1873, is famous as the type locality for ardealite (Schadler, 1932). The *locus typicus* of this mineral species, namely the "Dry" Cioclovina Cave, is located on Luncanilor Valley. It represents the upper (fossil) level of the Ponorici - Cioclovina cu Apa karst system (7890 m in length). The altitude of entrance is 775 m. The "Dry" Cioclovina Cave consists in a nearly sub-horizontal gallery measuring about 750 m and trending NE-SW; including the short divergent passages related to this gallery, the length is of about 900 m. The cave is developed in Tithonian - Neocomian algal micritic limestones with calacrenite levels.

The bat guano deposit inside was exploited for about 20 years until 1940s, when it was abandoned after extensive mining of about 3200 wagons (or 23 000 tons) of this precious fertilizer (Bleahu, 1976). The estimated P_2O_5 content of this deposit is 18-20% P_2O_5 (Schadler, 1929). Since the pioneering work of Schadler (1929) on this guano deposit, no comprehensive mineralogical studies on the composing phosphate minerals have been carried out, although it is

now becoming apparent that the mineralogy is very complex and includes many rare mineral species.

The mineral association from Cioclovina cave is typical of a "dry" system of phosphate-bearing cave deposits. About 22 mineral species have been identified until now. The list of these minerals, restricted to the species occurring in the phosphate-bearing zones, includes ardealite, brushite, taranakite, gypsum, hydroxylapatite, tinsleyite, crandallite, carbonate-hydroxylapatite, calcite, vaterite, aragonite, quartz, goethite, birnessite, hematite, kaolinite and illite. The aim of this paper is to give a brief description of the main phosphate species.

Ardealite was first identified in the Cioclovina cave by Schadler (1932). It occurs as irregular aggregates of very fine-grained crystals that generally overgrows brushite or hydroxylapatite and rarely crandallite. These aggregates may generally be discerned as damp, off-white to pale yellow powder. The cell parameters of many representative samples, obtained by least squares refinement of X-ray powder data, are given in Table 1.

Table 1. Crystallographic parameters of selected samples of ardealite from Cioclovina

Sample	A (Å)	B (Å)	C (Å)	β (°)	V (Å ³)	N ⁽¹⁾	N ⁽²⁾
2217 A	5.723(2)	31.113(9)	6.259(2)	117.23(2)	991.073	10	87
2217 B	5.725(2)	30.993(1)	6.252(3)	117.08(2)	987.626	3	78
D 2 B	5.720(1)	30.994(9)	6.242(2)	117.26(2)	983.843	4	65
D 2 C	5.720(2)	31.071(1)	6.242(2)	117.24(1)	984.445	6	48
D 9 B	5.723(2)	30.998(1)	6.251(2)	117.20(1)	986.334	5	50
D 35 C	5.725(4)	31.040(1)	6.238(3)	117.29(1)	985.119	7	51
D 37 B	5.713(2)	31.031(9)	6.234(3)	117.09(2)	938.391	9	93
D 59 E	5.723(2)	31.013(1)	6.241(2)	117.68(1)	985.020	5	70

(1) - Number of refinement cycles.

(2) - Number of reflections used for calculations (2 θ = 10 - 80°).

Brushite, first mentioned at Cioclovina by Schadler (1929), generally occurs as snow-white powdery coating on hydroxylapatite or as nodular earthy masses (several mm to 3 cm in diameter) in the bat guano groundmass. A wet-chemical analysis of a carefully handpicked separate gave CaO = 32.06, MgO = 0.03, P₂O₅ = 40.78 and H₂O = 26.43 (all expressed in wt.%). The corresponding chemical-structural formula is (Ca_{0.995}Mg_{0.001})H_{1.008}(PO₄)₂·2.049 H₂O. The cell parameters, taken as mean of least-squares refinements on 20 different sets of X-ray powder reflections, are $a = 5.810(4)$ Å, $b = 15.176(9)$ Å, $c = 6.239(5)$ Å, $\beta = 116.38(6)^\circ$, $V = 498.9(8)$ Å³.

Hydroxylapatite, identified at Cioclovina by Constantinescu et al. (1999) and recently described by Marincea et al. (2000), occurs as aggregates of acicular or fibrous crystals forming crusts or mounds that are generally overgrown on the carbonaceous support or on chalcedony coralloids. These crusts are orange-brown to dull-yellow and are generally overgrown by brushite. The cell parameters calculated for a sample whose chemical analysis clearly indicates a hydroxylapatite are $a = 9.436(1)$ Å, $c = 6.902(3)$ Å and $V = 532.2(4)$ Å³ (as obtained by least-squares refinement of 30 X-ray powder reflections in the 2 θ range 10 - 90°). The wet-chemical analysis of this sample gave CaO = 55.10, MnO = 0.19, MgO = 0.04, Na₂O = 0.30, K₂O = 0.05, P₂O₅ = 42.36 and H₂O⁺ = 1.80 (all expressed in wt.%), which leads to the formula: Ca_{4.939}Mn_{0.013}Mg_{0.005}Na_{0.049}K_{0.005}(PO₄)₃(OH)_{0.968}·0.018H₂O.

Carbonate-hydroxylapatite has essentially the same look as the hydroxylapatite. The subtle difference in the powder patterns between hydroxylapatite and carbonate-hydroxylapatite precludes the X-ray identification of this species. It is of note, however, that the infrared

absorption spectra of many apatite samples reveals the presence of carbonate groups, indicated by the weak bands at $\sim 875\text{ cm}^{-1}$ (ν_2 out-of-plane bending), 1420 and 1455 cm^{-1} (ν_3 and ν_3 antisymmetric stretching). These bands persist even after rapid etching with acetic acid of the sample, indicating that CO_2 is integrated in the phosphate network. A wet-chemical analysis of a sample identified as carbonate-hydroxylapatite gave a CO_2 content of 1.37 wt.%.

Tinsleyite occurs as composite aggregates or very fine-grained masses composed by clusters of gray-mauve crystals ranging from a few μm to $100\text{ }\mu\text{m}$ in size. Usually, the clusters of tinsleyite crystals are directly disposed on chalcedony (low quartz) crusts. The cell parameters of a selected sample, obtained by least-squares refinement of 82 X-ray powder reflections in the 2θ range $10 - 90^\circ$, are $a = 9.638(5)\text{ }\text{\AA}$, $b = 9.522(4)\text{ }\text{\AA}$, $c = 9.540(4)\text{ }\text{\AA}$, $\beta = 103.10(3)^\circ$, $V = 852.8(5)\text{ }\text{\AA}^3$.

Taranakite was identified in the wettest, internal zones of the guano deposit, where this mineral forms crusts or chalk-like nodular aggregates of dull white color. The cell parameters of a representative sample, obtained by least-squares refinement of 33 X-ray powder reflections in the 2θ range $5 - 45^\circ$, are $a = 8.678(5)\text{ }\text{\AA}$, $c = 95.669(12)\text{ }\text{\AA}$, $V = 6239.7(8)\text{ }\text{\AA}^3$.

Crandallite from Cioclovina was recently extensively described by Constantinescu *et al.* (1999). The mineral occurs as crusts of dull appearance or as earthy masses of yellowish-white crystals, intimately associated with brushite and ardealite, which are distinctly white in color. No supplementary analytical data on this mineral were obtained during the current study.

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HIDDEN PIEDMONT HYDROSTRUCTURAL IDENTIFICATION STRATEGY BY GEOELECTRICAL PROSPECTING

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Hydrodesigner always use the existing geological and hydrogeological information of specific references in view of water supply of localities.

Specialists take last years for hydrogeological study of sedimentary basins geoelectrical researches as an efficient, rapid and low-cost investigation tool adding new and useful information in groundwater domain.

Many field and lab measurements reveal for resistivity – electrical conductivity as an essential factor the fluid kind and content, besides the porosity-permeability and afterwards the mineral compounds spatial distribution. In these conditions, the subsurface resistivity distribution study by data acquisition led to a precise identification of principal parameters defining an

aquifer. An appropriate quantitative geoelectrical data interpretation carried out a good geostructural model for this case.

Thus, for groundwater supply of Miercurea Sibiului village a step by step investigation project was carried out:

- First, the hydrogeological documentation considering all research and exploitation borings contouring the phreatic aquifer as a polluted one being a non potential water-bearing supply;

- Second, geomorphological, hydrological and, of coarse, hydrogeological mapping as the base of three favourable detected hydrostructures;

- Third, geoelectrical prospecting connected with research and exploitation borings (just in case).

The resistivity measurements (VES in DC current) in an uniform distributed grid on 10 square km area were made, looking to a 3-D geoelectrical image of Apoldul de Jos region according to some geological and hydrogeological criteria, as follows:

- The existing (widespread) Pannonian marl-clay deposits with subordinate sand levels (perennial yield);

- The existing of large-developed Holocene fluvatile (alluvial) deposits around Secaşul Mare meadow and terrace zones;

- The zonal existing of an Upper Pleistocene piedmont usually including sand and gravel levels.

Optimal resistivity four-electrode array (Schlumberger) with $AB_{max}=200m$, respectively 70 m depth of investigation was considered. Resistivity pseudo-section by processed specific VES curves providing interpreted conductive and resistive levels have been done with apparent resistivity between 5 and 200 Ohmm, domains previously accepted as layers generating groundwater reservoirs or aquifers.

Two borings by geoelectrical data interpretation revealing two favourable hydrogeological areas were proposed: first on Dobâcii valley, second on Secaşul Mare near Miercurea Sibiului-Apoldul de Jos road, finally opened:

- F1- especially by advantageously technical conditions for water catching;

- F2- by favourable geoelectrical information.

Both borings were designed for 30m maximum depth due to marl-clay Pannonian deposits interception.

The F2 hydrogeological good results set up a beginning of collector contouring in Miercurea Sibiului-Apoldul de Jos area represented by a plate piedmont hydrogeologic functional.

Thus, based on hydrogeological information obtained in F2 the geoelectrical grid became more detailed (150x150m) with good results materialised in new 6 prospection drillings.

Among these 8 exploration boreholes drilled in Miercurea Sibiului-Apoldul de Jos area, only five with total pumping rate $Q_t=14.4$ l/s were identified, enough for village drinking water supply.

RIFT SYSTEM IN THE SOUTH-WESTERN PART OF THE SOUTH CARPATHIANS

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The Eastern Transylvanian Basin is one of the areas in Europe that displays typical depleted mantle geochemistry (Vasselli et al., 1995). Downes (1999) made a review on heterogeneity in lithospheric mantle, and concluded that despite the vicinity of the Carpathian subduction zone, most xenoliths from SCLM (subcontinental lithospheric mantle) are LREE-depleted and present no interaction with subduction-zone fluids. On the other hand, samples from the central Pannonian Basin, on the contrary, show strong evidences of interaction with subduction fluids.

Analysis regarding Alpine and pre-Alpine tectonothermal events in the South Carpathians from $^{40}\text{Ar}/^{39}\text{Ar}$ hornblende and muscovite ages (Dallmeyer, 1994) pointed out a phenomenon which occurred at 200 Ma. It could be connected with a rifting event at the Triassic/Jurassic boundary, and ages of 118 Ma suggest thrust propagation.

Fission track (FT) thermochronology analysis on apatite, zircon and sphene (Bojar, 1998, 1999) from several formations in the South Carpathians suggested an exhumation and cooling of the rift flanks prior to the Severin rift opening at about 200 Ma (i.e. between Getic and Danubian areas).

A thermic event, occurring at the same time, have been outlined by Badescu (1997), by a different method - stretching factor method.

Paleomagnetic measurements made by Hambach et al. (1996) Oxfordian limestones in the Padurea Craiului and Bucegi Mountains stated that this area was located at 18 - 20° N latitude in Middle-Late Jurassic, and since then suffered an important clockwise rotation. Measurements made by Patrascu and Panaiotu (1990) in Upper Cretaceous magmatic rocks in Hateg Basin and in Rusca Montana (western part of South Carpathians) and in the Apuseni Mountains, outlined a northward movement, and a clockwise rotation, (starting at least from 65 Ma). Similar results were obtained for the Apuseni Mountains (Surmont, 1990).

160 Ma ago, Earth's magnetic field intensity was at about half of the present day (Juarez, 1998), so it should be taken into account in convective processes modelling and in constraining history plate movement. Consequently, we assume that paleomagnetic measurements should be affected by a correction factor (i.e. paleolatitudes of 18 - 20° N at 160 Ma should be considered at about 180-200 Ma).

Newest alkali basalts occurrences in Europe are in the eastern part of the Panonian Basin, i.e. Banat area and Persani Mountains, Neogene - Q ages (2,64 - 0,7 Ma), (Seghedi et al., 1994): one in Sumeg hill, in the southern part of Gataia, and the other one crops out between Lucaret and Sanovita, on a 40 sq.km area. In both cases, magmatites are trachybasalts in Le Bas et al. (1986) diagram. To note that in both areas Cr and Ni are in higher percentages than usual, i.e. (119 - 213 ppm Ni, 210 - 488 ppm Cr), and Cr percentage is higher in the Persani Mountains.

That is why we propose here a kinematic model for the western part of the South Carpathians. We used geophysical data (gravity, aeromagnetic, and magnetotelluric sounding) and geological data, and constructed a 3D Model. Fourier and Wavelet analyses were used to constraint this model. In our model the rift initiated 200 Ma ago, in Severin zone, at 18 - 20° N

latitude. Then it propagated northward, and suffered clockwise rotation. At that time, Severin and Ceahlau units were the same. Later, the South Transylvanian Fault, that we consider to be a transform one, detached these units, and has been affected by the strong Cretaceous thrusting event, so making it difficult to reconstruct the plate movement.

One of the problems of tectonic plates is that a spreading ridge will eventually approach a subduction zone (Kreemer, 1998) and then it will break-up or not.

That is why we have constructed this model, trying to fit measurement data with processed geophysical data. Finally, we made a rheological model and a simulated one (using MathLab 5.0).

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SULPHIDES OF Mn METAMORPHOSED DEPOSITS IN THE BISTRITA MOUNTAINS, ROMANIA

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The Mn-metamorphosed deposits of BM are situated in the middle part of the Cambrian Tulghes Series (Tg2) in the Putna Nappe. The primary ore consists mainly of approximately 70% Mn carbonates, approximately 20% Mn-silicates and approximately 10% oxides+sulphides. Their distribution is very unhomogeneous. The sulphides can represent 5-10, sometimes 15% of the entire ore. They appear as accessory minerals, like Ni, Co, Bi, As sulphosalts, but also as constituent minerals, like pyrite, chalcopyrite, alabandite, bornite, sphalerite, galena, tetraedrite, tenanite, etc. The main Ni, Co, Bi, As sulphosalts enclosed in Mn-humite-jacobsite-rhodochrosite-alabandite association are: cattierite, gersdorffite, carrollite, lollingite, glaucodot, breithauptite, rammelsbergite, cobaltite, linneite, arsenopyrite etc. Figure 1 presents the chemical profile of cobaltite in the Dadu deposit. These sulphides have formed at $T > 550^\circ\text{C}$, $\log f_{\text{S}_2} = +1/-3$, (higher than the pyrite-pyrrhotite buffer), $\log f_{\text{O}_2} = -16/-20$ (Hirtopanu, 1999). Based upon carbonate thermometry and silicates phase equilibria a temperature of $550^\circ\text{C} \pm 30$ and a pressure

of 6Kb+2kb for the first metamorphic event of Tg2 bearing sulphides have been inferred. Also, recent determination of alabandite in the Holdita baryte-sulphides deposit, as constituent mineral, demonstrates the common origin for these mineralisations. In this deposit there is a banding of baryte, sulphides, and Mn-silicates in the same sequence. The presence of Ba-feldspars (celsian, hyalophane) together with baryte and sulphides Holdita deposit indicates special formation in conditions – rarely occurring in nature. Ba-feldspars can form from baryte or from earlier hydrous silicate phase (harmotome).

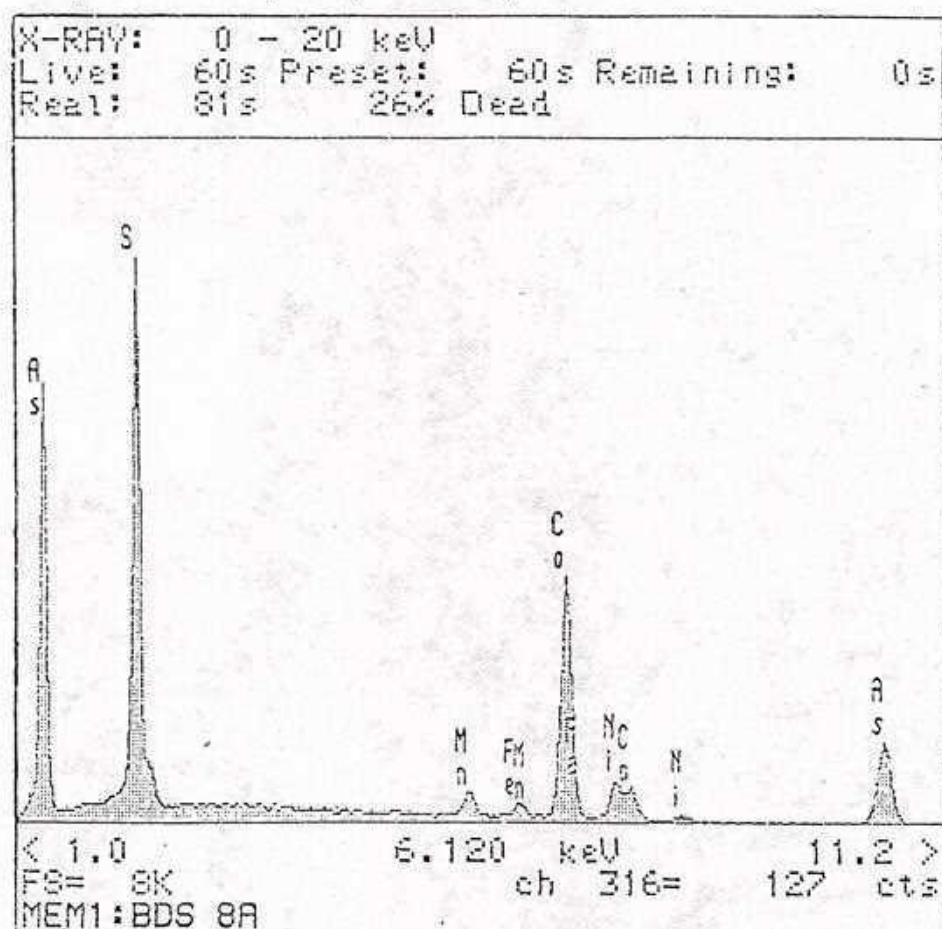


Fig.1 - Chemical profile of cobaltite in Dadu deposit

Generally, it is argued that the Ba in exhalative environments was derived from underlying oceanic basalts. The evidence for such a submarine hydrothermal system includes the presence of some characteristic trace elements of Mn silicate ore (Hirtopanu, Popescu, 1999), the Sr-rich baryte, the presence of Ni-Co-Bi sulphosalts, which are commonly associated with this system. The unmixing structures of chalcopyrite and bornite in the Orata deposit indicate temperatures above 475°C. Some grains of chalcopyrite in the Brosteni ore contain numerous minute stars and blebs of sphalerite.

The high temperature at which the unmixing develops explains the rarity of those intergrowths in nature. The occurrence of such an intergrowth is evidence that the deposit has formed at a temperature above 500°C. The presence of cassiterite enclosed in pyrite is a evidence of a relatively high temperature too, for this second metamorphic phase. The third phase of

sulphide vein mineralisation contains: bournonite, sphalerite, semseyite, tetraedrite, arsenopyrite, freibergite, boulangerite, matildite, jamesonite, tenanntite, stannite, galenobismutite, bornite, etc which have been recently determined in the Puiu-Suharzel deposit closely associated with Mn-silicates. Figure 2 presents elemental maps of pyrite, chalcopyrite, galena, Ag-tetraedrite and quartz in the Puiu deposit.

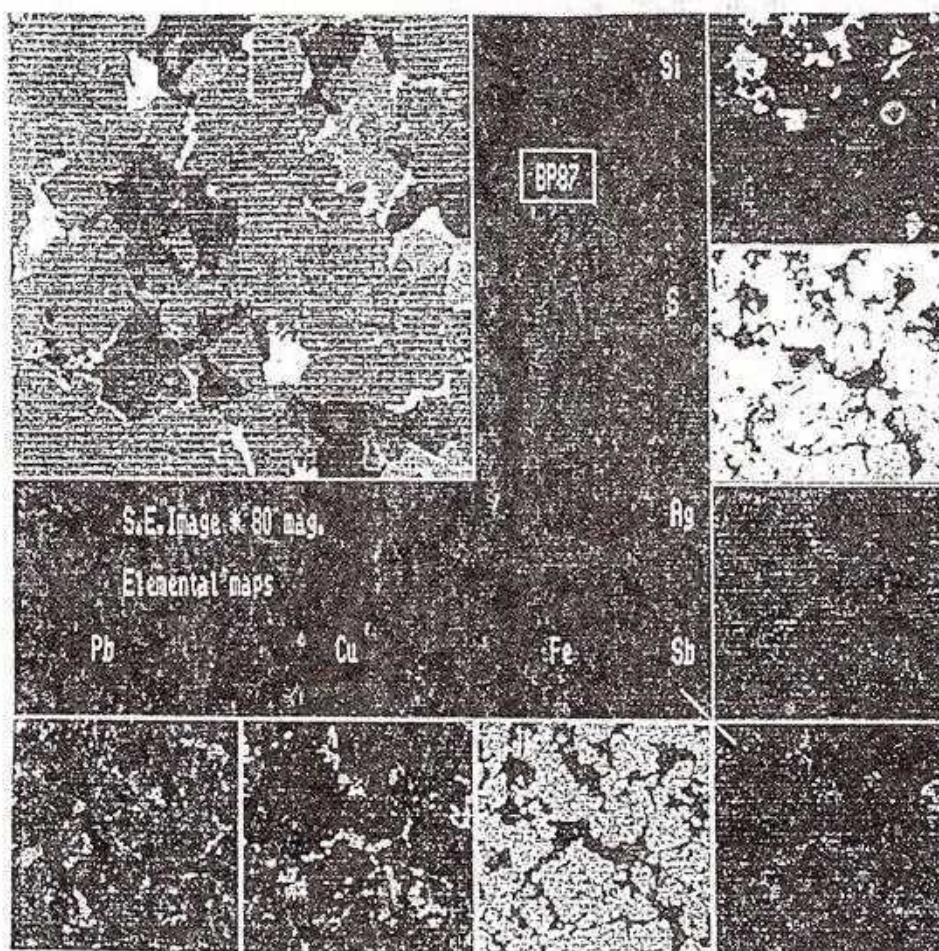
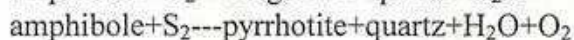


Fig. 2 - Elemental maps of pyrite-chalcopyrite-galena-Ag tetraedrite-quartz in the sample BP87 Puiu deposit

The association of sulphides with the Mn-Fe amphiboles is very interesting. Pyrrhotite coexists with grunerite amphiboles in ferrous sequence of the Mn deposits in the association amphibole+pyrrhotite+magnetite+garnet+quartz. The grunerite amphibole has a composition which situated it about the value of 29 mol%wt end term. It is clear that f_{S_2} exert a strong control over Fe content of the amphibole. Experimental data of over the amphibole-pyrrhotite are expressed by the simultane equilibria:



The fS_2 can affect the stability of the amphiboles through the influence of the fH_2O (which is low at the high fS_2) and through the directly reaction with the Fe-component thus forming pyrrhotite. The primary pyrite occurs in silicate-carbonate ore and in graphite quartzite. The idiomorphism of pyrite of the graphite quartzites is due to a statical growth, probably provoked by a relaxation, an uplift, which followed the orogeneses phase, most probably the Variscan one. We believe that the mineralisations of sulphides+oxides, Ba-sulphates, Mn-carbonates and silicates have a common origin, namely from a submarine hydrothermalism, probably of midocean ridge or back arc basin type.

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ROMANIA'S MINERAL WATER ATLAS

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Mineral Water Atlas presents data concerning the hydromineral patrimony of Romania, so that it should provide a wide range of informational elements, concentrated in a relatively restrained volume, easily accessible and graphically attractive.

Economically, this paper is interesting for natural and medicinal mineral water sale, health resorts, tourism and turning to better account of thermal water as thermic agent.

Romania's Mineral Water Atlas is drawn up by a staff of the S.C. Prospectiuni S.A. together with specialists of the Mineral Water National Society (M.W.N.S.); it is based on the processing of a great number of data, mainly from the S.C. Prospectiuni S.A. archives, as well as from the National Agency for Mineral Resources (N.A.M.R.), Mines-Geology General Directorate within the Industry and Trade Ministry and M.W.N.S. archives.

As a geological and land survey basis the Geological Map of Romania - scale 1:200,000 (50 sheets), edited and published by the Geological Institute of Romania is used.

Data processing and plotting is mostly elaborated by computer processing within S.C. Prospectiuni S.A.

Artemiu Pricajan (1972) defines mineral water as *underground or shallow water that, due to mineralization or to some special physical qualities, can be used in balneary cure or as raw material, in industry. This category includes the thermal water with reduced mineralization, utilized as energy source.*

The Health Ministry aligned itself (1961-1973) to the international balneological conception based on "The decision from Nauheim of 1913", according to which, positioning of a water in "mineral water" category is made as a result of its compliance with one or several of the following conditions:

- to contain at least 1 g salts obtained at 1 liter of water;
- to contain chemical elements with enhanced pharmacological action (S, Fe, I, Br), in a proportion admitted as necessary minimum;

- to comprise some gas as CO_2 , H_2S , Radon, in a certain concentration;
- to have at emergence a temperature above 20°C ;
- to have a curative effect, scientifically recognized.

The governmental decision (1176/November 1996) defines the natural mineral water as "exclusively underground water, microbiologically pure, extracted by drillings or from natural sources".

- The same governmental decision defines, within drinking mineral water, the following categories of water: gaseous natural mineral water, decarbonated (still) natural mineral water, natural mineral water re-impregnated with carbon dioxide from the source or gaseficated.

1. CONSIDERATIONS ABOUT CHEMICAL PROPERTIES

The chemical character of water is related to the complex conditions from the deposit in terms of the substance exchanges with the bedrock, the blends with fluids and the underground circulation evolution.

- a) Within the hydromineral system, the local geological particularities confer the unique character for each deposit, implicitly resulting the specificity of the waters housed by it, concerning the temperature, flow and chemical character.
- b) Within a deposit, the water chemical variations result from the process of mixture of different origins waters (different mineralizations), in proportions variable in the space.
- c) At the same source, there are present variations of the physical-chemical parameters, due to the variation in time of the mixture between different origins waters, of the resulted flow and inflow (dissolving and loss) of dissolved gas.

2. MINERAL WATER CLASSIFICATION APPROPRIATE FOR THE ROMANIA'S MINERAL WATER ATLAS

Due to the interference between the processes that lead to the above mentioned mineral water genesis, their classification cannot be unique.

Further there will be presented some elements that serve as classification criteria and related positionings:

2.1. Classification depending on chemical composition (major chemical types):

2.1.1. Classification depending on the prevailing anion

- bicarbonated water
- chlorosodic water
- sulphated water

2.1.2. Classification depending on the prevailing cation

- calcic water;
- magnesian water;
- sodic water.

2.1.3. Classification depending on the specific components: - Dissolved gas

- carbonated water ($\text{CO}_2 > 500 \text{ mg/l}$)
- sulphurous water ($\text{H}_2\text{S} > 1 \text{ mg/l}$)
- Specific chemical elements

- iodided water ($\text{I} > 1 \text{ mg/l}$),
- bromided water ($\text{Br} > 5 \text{ mg/l}$),
- ferruginous water ($\text{Fe} > 10 \text{ mg/l}$);

2.2. Classification depending on tonicity (total mineralization without dissolved gas)

- oligomineral water (min. tot. $< 1000 \text{ mg/l}$)

- isotone water (1000 < min. tot. < 8000 mg/l)
 - hypotone water (8000 < min. tot. < 10000 mg/l)
 - hypertone water (min. tot. > 10000 mg/l)
- 2.3. Depending on temperature
- cold water (temp. < 20°C),
 - hypothermal water (20 < temp. < 35°C),
 - isothermal water (35 < temp. < 40°C),
 - hyperthermal water (temp. > 40°C);
3. Classification depending on utilization (Bottlable mineral water):
- decarbonated natural mineral water (still);
 - carbonated natural mineral water;
 - medicinal mineral water (used with medical prescription);
 - Mineral water of balneary and/or entertaining use;
 - Mineral water used as thermic agent.

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THERMAL AND CHEMICAL EVOLUTION OF THE CAVNIC HYDROTHERMAL SYSTEM, BAIA MARE MINING DISTRICT, THE ORIGIN OF THE MINERALISATION FLUIDS

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The Cavnice base-metal sulphide + (Au, Ag) deposit is located in the central part of Maramures county and is a part of the Oas - Gutâi - Varatec Neogene magmatic province of the East Carpathian chain in North - Western România. The magmatic activity in the Baia Mare Mining District occurred between the Badenian and the late Pliocene. The products of volcanism are constituted of andesites and a number of acid rock varieties: dacites, rhyolites, quartziferous andesites.

The fluid mineralisation was deposited in a single metallogenetic process, during which seven fluid tectonic and metallogenetic evolution stages [M₁ - M₇] were individualised (Marias, 1996 a). Each moment is characterised by specific paragenesis, whose limits are marked with the vein filling.

1. The Mineralisation Fluid Temperature. In all samples the forming temperatures range between 207° C and 324° C (average = 282±21° C, n=286).

The relatively low variation of the deposition temperature of the mineralisation moments, of ~75° C (Table 1) is a indicator of the retrograde boiling of the hydrothermal fluids during the mineralisations deposition in this deposit.

The fossil fluid salinity in the Cavnice deposit was calculated from the temperature of final ice disappearance, using the Potter equation (1977); in this respect the salinity values range

from 1,2 to 14 % equiv. NaCl for all mineralisation moments. The low eutectic temperatures (around -50°C), suggest the presence of bivalent cations (Ca, Mg, and Fe...) in the hydrothermal solutions.

Table 1. *Temperatures at which the Cavnic mineralisation was settled, corresponding to the mineralisation moments*

Moments	Freezing temperatures (CO_2)			Filing temperatures $^{\circ}\text{C}$		
	Min.	Max.	Average	Min.	Max.	Average
M ₁	-4	-1.8	-2.9	279	324	302
M ₂	-7.3	-1.7	-4.5	266	322	294
M ₃	-3.2	-1.6	-2.4	264	298	281
M ₄	-2.6	-0.7	-1.7	245	298	271
M ₅	-3.6	-1.7	-2.7	265	302	284
M ₆	-3.8	-1.6	-2.7	207	248	227

A fall of the freezing point was observed of $1,85^{\circ}\text{C}/\text{CO}_2$ mol. The distinct enrichment in gold during the last habitual mineral depositions at Cavnic and the low sulphidation epithermal deposits generally coincide with the occurrence of relatively saline fluids (Heald et al., 1987).

2. The Mineralisation Fluid Temperature obtained on Basis of the Sulphur Isotopic Composition. For a temperature of 3000°C , corresponding to the average temperature obtained by microthermometry, the slight variations that were noted are consistent with the values of the fraction factors given by Ohmoto (1972).

Three pairs of sulphides were selected to estimate the sulphide crystallisation temperature corresponding to the M₄ moment; this is the first important fluid mixture (magmatic + meteoric) with consequences in precipitating the gold sulphides and sulphosalts in the calcite - dolomite gangue.

The obtained results indicate that the temperatures for the sphalerite - galena pair (sample 203) are abnormally high (Table 2), as compared to the geothermometric results based on the study of fluid inclusions; the only temperatures obtained for the sphalerite-galena pair, which are consistent with the data obtained from the fluid inclusions, are the ones from samples 210 and 227.

Table 2. *Thermometric values based on isotopic compositions of simultaneously crystallised sulphides from the fluid on the moment M₄ of the Cavnic hydrothermal system*

M	Sample	SP H	GN	Py	DPy/G N	DSPH/ GN	DPy/S F	T $^{\circ}\text{C}$ Py/G N	T $^{\circ}\text{C}$ SPH/G N	T $^{\circ}\text{C}$ Py/SP H
M ₄	203	2.4	1.1	3.5	2.4	1.4	1	379	445	277
M ₄	210	4	1.2	4.3	3.1	2.8	0.3	300	234	731
M ₄	227	2.6	0.3	3	2.7	2.3	0.4	341	287	596

The unconvincing result obtained with sample 203 and the contradictory results of the pyrite-sphalerite pairs (samples 210 and 227) suggest that the fraction equilibrium was not reached and therefore the pyrite did not deposit simultaneously with the galena and sphalerite. Supposing that the sulphide deposition temperatures for moments [M₂ - M₄] were of

approximately 300° C - a result obtained from the study of fluid inclusions - we can calculate for a dominant average H₂S values of d³⁴S of +3.4 ‰ for the hydrothermal fluid. These values are comparable with a magmatic sulphur source: 0‰--5 ‰ (Ohmoto, Rye, 1979).

3. The Origin of the Mineralisation Fluids. All the types of isotopic analyses and of fluid inclusions were performed in the BRGM - Orleans Laboratories, France. The d¹⁸O from the quartz of the metallogenetic moments varies between +6,7 and + 11,1 ‰ as compared to SMOW.

The changes of the d¹⁸O_{quartz} values in time throughout the metallogenetic events between M₁ and M₅ suggests a heavy isotope enriching for the interval M₁ - M₃ - M₅ (Marias, 1996 b). This aspect indicates the concentration of heavy isotopes as the boiling evolves and is subsequently generalised in M₃. The dD values range between -71 and - 109 (± - 10‰) (Piantone et al., 1999).

Consequently, from the point of view of the d¹⁸O-dD ratio the Cavnic hydrothermal system was dominated by fluids in which the magmatic component increased during the [M₁-M₃] metallogenetic interval ; while in the late stages of the process, [M₄-M₇], the mixed and finally meteoric fluids prevailed (Fig. 1).

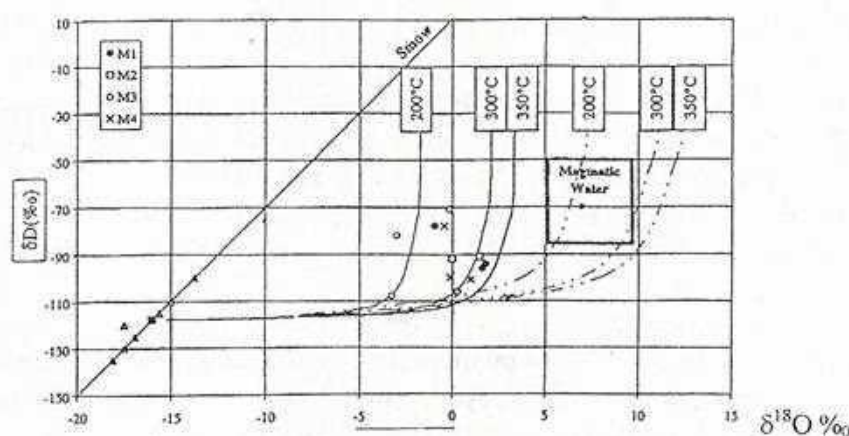


Fig. 1 - d¹⁸O plotted against dD of quartz from the four main ore deposition moments (Piantone et al., 1999).

The diagram shows variations in fluid isotopic composition equilibrated with propylitized volcanic rocks (full lines) and sedimentary rocks (dashed lines) as a function of the initial fluid composition T. Various water / rocks ratios are also reported.

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STRUCTURE AND DISTRIBUTION OF COMPLEX ORE RESOURCES EXISTING IN ROMANIA

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Introduction

In Romania, the polymetallic (complex) character of the ores is given by the presence of Zn, Pb and Cu as major metals. These metals occur as sulphides and seldom contain small quantities of Au and Ag, sometimes in recoverable amounts.

The composition of the polymetallic ores can also contain a series of rare, disperse or minor elements (Mo, Sb, Bi, As, Se, Ge, In, Ga, Ta, Cd, Te, W etc.), some of them valuable in economic respect.

From the total of the common non-ferrous ores of Romania (complex, copper, gold-silver and bauxite), the complex ores are ranking on the second place as importance (after the copper ores) and on the first place considering the number of occurrences.

1. Major Geo-Structural Units Hosting Polymetallic Ore Resources

The existing mineral resources, known up-to-now within the North Dobrogean Orogen are related to the Mesozoic magmatic activity.

From the five occurrences known, only three were quantified as resources of polymetallic ores. It represents about 1% from the total quantified resources existing in Romania.

In the Carpathian Orogen the pre-Alpine metamorphic and magmatic formations, as well as the Alpine magmatic formations comprise complex ore deposits.

The numerous occurrences identified in the Carpathian Orogen contain 99% from the total quantified resources known in Romania.

2. The Structure of Existing Reserves of Complex Ores

The polymetallic ore resources often contain, as recoverable utile minerals, sulphides: galena, sphalerite, chalcopryrite, and pyrite. Sometimes, besides sphalerite occurs wuertzit. More often, the chalcopryrite appears together with other minerals of copper: chalcosine, covellite, bornite, tetrahedrite. Also, besides pyrite, pyrrhotite, marcasite, and mispickel, as minerals containing iron can be noticed.

It is to note that the recoverable utile minerals represent 15% from the total amount of polymetallic ore.

The quantitative mineralogical structure, in weight percent, of recoverable utile minerals from the polymetallic ores resources existing in Romania is, as follows: galena – 7.20%, sphalerite – 15.40 %, equivalent chalcopryrite – 4.70%, equivalent pyrite – 72.70%. The oxide form of the polymetallic ore is rare.

From the recoverable elements of the Romanian polymetallic ores on the first place are: S, Zn, Pb, Cu. As secondary metals, Au, Ag are present in recoverable quantities.

If we report the whole amount of the useful minerals to the whole amount of complex ores, the following mean contents are obtained: sphalerite – 2.4%; galena – 1.1%; equivalent chalcopryrite – 0.7%; equivalent pyrite – 11.2%.

Reporting the quantity of elements to the whole existing resources of complex ores the following mean contents are obtained: 1.6% Zn; 1.0% Pb; 0.2% Cu; 0.3 g/t Au; 20 g/t Ag; 8.8% S.

3. The Occurrence of Polymetallic Ore Resources

The term of objective is seldom similar to ore deposit/accumulation. There are also situations when objective means zone in extension (on surface/depth) of the ore deposit or within the ore area but with different mineralization (oxide/sulphide ore, compact/impregnation ore etc.).

In this paper 183 objectives have been considered.

With about 105 objectives the East Carpathians rank on the first place among the geo-structural units. Following the geographical criteria the area can be structured, as follows: Gutâi Mts. (31 objectives), Maramureş Mts. (30), Rodnei Mts. (19), Bistriţei Mts. (11), Oaş Mts. (5), Țibleş Mts. (4), Giurgeu Mts. (3), Călimani Mts. (1) and Gurghiu Mts. (1).

Apuseni Mountains contain only 39 objectives. The geographical distribution is: Metaliferi Mts. (19 objectives), Bihor Mts. (10), Gilău Mts. (5), Vlădeasa Mts. (2), Şes Mts. (2) and Zarand Mts. (1).

In the South Carpathians are located 36 objectives with polymetallic ore deposits, geographically spread, as follows: Făgăraş Mts. (14 objectives), Poiana Ruscă Mts. (13) and Banatului Mts. (8).

With 2% of the objectives containing polymetallic ore resources, the North Dobrogea Orogenic area ranks on the last place. Only 3 objectives with quantified resources are known: Somova – Cortelu, Căşla – Mineri – Dealul Carierei and Movila Săpată.

The reserves distribution upon quantity is similar with that performed by a number of objectives.

The orogenic cycles related to the genesis of the polymetallic ore resources are: Middle - Upper Proterozoic, Early Caledonian, Hercynian and Alpine cycles.

The Alpine orogenic cycle generated the most favourable accumulation conditions. During the alpine and early Caledonian orogenesis 83% of the Romanian resources have been formed. A small part of the existing resources (0.3%) have an uncertain appurtenance to any of the cycles.

About half of the Romanian polymetallic ore resources have a hydrothermal genesis. The other well represented type (35%) is the metamorphosed volcanogene-sedimentary one.

Among the other genetic types the contact-metasomatic and hydrothermal and metamorphosed hydrothermal represent 10% from the existing resources.

The andesitic magmatism related to the Mio-Pliocene subduction has generated almost half of the polymetallic ore resources of Romania. Together with the Cambrian rhyolitic volcanism, carbonaceous, amphibolitic and micaceous formations and granodioritic magmatism, related to Late Cretaceous - Palaeocene subduction processes, has generated 90% of the resources.

The polymetallic ore resources are known in 42 metallogenetic districts out of which only 4 (Dealul Crucii – Băiuţ, Baia Borşa, Tarna Mare and Valea Blaznei – Guşet) exceed 50 million tones of ore.

Most of the districts (55%) have resources of less than 10 million tones and about 43% less than 5 million tones.

An important criterion for the resources classification is the degree of geological assurance. From this point of view the resources are described as identified/unidentified (hypothetical, speculative).

The Romanian polymetallic resources are divided, after the degree of geological assurance, into identified (29%) and unidentified (71%).

Some of the ore deposits contain only identified or unidentified resources, but usually they appear together.

THE RĂNUȘA DEPOSIT – CLOSE DOWN OR A NEW ECONOMIC POTENTIAL FOR U – MO

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The Rănușa deposit is located in the south-western part of the Codru Moma Mountains, under the crest between Crețu and Zalea Neagră valleys, at 9 km from Moneasa spa and about 130 km from Arad city, respectively. It represents the only U – Mo deposit in Romania.

Geologically and structurally the mineralized zone is located in the Moma unit and within it in the "Lower Rhyolite Formation" (ignimbrites) framed between the basal "Bioturbational Sandstone Formation" and the "Basic Formation" (basalts, argillites, sandstones). The whole stratigraphic aggregate is of Permian age. The U-Mo deposit is developed on the N-W limb of an inclined fold, looking like a false monocline orientated NE-SW, with dips of 30-35° towards SE. The thickness of metarhyolites ranges between 15 and 85 m.

The host rocks of the mineralization is exclusively represented by metarhyolites, which are quasiconformably or tectonically related to the surrounding rocks.

The mineral paragenesis is: pitchblende-molybdenite ($\pm$ jordisite, ilsemanite)-uranium molybdates (umohoite, iriginite, moluranite), along with uranium black, torbernite, autunite, uranophane associated with wulfenite, chalcopyrite, chalcocite, pyrite, smaltite, chloantite, tetrahedrite, galena, hematite, malachite and barite.

The geochemical spectrum of the mineralizing process consists of: U, Mo, Bi, Co, Cu, Pb, Li, Ag, Tl and As and the elements characteristic of the rock background are: V, Ba, Sr, Ti, Zr, Ni and Mn. Type correlations ($r = 0.8-0.9$) were found for U-Cu, U-Mo, Mo-Bi, Bi-Co, Pb-Co and lack of correlation for U-Pb and Pb-Ba. Lithium spatially superposes U and Mo with no correlation with those or other elements.

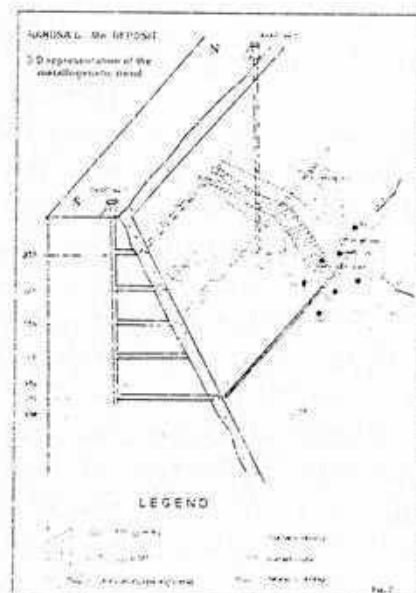
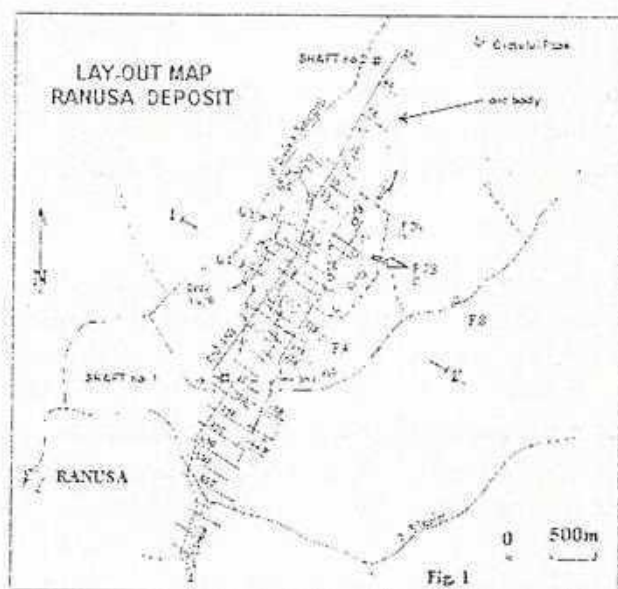
The mineralization is present as impregnations in the massive and compact rock as well as in pellicular form on the joint and foliation plans, forming lenticular ore bodies disposed quasiconformably with the foliation, the morphology being complicated by tension and plication faults.

From the genetic point of view, from the literature, it can be classified in the volcanic type; strata bound extracaldera (Dahlkamp, 1993), model 25 f – volcanogenic U, respectively (Cox, Singer, 1992), and the authors as tectonically redistributed volcanogenic-sedimentary.

Economic aspects. The deposit is mostly explored on a length of about 3 km, opened by three adits and by a 195 m deep exploration shaft from which two research levels were dug, accumulating a great amount of underground mining work and of underground and surface drilling operations (Fig. 1). At 2 km north of shaft no.1 shaft no. 2 was partly operated which needed only 7 m to fulfil the geological target, but it was abandoned.

The economic value of the deposit is the U-Mo ore, adding to this lithium (700-1000 ppm) for which no reserve computations were made. The last findings, in contrast to the earlier ones, make obvious a substantial enrichment in uranium towards the outermost northern part and towards the falling of the mineralized structure (Fig. 2), followed by the decrease of the molybdenum content to the level of the geochemical background, resulting in the disappearance of this undesirable element in the milling process. In spite of these findings, that lie at the basis of the reguinding the geological research that resulted in improved economic parameters and in an increased amount of outlined resources due the workings made in the last five years, the deposit is proposed for final close down. In conclusion, it results that the exploration of the deposit is not finished and in this stage the adjoining field represents an ongoing important metallogenic potential for U-Mo-Li $\pm$ associated sulphides.

After the INTURGEO (1988) classification the deposit is placed in category "D" size, of word occurrences (except for the USA and Canada).



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GEMOLOGICAL CONSIDERATIONS ON THE GEOAGIU- HARTAGANI- VALISOARA- BRAD REGION (APUSENI MOUNTAINS)

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The gemological investigations on the region surrounded by the Geoagiu Valley in the east and the Valisoara- Luncoiu Valley in the west, carried out by the Institute of Gemology (Babes-Bolyai University, Cluj-Napoca), pointed out a few interesting sections, in the context of the host geological formations, that we are now going to present in brief.

Extensive or brief geological information on the above mentioned region is provided by Giusca et al., 1963; Ianovici et al., 1969, 1976; Berbeleac, 1976; Cioflica et al., 1981; Savu, 1980, 1983; Ghiurca, 1981; Sandulescu, 1984; Marza et al., 1989; Balintoni, 1997; Ghergari, Ionescu, 1999.

The investigated region is part of the Metaliferi Mountains and it encloses the Transilvanides (Sandulescu, 1984) and basic units (Balintoni, 1997) made of ophiolites and Mesozoic and Badenian sedimentary rocks.

The ophiolitic Mesozoic complex-volcanic rocks (basalts, andesites in various facies) and volcanoclastites (volcanic breccia) - present in several sections (Hartagani, Luncoiu de Sus and Luncoiu de Jos, Valisoara - Baita) and the geyserites (Badenian) from Sanatoriu (Brad) are of major gemological interest.

The way silicas are presented, that is in free spaces (pores, degasification alveoli, voids of dissolution, fissures, fractures, deposits around fragments of volcanic breccia, tectonics) and metasomatic, replacing basic mineral components and the rock paste (vitrous, hyalopilitic, pilotaxitic), suggest the genetic mechanism.

Areas of gemological interest

1. *The Luncoiu Valley- Lunga Valley area.* It is constituted of ophiolitic Mesozoic rocks, Neogene andesites and Badenian gravel (of Almasu Mare). Fragments of micro-crystalline vein quartz (hydrothermal), light gray, dark gray and reddish gray colored, appear occasionally in the alluvions of the valleys.

Hydrothermal silicas are inhomogenous from the point of view of their structural- textural aspect as they are composed of isometric areas (0,5- 1,0 mm), which can be parallel or elliptic (0,80x2,5 mm), with massive or concentric microtexture, made of microgranular and microfibrinous quartz associated with calcite and chlorite.

2. *The Valisoara Valley - Orazii Valley area.* It mostly belongs to the ophiolitic Mesozoic complex, but Cretaceous limestone and Almasu Mare gravel can also be identified. Little gray quartz fragments resulting from ophiolites may very rarely appear in the alluvions of the valleys.

Under the microscope, the quartz presents areas with different degrees of crystallization (crypto- and micro-granular). The impregnation with iron hydroxides - sometimes the goethitic mass is over 50% - is very frequent.

The microscope analysis can also reveal the substitution of the rock with silica and relics of plagioclase feldspar and hornblende.

3. *The Cheile Baita-Craciunesti area.* It is composed of Mesozoic ophiolitic magmatites (usually pyroclastites) and reef limestone of a Jurassic age, placed in a vertical position over the magmatites. The Almasu-Mare gravel is present around the Baita locality. On the Cainet Valley

(at Craciunesti) as well as on a torrent from Padurea lui Cornel (Cornel's Forrest) red jaspers associated with ophiolites can be found.

4. *The Hartagani area.* The alluvions of the Cordurea and Racas Valleys contain fragments of ophiolites crossed by little veins of calcedony and quartz. A genetic relation between the hydrothermal activity associated with Neogene and ophiolitic magmatites, which in most cases represent the hydrothermalized (mineralized) support rock. In this area the following have been identified:

- Microcrystalline quartz as little veins (<5 cm) in ophiolitic rocks;
- Massive silica of gray color and spotted: the bright gray silica corresponds to the cryptogranular variety and the gray one with the microgranular variety formed through the recrystallization of the first variety;
- Little white quartz veins with a belt structure (the belts are caught in the mass of the pyroxene andesites) associated with carbonates and sometimes with epidote and zeolite.
- Little gray or pale green quartz veins (3.5 cm thick) caught in andesites can frequently be found in the alluvia of the Cordurea Valley at Hartagani.
- The varieties of reddish quartz (the carneole type), associated with white quartz, spotted in this area are of a major gemological interest, and so are the silica concretions (<5 cm $\bar{R}$) found in alluvia (the Cordurea Valley, Hartagani).

5. *The «La Sanatoriu» Area (Brad)*

Polychromatic silica products have been mentioned in the previous centuries in the Magura Bradului Hill (at Sanatoriu), which have subsequently been attributed to the activity of the geyserites associated with Neogene volcanism (Ghitulescu et al., 1968; Ghiurca, 1981; Ghergari, Ionescu, 1999). The deposition of the siliceous solutions (epithermal) took place in an aquatic environment (geyserian lake), in small limnic basins, the proofs being the mollusca and water plant remains incorporated in silica and substituted by SiO_2 . The environment, rich in iron and manganese hydroxides with irregular spatial distribution, determined a large chromatic variation of the geysers, the dominant varieties being ochre and red of different shades.

The mineralogy of these geysers has been detailed by Ghergari and Ionescu (1999) who pointed out, besides microcrystalline and fibrous quartz, opal, chrysobalite/ tridymite.

Conclusions

Five areas with silica gems have been found in the researched region. The economic values of the identified mineral substances lies in their technical qualities (hardness, degree of polishing) as well as in their esthetic qualities (color, micro texture and structure, inclusion). The areas with the most frequent gem minerals are Hartagani and Brad.

The processing of these silica with a various geometry under the form of gems can be performed as stones mounted in rings, bracelets, ear rings, buttons, trinkets, beads and as interesting decorative art objects.

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NEOPROTEROZOIC SUBALKALINE AND ALKALINE GRANITES IN SOUTHEASTERN BRAZIL

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Introduction

The arc-type structure, which develops over more than 47,500 sq.km in southeastern Brazil, between the 17° and 21° S latitudes, is responsible for the sea-shore protuberance in northern Rio de Janeiro state, and links many lithospheric tectonic discontinuities to an abundant magmatism of various types. The subalkaline and alkaline granites intruded in the Archaean and Paleoproterozoic magmatic and metamorphic basement were emplaced during the late tectono-metamorphic events.

Geological Setting

The mid-northern part of Mantiqueira Structural Province is located in the southeastern Brazil, east of the São Francisco Craton. This geological province is related to the Brasiliano orogeny (from 600 to 450 Ma), and it consists mainly of Neoproterozoic mobile belts surrounding the São Francisco cratonic block. These structural units in the Mantiqueira Province are formed by: (i) early Proterozoic basement such as the high and low-grade metamorphic rocks which form the Piedade, Paraíba do Sul and Pocrane complexes; (ii) late-Proterozoic supracrustal sequences of the Rio Doce Group, and (iii) granitoids and pegmatites intrusions related to the mobile belt dynamics. Deposits of rare metals, and gem-rich pegmatites are common along foliation planes of the Rio Doce Group metasedimentary rocks. The regional geodynamic evolution has been sealed by the Gover-nador-North Guaçu and the Vitoria shear zones. Two main folding phases (D1 and D2) were developed under amphibolite facies conditions before and after the granitic intrusions, respectively. The first deformation (D1) is responsible for the N10-30° penetrative foliation (solid state deformation) with western intermediate to vertical strips, and mineral lineation affecting both the host rocks and the pre- and syn-tectonic granitoids. The high density of these structural features suggests an important role of the shearing process during the emplacement of the granitoids. The second deformation (D2) is outlined by cleavage crenulation, boudinage and normal faults, and it is related to an extensional phase following the intrusion of late and post-tectonic granitoids. Recent U-Pb and Sm-Nd age determinations in the

working region, indicate two tectono-metamorphic events, dated at 590-565 and 535-520 Ma, respectively.

Late to post-tectonic granitoids

Ring-like intrusive complexes (from 537 to 520 Ma U/Pb) are located in the Espírito Santo and Minas Gerais states. These plutons intrude the Juiz de Fora and the Paraíba do Sul Complexes of Archaean to Proterozoic ages. They consist of six main intrusions and several smaller ones. Three main types of rocks have been recognized in different ring-like intrusions. They present a structure with fine-grained diorite in the center and hypersthene-bearing granite and/or granodiorite at the margins or at the roof of the intrusion. The intraplutonic contacts are gradational showing intense mixing and mingling processes. All the previous facies of the ring-like intrusive bodies are penetrated by a porphyritic granitoid suite mainly made of coarse-grained granite, granodiorite, fine-grained granite, and vein-dykes of simple pegmatites. Their relative volume does not exceed 10% of the ring massifs.

The ringlike intrusive complexes are characterized by a metaluminous series of rocks whose common features are: the agpaitic index range from 0.45 to 0.77; SiO₂ content ranging from 51 to 71wt%; total alkalis (Na₂O+K₂O) increase (5 to 10wt%) related to the SiO₂ one, and overlapping the alkaline and the sub-alkaline granitoid fields in the TAS diagram (total alkalis/SiO₂); decrease in Al₂O₃, Na₂O, CaO, TiO₂, MgO, Fe₂O₃, MnO, ZnO and P₂O₅, all in relation to the SiO₂ increase, reflecting the fractionation of plagioclases and mafic minerals; MgO/TiO₂ ratio nearing 1 which fits their sub-alkaline characters; Ba/Sr, Sr/Rb, Ba/Rb, Zn/MgO, and Sc/MgO ratios pointing out that the crystallization of pyroxene and plagioclase in the former, and of amphibole, biotite and K-feldspar in the latter, played a major role in the differentiation processes; high Zr+Nb+Ce+Y content (from 500 to 1000 ppm), similar to the post-tectonic granitoids and abundance of REE (200 to 800ppm) with LREE enrichment and LREE depletion ($10 < \text{La/Yb}_{\text{CN}} < 200$), and with Eu anomalies weak or absent.

In the ringlike complexes, the porphyritic facies present several particular features of special interest. They have the highest ASI values (from 0.82 to 1.35) and Fe₂O₃ contents (from 0.52 to 6.56wt%), and they are K-rich ($2 < \text{K}_2\text{O} < 8.4$) which explains the high alkali contents (from 5.45 to 10.6wt%). As a paradox, the highest ASI values are obtained in unusual Mg-rich and Si-poor rocks (MgO= 2.1 and SiO₂=63wt%), which may be related to the role of two different magmatic sources, (i) a metasedimentary one and (ii) a lamprohyric one located in a Fe-Mg-rich mantle. The other major elements evolutions are usual, with decreasing Al₂O₃, TiO₂, MnO, MgO, CaO and Na₂O, and K₂O increasing while SiO₂ increases. The trace elements contents are very low (in ppm: Ni from 1 to 9, Co from 0.8 to 7, Th from 3 to 22, Sr from 56 to 467 and Rb from 61 to 217) but Ba which is abundant (from 464 to 2,940 ppm) and LREE contents which are relatively high ($20 < \text{La/Yb}_{\text{CN}} < 33$ in the hypersthene bearing granites and $10 < \text{La/Yb}_{\text{CN}} < 200$ in the porphyritic granites), the Eu anomalies staying weak or absent, as for the other facies of the ringlike complexes.

Post-tectonic granitoids

The Ibituruna syenite complex, and the Aracé and the Garrafão complexes consist mainly of syeno-granite and syenite, and in lesser amounts, granite and gabbro. The most important of them is the Ibituruna syenite complex (511 Ma Rb-Sr, 509±4 Ma U-Pb age), which intrudes the early-Proterozoic basement. This complex presents predominant fine-grained syenite and quartz syenite, which are cut by many dykes of alkaline granite, of which the largest one was emplaced

as a ring dyke in the south-western border of this complex. The syenites always contain dark enclaves and mafic and ultramafic xenocrysts of early magmatic crystallization.

Syenites and granites have a metaluminous composition ($0.85 < ASI < 1$ and agpaitic index from 0.8 to 1.2). The low contents in TiO_2 , MgO, Ni, Co, Sc, Zn, Nb and Y suggest a major role of olivine, pyroxene and Fe-Ti oxides in the early fractionation stages. The unusual Sr and Ba contents (from 475 to 1,868 and 1,418 to 5,738 ppm, respectively) are significantly higher in some syenites and granites in which feldspar accumulations lead to a Ba-content ranging between 0.13 and 1.2 wt%. The chondrite normalized spidergrams (Thompson et al., 1983) expresses the similarities of syenites and granites in terms of trace elements, except for a few HFS rich samples. The Sr negative anomaly (50 x chond. to 100 x chond.) is related to plagioclase fractionation. Comparing syenites and granites, the first are LREE enriched ($(La/Yb)_{CN}=120$) while the second are depleted ($(La/Yb)_{CN}=55$), but both present a negative Eu anomaly related to feldspar fractionation from a more mafic initial magma. Most of the previously described chemical features, such as the incompatible trace elements ratios ($Y/Nb < 1.2$), the high Sr and Ba contents, the main fractionation role of clinopyroxene + olivine + Fe-Ti oxides and the secondary one of the plagioclase crystallization in the evolution process, and the predominance of syenites vs. granites, may be related to an H_2O enrichment of the parental magma which occurrence is favoured by the Governador Valadares shear zone.

Magmatism and tectonic relationships

The second main tectono-magmatic period is well delimited in time from 537 to 520 Ma, 45 Ma later than the previous event. The second period of deformation (D2), which corresponds to an extensive episode, is also related to a thermal event. During that period, the major crustal thrusts have been rejuvenated, leading to a quick exhumation of the adjacent high-grade gneissic rocks, such as the complexes of Juiz de Fora and of Paraíba do Sul. The uplifting rate is similar to that of the metamorphic zones in a collisional orogeny, following isostatic adjustments. The so-called late-tectonic granitoid ring-like complexes were emplaced during that extensive episode. The intrusions are related to lateral opening of blocks formed by the superposition of thrusting and strike-slip faulting tectonics. During the D2 events, a second partial melting of the crust occurred and produced simultaneously the porphyritic leucogranites and the second generation of less evolved and differentiated pegmatites. Petrological and geochemical signatures of the porphyritic granitoids attest of a crustal origin different from that of the syn-orogenic suites, and the source material is probably the high grade metamorphic rocks, *i.e.* the orthogneiss. This last extensive period, closed by the emplacement of the post-tectonic granitoids, is well recorded in the Ibituruna, the Aracé and the Garrafão massifs. In these syenitic and granitic plutonic bodies, the presence of numerous ultramafic enclaves brings out the role of a mantle source. Structurally, such framework may be explained by a lithospheric scale of the post-Brasiliano strike-slip faults allowing the uplift of mantle melts into the upper crust.

INVERTED STRUCTURE TYPES OF THE ROMANIAN OFFSHORE

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The Romanian offshore is situated in the western part of the Black Sea basin. The following units form the Romanian sector:

- Scythian Platform in the northern part,
- Dobrogea Rift in the central part,
- Moesian Platform in the southern part.

Two main fault systems have been recognized on the Romanian shelf: a roughly NW-SE trending system and a N-S trending one; both systems have built different structures on the three major units.

About the fault systems on the Romanian offshore, we can say that, the E-W system is considered to be older than the subsequent N-S system. The former had probably been initiated during the Jurassic and it ceased its movement during the Paleogene. This system was the result of extensional, and afterwards, compressional tectonic forces. The N-S system affects the first one, and could be post-Eocene in age. The second system is a strike-slip type, separating different uplifted blocks as Midia, located between Lacul Rosu and West Midia faults.

According to the existing data three main tectonic stages can be recognized on the Romanian offshore.

The first stage begins within the Jurassic and continues till the Albian. During this time span, the opening of a NW-SE oriented rift took place at the boundary between the Moesian Platform and Scythian Platform, due to the extensional movements. In this stage, a proto-depression with the axis located north of the present Peceneaga- Camena fault, extended to the whole Romanian offshore. Troughs, grabens and halfgrabens occur on its flanks.

The second stage is characterized by a reduced tectonic activity. It extended over the Upper Cretaceous-Eocene time span. The rift development stopped a medium subsidence of the basin started and the depositional rate slightly exceeded.

The third stage corresponds to an inversional tectonics, from an extensional to a compressional regime, during the post-Eocene-Lower Oligocene time. Reverse or thrust faults occurred in the Moesian Platform (i. e. Delfin fault); in the central unit, former lystric faults, such as Sinoe, Portita-Lebada and Heracleea, became reverse or thrust faults, as an effect of compressional stress. In the Scythian Platform, Pelican is the most important fault that proves compression.

The end of this stage is characterized by decreasing uplift activity and at the same time, a N - S trending fault system occurred. These faults affected all the sedimentary sequence below Oligocene (including Eocene), and towards the east, even younger formations; Lacul Rosu and West-Midia are the most important faults of this system.

The inversion stage causes uplift of the former basin or parts of it. Many former normal border faults are reverse activated, building up different type of structures.

Inverted fault systems vary from reactivation of one isolated fault to reactivation of all major faults, forming significant anticlinal type fold structures.

In the post-rift sedimentary "growth anticlines" were formed. This type of structures are characteristic of the reactivation of a single major fault.

In the syn-rift and syn-extensional sedimentary, the inversion produced typical structures with "harpoon" or "arrowhead" geometries. These geometries result from the wedge of syn-rift sediments that are elevated above regional level.

The half-graben systems can undergo partial inversion with horizontal contractional displacement on the main extensional fault. In this case, "pop-up" type structures can form.

These types of structures have a common characteristic: they appear on the former main listric faults after their reactivation (inverted). But the inversion can form, on the other hand, new faults, producing complex and complicated inverted structures.

The inversion structures, associated with the compressional reactivation of normal listric faults, form important structural traps for hydrocarbons.

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AGE DES EPIMETAMORPHITES DU GROUPE TULGHES (CARPATES ORIENTALES)

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Le Groupe Tulghes (Tg), loge la Zone cristallino-mesozoïque (ZCM) des Carpates Orientales, représente une pile à épimétamorphites (métamorphisme régional dans le faciès de schistes verts - le type barrovien - Krautner et al., 1975), constituée par quatre formations lithostratigraphiques (Tg 1, Tg 2, Tg 3, Tg 4) (Bercia et al., 1976; Voda, 1980).

Les recherches palynologiques, de la période 1970-1983 (Iliescu, Muresan, 1970, 1972 a; Iliescu, Krautner, 1975; R. Fomov dans Voda et al., 1976; Iliescu et al., 1983), ont mis en évidence des Acritarches cambriennes, qui ont constitué les raisons pour attribuer la pile du Tg au Cambrien. En même temps, on a considéré que l'âge du métamorphisme régional du Tg correspondait à l'âge isochrone K/Ar de 505 +/- 5 m.a., établie par Krautner et al. (1976), bases sur les âges modèles K/Ar existantes dans la littérature (Boiko et al., 1970; Gorohov et al., 1967;

Lazarenko et al., 1973; Matkovski, 1970; Manzatu et al., 1971, 1975; Pop et al., 1974; Semenenko et al., 1969). Tenant compte que la limite entre le Cambrien et l'Ordovicien se situe au 495 m.a. (cf. Gradstein & Ogg, 1996), cet age attribue au metamorphisme regional du Tg nous montra que: a) ce processus a eu lieu vers la partie terminale du Cambrien; b) la pile du Tg ne peut pas renfermer des terms plus neufs que le Cambrien.

Recemment, Vaida (1999) a identifie, dans les Tg 3 et Tg 4, des Quitinozoires, parmi lesquelles il y a des formes ordoviciennes, a cote des quelques formes d'Acritarches, rencontrees dans le Cambrien. Tenant compte que dans la toute litterature palynologique, il y a un consensus que le Groupe de Quitinozoires fait son apparition commençant avec l'Ordovicien, Vaida a considere justement que les formations Tg 3 et Tg 4 sont ordoviciennes, acceptant que les Acritarches associees, considerees anterieurement cambriennes, se continuent aussi dans l'Ordovicien.

Les resultats obtenus par Vaida (1999) nous offrent la possibilite pour rediscuter l'age de la toute pile primaire du Tg et aussi celle du metamorphisme regional du Tg.

1) Dans la pile connue du Tg, peuvent coexister ou non des terms cambriens (Tg 1 et Tg 2, dans lesquelles, les recherches palynologiques ont mise en evidence, jusqu'a aujourd'hui, seulement des Acritarches, parmi lesquelles il y a - dans Tg 2 - des formes rencontrees dans le Cambrien) avec des terms certainement ordoviciens (les formations Tg 3 et Tg 4, qui contient des Quitinozoires)? Pour resoudre cette dilemme, nous devons tenir compte de quelques situations: a) dans plusieurs massifs paleozoiques de l'Europe continentale (par exemple, le Massif armoricain, Montagne Noire, les Ardennes, le Massif bohémien, Lyssa Gora), dans les Caledonides precoces d'Ecosse et d'Irlande (Dewe, 1971; Pankhurst, 1974) et aussi dans les Alpes Orientales (Purtscheller, Sassi, 1975), entre le Cambrien et l'Ordovicien il y a une discordance stratigraphiques importante, du au Phase orogenique sarde (salairique); b) les recherches lithostratigraphiques ont montre que dans la succession de la pile du Tg il n'y a pas aucune paleodiscordance stratigraphiques; c) l'age cambrien des parties inferieures du Tg est douteuse, parce qu'elle a ete etablie sur la base d'Acritarches (similaires avec celles trouvees dans le Tg 3 et Tg 4), dont leur valeur biostratigraphique pour le Cambrien, dans le cas des Tg 3 et Tg 4, a ete infirmee par la presence des Quitinozoires. Tenant compte de ces observations, pour nous c'est logiquement accepter la formation pendant l'Ordovicien de la toute pile primaires du Tg.

2) Puisque au moins les parties superieures du Tg (Tg 3 et Tg 4) revient surement au l'Ordovicien, il en resulte que l'age isochrone K/Ar 505 +/- 5 m.a. (Krautner et al., 1976) ne peut pas exprimer en realite l'age du metamorphisme regional du Tg, etant donne que cette valeur coresponde au partie superieure du Cambrien. Il doit accepter que ce metamorphisme a eu lieu plus tard, apres la formation des depots ordoviciens englobes dans le Tg. Par consequent, nous considerons que l'age modele K/Ar de 472 m.a. (determine par l'analyse integrale d'un schiste sericiteux-chloriteux - Monts Bistrita, region Gemenea-Ostra - Manzatu et al., 1975), qui est le plus grand age obtenue pour les metamorphites du Tg, evalue corectement l'age du metamorphisme regional caledonien du Tg, le placant a la fin de l'Ordovicien inferieur, a la limite Arenigien / Llanvirnien (470 m.a., - cf. Gradstein & Ogg, 1996). Nous mentionnons que parmi les roches du Tg analysees, Manzatu et al. (1975) et Krautner et al. (1976) ont releve des nombreuses donnees K/Ar qui reflechissent les rajunissements varistiques et alpins.

Dans la partie SE de la ZCM (a l'est de Monts Haghimas), il y a aussi des metamorphites caledoniens - des schistes muscoviteux-biotitiques a graphite et grenat, englobes dans la Serie de

Damuc (Muresan et al., 1974), qui accuse un metamorphisme regional taconique (les ages modeles K/Ar sont 415-420 m.a.), disposee transgressivement sur les micaschistes precambriennes du Groupe Bretila, de la Nappe de Rarau s.s. (sensu Muresan, 1998).

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LE STRATOTYPE DU FACIES SEPTENTRIONAL D'ES DEVONIEN MOYEN, DEVONIEN SUPERIEUR ET CARBONIFERE INFERIEUR DU CRYSTALLIN DE POIANA RUSCA S.S. (CARPATES MERIDIONALES)

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Dans l'Unite epimetamorphique (UE) du Massif Poiana Rusca, il y a une pile de metamorphites (le Groupe Batrana - Paleozoique inferieur) qui supporte la deuxieme pile (Devonien-Carbonifere inferieur - Krautner et al., 1973), separees par une discordance stratigraphique premetamorphique (Krautner et al., 1968), tout l'ensemble constituant le "Cristallin de Poiana Rusca s.s." (CPR s.s.), metamorphise pendant la Phase sudete (donnees K/Ar - Krautner et al., 1973). Recemment (Muresan, 2000 a), on a demontre que la pile inferieure, representee par le "**CRISTALLIN DE BATRANA**" (CBt) (plus que 1500 m), revient a l'Ordovicien inferieur et constitue le socle metamorphise caledonien, sur lequel se dispose transgressivement la deuxieme pile d'epimetamorphites, qui constitue le "**CRISTALLIN DE POIANA RUSCA s.s.**" (CPR s.s.) (**Devonien-Carbonifere inferieur**) (plus que 10.000 m), metamorphise pendant la Phase sudete. La succession du Devonien et du Carbonifere inferieur renferme (Krautner et al., 1968, 1969, 1973; Muresan, 1968, 1973, 2000 b): **1. Groupe Govajdia (Gv)** (Devonian inferior), **2. Groupe Ghelar (Gh)** (Devonien moyen et superieur) et **3. Groupe Roscani (Ro)** (Devonien superieur-Carbonifere inferieur). **I. GROUPE GOVAJDIA (Gv)** (Devonien inferieur) (800-1000 m) englobe deux entites: **1.1. Formation Gv 1 - de Valea**

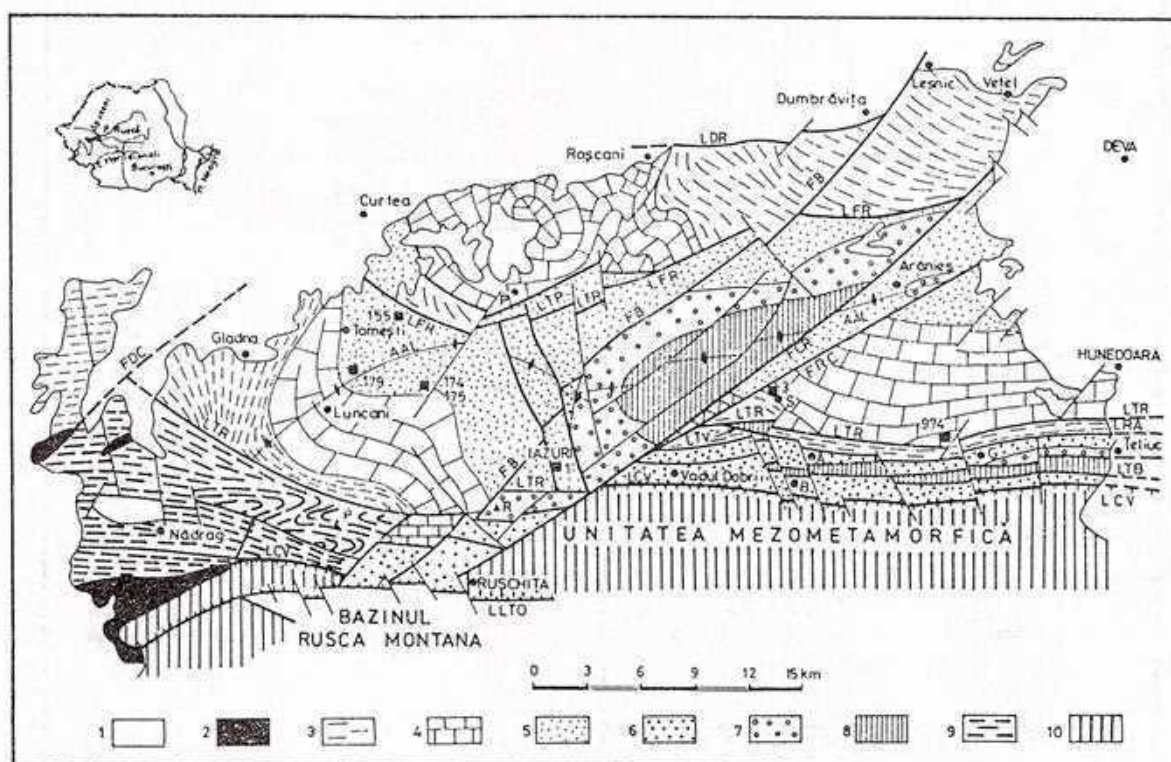


Fig. 1 - ESQUISSE TECTONIQUE DE L'UNITE EPIMETAMORPHIQUE DU MASSIF POIANA RUSCA (partiellement selon: Krautner et al., 1965, 1868, 1969, 1973; Muresan, 1965, 1968, 1973, 2000)

1, Depots mesozoique et tertiaire; 2, Corps intrusives banatitiques (granodiorites, diorites)

UNITE EPI-METAMORPHIQUE (3, 4, 5, 6, 7, 8, 9): **Cristallin de Poiana Rusca s.s.** - Devonien-Carbonifere inferieur; metamorphisme sudete (3, 4, 5, 6, 7) : 3, 4, Groupe Roscani - Devonien superieur-Carbonifere inferieur (3a, Formations Ro 1 et Ro 2 ?; 3b, Formations Ro 2 et Ro 3; 4, Formation Ro 1); 5, 6, Groupe Ghelar - Devonien moyen et superieur (5, Facies septentrional; 6, Facies meridional); 7, Groupe Govajdia - Devonien inferieur; 8, **Cristallin de Batrana** - Ordovicien inferieur; metamorphisme caledonien; 9, **Cristallin de Nadrag s.l.** - Cambrien? Ordovicien?; metamorphisme caledonien? retromorphisme sudete? **UNITE MESOMETAMORPHIQUE**: 10, Metamorphites precambriennes. **ABREVIATIONS** : DH, Massif des Dolomites de Hunedoara; DL, Massif des Dolomites de Luncani; AAL, Anticlinorium Aranies-Luncani; LCV, Ligne (charriage) Cincis-Vadu Dobrii; LTR, Ligne nord Teliuc-Vallee de Runc; LRA, Ligne Retisoara-Alun; LFR, Ligne Fata Rosie; LDR, Ligne Dumbravita-Roscani; LLTO, Ligne Lunca Cernei-Tincova-Oravita; FCR, Faille Cherghe-Ruschita; FRC, Faille Runc-Cutin; FB, Faille Batrana; FDC, Faille Drinova-Curtea; LTB, Lame tectonique Teliuc-Bunila; CPH, Compartiment tectonique Pades-Hauzesti; CN, Compartiment tectonique Nadrag; CI, Compartiment tectonique Izvodia; CTP, Compartiment tectonique Poieni; P, Sommet Pades (1377 m); R, Sommet Rusca (1356 m); C, Sommet Carnu (757 m); G, Localite Ghelar; A, Localite Alun; B, Localite Bunila; VD, Localite Vadu Dobrii; S, Localite Sohodol; H, Localite Hauzesti; P, Localite Poieni; carre noir: point palynologique.

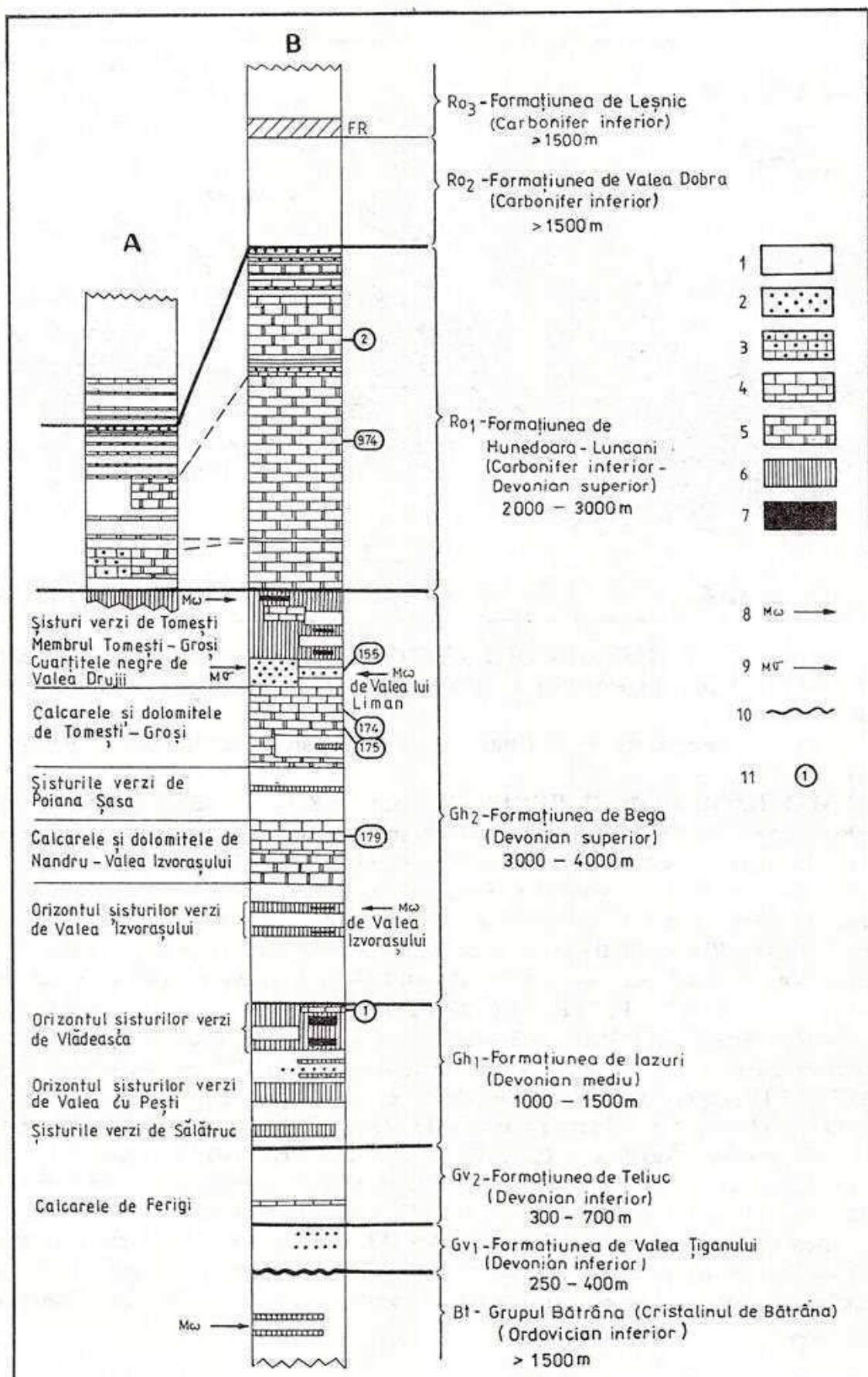


Fig. 2. - STRATOTYPE DU FACIES SEPTENTRIONAL DES DEVONIEN MOYEN, DEVONIEN SUPERIEUR ET CARBONIFERE INFERIEUR DU CRISTALLIN DE POIANA RUSCA s.s.

1, Roches terrigenes (dans Bt: schistes sericiteux-chloriteux et sisturi sericiteux-graphiteux; dans Gv 1: schistes quartzeux sericiteux a chlorite; dans Gv 2: schistes sericiteux graphiteux; dans Gh 1, Gh 2, Ro 1, Ro 2 et Ro 3: predominantement des schistes sericiteux-chloriteux); 2, Quartzites noirs; 3 Quartzites carbonatiques (surtout calcite); 4, Calcaires, calcaires a dolomite;

5, Dolomites, dolomit a calcite; 6, Roches verts; 7, Concentrations feriferes oxydiques (type Lahn-Dill); 8, Niveau d'intrusion des metagabbros; 9, Niveau d'intrusion des metaserpentinites vehrlitiques; 10, Discordance stratigraphique et metamorphique;

11, Point fossiliferes a palynomorphes; Bt, Cristallin de Batrana (Ordovicien inferieur); Gv 1, Formation de Valea Tiganului (Devonien inferieur); Gv 2, Formation de Teliuc (Devonien inferieur); Gh 1, Formation de Iazuri (Devonien moyen);

Gh 2, Formation de Bega (Devonien superieur); Ro 1, Formation de Hunedoara-Luncani (Devonien superieur-Carbonifere inferieur); Ro 2, Formation de Vallee Dobra (Carbonifere inferieur); Ro 3 Formation de Lesanic (Carbonifere inferieur - FR, Membre Fata Rosie); A, Collone lithostratigraphiques pour le secteur Tomesti-Varful Colii-Zolt; B, Collone lithostratigraphique pour le secteur Vallee Iazuri-Vallee Izvoras-Vallee Sasa-Luncani-Vallee Mare.

Gv 1 - de Valea Tiganului (Gv1) (200-300 m) est constituee seulement par des schistes quartzeux sericiteux a chlorite, disposee transgressivement sur CBt. **1.2. Formation Gv 2 - de Teliuc (Gv2)** (300-700 m) renferme des schistes sericiteux-graphiteux (ssgf), dans lesquelles s'intercalent les **Calcaires de Ferigi**. **2. GROUPE GHELAR (Gh) (Devonien moyen et superieur)** (4.000-6000 m) renferme (Krautner et al., 1968, 1969, 1973): **a) un facies septentrional - GhN**, caracterise par: des grandes epaisseurs (plus que 5000 m), des grands volumes de roches terrigenes, dans lesquelles s'intercalent des dolomites (do) et des calcaires (ca) et des niveaux de schistes verts (sv); les concentrations feriferes sont de type Lahn-Dill); **b) un facies meridional - GhS**, caracterise par: la richesse en sv et en calcaires marmoreenes - Alun, Ruschita; les concentrations feriferes sont carbonatiques (Teliuc si Ghelar) Chaque facies a deux formations: la Gh 1 et la Gh 2. La GhS est logee dans la **Subunite Teliuc-Ruschita (STR)**, situee dans le sud de l' UE, tandis que la GhN, dans la **Subunite Hunedoara-Luncani (SHL)** et (partiellement) dans la **Subunite Lesnic-Poieni (SLP)** (Fig. 1). Le **STRATOTYPE DE LA GhN ET DE LA Ro (STGhNRo)** (Fig. 2) a ete etabli dans la partie de NO de la UE (la region Vallee Iazuri-Luncani-Tomesti, situee, principalement, sur le flanc meridional de l'Anticlinorium Aranies-Luncani (AAL), la structure plicative majeure de la UE. La GhN a deux formations: la GhN 1 - de Iazuri et la GhN 2 - de Bega. **2.1. Formation GhN 1 - de Iazuri (Devonien moyen)** (1000-1500 m) debute avec une alternance de schistes sericiteux-chloriteux (sscl) et de sasgf (qui fait la transitions vers la Gv 2), dans laquelle s'intercalent les **Schistes verts de Salatruc (SvS)** (developpees proche de la Cime Salatruc, au N de Vallee Iazuri). Au-dessus du cet ensamble (dans le bassin de Vallee Iazuri) se dispose sscl, suivi par de l'**Horizon des schistes verts de Valea cu Pesti**, qui supportent des schistes predominantement grafiteux, a des minces intercalations de quartzites noirs (qtn). La succession continue avec l'**Horizon de schistes verts de Vladasca -HSVV** (150-200 m), qui acheve la GN 1, est mieux developpe dans le secteur Dealul Vladasca-Dealul Munteanu, ou sont logees des couche lentilleformes de roches quartzeux hematitiques a magnetite (qthemmt) - type Lahn-Dill. Dans les calcaires (interceptes par le forage 15, dans la partie superieure du HSVV), ont ete mises en evidence (l'epreuve 1, Fig. 2) (Iliescu in Krautner et al., 1973) des palynomorphes rencontrees dans le Devonian (Punctatisporites sp., Acanthotriletes sp., Retusotriletes sp., Emphanisporites sp., Leiotriletes simplex Naum.) ainsi que des formes specifiques pour le Devonien moyen (Leiotriletes minutus

(Knox) Pot., *Leiotriletes* cf. *marginalis* Mc Gregor, *Geminospira* sp., cf. *Archaeozonotriletes* sp.). **2.2. Formation GhN 2 - de Bega (Devonien superieur)** (3000-4000 m) a une succession, mieux representee dans le secteur Vallee Izvoras-Vallee Sasa-Varful Stalpului-Vallee Bega-Tomesti. La succession commence avec des sscl quartzeux (> 500 m), dans lesquelles s'intercalent deux minces niveaux de sv, qui etant proches lithostratigraphiquement, nous les ont groupes (avec les roches terrigenes qui les separent) dans l'**Horizon de schistes verts de Vallee Izvoras**; dans le niveau superieur de sv, sont loges les **Metagabbros de Valea Izvoras**. Dans la pile terrigene suivante, s'intercalent deux importants horizons de ca et de do (quelques centaines de metres d'epaisseur): **Les Calcaires et les Dolomites de Nandru-Vallee Izvoras (CDNI)** (a la partie inferieure) et les **Calcaires et les Dolomites de Tomesti-Grosi (CDTG)** (a la partie superieure), separees par des sscl (dans lesquelles s'intercalent les **Schistes verts de Poiana Sasa**). Tant les CDNI que autant les CDTG commencent avec des do, suivis par des ca. A la partie superieure de la GhN 2, au-dessus de CDTG, se developpe le **Membre Tomesti-Grosi (MTG)** (800-1200 m), constitue, principalement, par les **Quartzites noirs de Vallee Druja (QtnD)** (a la partie inferieure) et les **Schistes verts de Tomesti (SvT)** (a la partie superieure); frequemment, entre eux s'interposent des sscl et, parfois, des ca. Dans les SvT, s'intercalent, a quelques niveaux, des qthemmt, de type Lahn-Dill (Vatrani, Paraul Ursului, Vallee Druja). Aussi, dans le MTG, sont loges les **Metagabbros de Valea lui Liman** et des Mu (les metaserpentinites vehrlitiques, proches de Varful Scaunului). Anterieurement, la GhN 2 a ete attribuee au Devonien superieur (Krautner et al., 1973), tenant compte de la lithostratigraphie et de les comparations avec le Paleozoique de l'Europe varistique. Les palynomorphes determinees par Maria Margarit (dans Berghes et al., 1988 - Rapport geologique - Arch. I.G.R., Bucuresti) confirment ce point de vue. Ainsi, dans les epreuves 179 (de Valea lui Liman - de CDNI), 175 (de Paraul Sec - de CDTG) et 155 (proche de Varful Scaunul - de QtnD du MTG) (voire Fig. 2), il y a des formes specifiques pour le Devonien superieur (*Archaeozonotriletes variabilis* Naum.si *Brochotriletes* sp.), a cote de la forme devonienne *Brochopsosphaera vitilis* Cibrik (epr. 174, de Paraul Sec - de CDTG) - les intervalles stratigraphiques des toutes les formes mentionnees dans cet article sont revises par dr. Marioara Vaida (I.G.R.). **3. GROUPE ROSCANI - Ro (Devonien superieur-Carbonifere inferior)** (5500-6500 m), anterieurement denomme le Groupe Pades (Krautner et al., 1969, 1973; Muresan, 1973), une notion remplacee recemment (Muresan, 2000 a), a causes des raisons lithostratigraphiques. Ro renferme la Ro 1, la Ro 2 et la Ro 3. **3.1. Formation de Hunedoara-Luncani (Ro 1)** (2000-3000 m), situee dans la SHL et dans la SVP, este formee, predominantement, par des roches carbonatiques (surtout des dolomites et, subordonnement, des calcaires), groupees, surtout, dans le **Massif des Dolomites de Hunedoara (MDH)** (dans l'est de l'UE) et dans le **Massif des Dolomites de Luncani (MDL)** (dans la partie NO de l'UE). Dans ces massifs, s'intercalent des sscl, des qtn (qui constituent des niveaux reperes, dans le MDL) et des quartzites carbonatiques. Le MDH et le MDL sont synchrones, ayant la meme position lithostratigraphiques dans la pile de la Ro. Le MDH et le MDL passent lateralement aux roches terrigenes. La pile des roches terrigenes synchrone avec MDL est d'environ de 2 fois plus mince en comparations avec MDL (Fig. 2). La Ro 1 a ete attribuee au Carbonifere inferieur (Krautner et al., 1973), a cause des palynomorphese (rencontrees dans tout l'intervale du Carbonifere) de l'age radiogenique de 320 m.a du metamorphisme sudete du CPR. Ainsi, dans l'epreuve 2 (proche de Crivina de Sus - phylite intercale vers la base du tiers superieur du MDL (sur le flanc septentrional de l'AAL), Violeta Iliescu (in Maier et al., 1968) a identifie une associations de palynomorphes carboniferes: *Ahrensiporites* sp., *Leiotriletes gulaferus* Pot.-Kremp., *Leiotriletes*

cf. *adnatus* Koosanke, *Dictyotriletes trivialis* Naum. Puisque la dernière forme est, en réalité, spécifique pour le Carbonifère inférieur (cf. dr. Marioara Vaida), elle indique la présence de celui-ci dans le MDL, commençant avec le niveau du ce point fossilifère. En échange, dans l'épreuve 974 (calcaire dolomitique, récolte de la partie moyenne du MDH), Maria Margarit (dans Berghes et al., 1988 - Rapport géologique - Arch. I.G.R., Bucuresti) a déterminé des palynomorphes spécifiques pour le Devonien supérieur (*Hymenozonotriletes* sp., *H. aff. subdeliquescentis* Tsch., *Trileites* sp.), à côté de *Archaeozonotriletes* sp., rencontrée dans le Devonien moyen et supérieur. Ces formes attribuent la moitié inférieure (au moins) du MDH et du MDL au Devonien supérieur. **3.2. Formations Ro 2 - de Valea Dobra** (plus que 1500 m), au S de MDL, renferme des sscl, dans laquelle s'intercalent des qtn et des roches carbonatiques. **3.3. Formations Ro 3**, au S de Ro 2, englobe une pile de sscl, qui ont à la base une association des sv et des metavulcanites rhyolitiques, toute semblable avec le **Membre Fata Rosie** (séparé à Roscani par Krautner et al., 1969).

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PYROLYTIC CARBON

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Pyrolytic carbon is a term introduced by Kisch & Taylor (1966) and Schapiro & Grey (1966) to denote "cone in cone" or concentrically structured spherical small bodies, deposited from the gas phases by the chemical cracking of volatiles generated by thermal altered coals during igneous intrusion. Derivation: carbon (Fr) < carbo (L) - coal and pyr (Gr) - fire. This term was used by Prowel, Oxley (1966, 1988, 1991); Pierson, Liberman (1975); Pierson (1992); Hesp (1971); Stach et al. (1982); Goodarzi (1985), Taylor et al. (1998).

Other related terms circulated in literature:

- Pyrocarbon (Feys, Greber, 1952; Fabre, Feys, 1963; Sousa, 1974, 1978; Nedelcu, 1990, 1995, 1996, 1998)
- Retortengraphite (Ramdohr, 1928, 1969; Mackowsky, 1951; Lichtemberg-Strunk, 1952)
- Gas graphite (Stach, 1949)
- Graphitoid Sphaerolith (Stach, 1952 b)
- Small Spheres (Ujei, 1936).

Pyrolytic carbon is a highly anisotropic secondary product occurring in layers 1 to 10 microns thick, lining or filling cavities. It shows "cone in cone" or concentrically spherical structures.

Comment: For the first time pyrolytic carbon was observed in economic or laboratory practice of coal heated to temperatures of more than 300 °C in the absence of air. These small spheres are a result of cracking of volatiles subsequently deposited on cooler areas. Ujei (1936) observed them in transmitted light; Stach (1952 b) described as graphitoid sphaerolith (gas graphit, Stach, 1949) in reflected light an aggregate of fine spheres of 2 to 5 microns in diameter.

In nature, many coal petrographers observed small concentrically spherical structures of 1 to 10 microns in coals thermally affected by igneous rocks (dyke, sill and others). These small spheres show a stationary Brewster cross in rotation of the microscope stage, in crossed nicols. Usually, these small spheres are referred as pyrolytic carbon or pyrocarbone.

Physical properties. Colour: grey to metallic white-grey; anisotropy is strong; colours in reflected light range from light white to grey and black; reflectance is from 2.00% for R_{min} and 4-6.5% for R_{max} , $\Delta R_{max-Rmin} = 2-4\%$, in oil immersion. Pyrolytic carbon of identical form and properties was produced in laboratory at temperatures of 500°C and higher. Reflectance and anisotropy of pyrolytic carbon increases with variation in the composition of the gases (thermally cracked gases transformed in pyrolytic carbon). In the laboratory, pyrolytic carbon column, cone in cone structures and optically isotropic carbon are produced. The column and cone in cone structures were produced at low temperature (below 1400°C), high pressure and a low rate of C/H of transformed gases. These types of pyrolytic carbon have an imperfect graphitic structure, which was studied in X-ray diffraction. They are of "pre-graphite stage" (Kwiecinska, 1992; Nedelcu, 1990, 1994, 1995, 1996). In nature, pyrolytic carbon has been observed in coaly deposits associated with volcanic rocks and in anthracites and meta-anthracites from anchimetamorphic complexes. Usually, these pyrolytic carbon structures from nature are similar to those "cone in cone" structures produced in the laboratory. In X-ray diffraction, the carbonaceous matter from meta-anthracites with pyrolytic carbon shows the d_{002} layer formed of graphite (of 3.48-3.68 Å). This pyrolytic carbon has a turbostratification structure.

Pyrolytic carbon is a good electric semiconductor.

In X-ray diffraction, pyrolytic carbon shows the d_{002} value of 3.48-3.70 Å only. In thermo-analytical studies, the carbonaceous matter with pyrolytic carbon but without graphite has the exotherm effects under those of the graphite.

Polishing hardness: Pyrolytic carbon is resistant. In polished blocks, it shows its own strong relief.

Pyrolytic carbon comes from thermal cracking gases derived from coal affected by igneous intrusion, very low-grade metamorphism (anchimetamorphism), low-grade metamorphism.

Industrial procedures and laboratory experiments show that the pyrolytic carbon comes from cracking of gases from coking coals, which produce heated gases in association with mineral matter.

Pyrolytic carbon appears in coals affected by contact metamorphism from igneous intrusions, in coal nearby volcanic rocks, in meta-anthracites from very low-grade (anchimetamorphism) and low-grade metamorphism complexes.

Currently, natural pyrolytic carbon is of no industrial importance. But, in geological research it is an important index of temperature source of the geological environment.

The production of the carbon semiconductors is very important in the whole world.

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ABOUT THE INTERNATIONAL CODIFICATION FOR LIGNITE AND SUB-BITUMINOUS COAL UTILIZATION ECE-UNO

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In Bucharest, on 20 September 1999, the Second Meeting Coal Petrology Experts Commission of Economic Commission for Europe of United Nations Organization for "Task Force on the Elaboration of an International Codification for Lignite and Sub-bituminous Coal Utilization" took place*. The first attempt to formalize a systematization of coal with international value was elaborated and published in 1956 by the Economic Commission for Europe of the United Nations [ECE-UN] within the scope of **Hard Coals** (*International Classification of Hard Coals by Type*, 1956). This was followed (1957) by an identical effort in the domain of **Brown Coals** (*Mining and Upgrading of Brown Coal in Europe. Developments and prospects*, 1957) which was later adopted, with modifications, as ISO 2950. Today, the term "Brown coal" is no longer used in the international systems of Classification and Codification of the ECE-UN. Both systems are expressed by numerical codes, thus they can also be considered, in modern terms, as Codifications. Both cited systems are based on Northern Hemisphere coals and therefore are not necessarily applicable to coals presently known and used worldwide, particularly regarding Hard coals; it is not applicable to coals of diverse petrographic composition. Official representation of several international organisations, such as the former Council for Mutual Economic Assistance (CMEA), the European Union (EU), the European Coal and Steel Community (ECSC), the International Committee for Coal and Organic Petrology (ICCP), the International Energy Agency (IEA/OECD) and the International Organization for Standardization (ISO), was also requested, and has also participated in many meetings. A new *International Codification System for Medium- and High-Rank Coals* (1988) aimed at replacing the 1956 system. This classification is the first attempt to create a world-wide instrument that will permit the classification of all coals in modern terms, i.e. considering the three fundamental characteristics which, altogether, and according to the present-day knowledge, permit to unequivocally define the coal as a geological entity (rock): rank (degree of coalification), petrographic composition (organic facies) and grade (amount of impurities; inorganic facies).

Finally, considering that the ECE-UN also recently published a modern, word-wide applicable system, the *United Nations International Framework Classification for Reserves/Resources-Solid Fuels and Mineral Commodities* (1997) it should be emphasised that on combining this system with the *International Classification on In-Seam Coals* (1998) now exists an instrument that permits one to calculate coal Resources/Reserves, at an international level, on a common basis, and thus applicable to all world know coals deposits.

In order to finalize the revision of old ECE-UN coal Codification/Classification systems, the Meeting of Experts on Research, Management and Transition in the Coal Industry recommended, at its twenty-fifth session (1995), to convene a **Task Force on the Elaboration of an International Codification for Lignite and Sub-bituminous Coal Utilization**. This recommendation was subsequently approved by the Working Party on Coal at its fifth session (1995).

This "Task Force .." developed the work by correspondence and in the course of two meetings (Porto 1997—report under ECE-UN document ENERGY/WP.1/AC.22/2 and Bucharest 1999—report under ECE-UN document ENERGY/AC. 4/1999/1). A first proposal prepared by the former G. D. R. Government (see ECE-UN document COAL/AC. 5/R.7), revised in 1991 by the Deutsches Brennstoffinstitut and submitted as an official German proposal. Australian AS 2096 standard. *International Codification System for Medium- and High-Rank Coals* (1988) and in the *International Classification of In-Seam Coals* (1998), established: **Low-rank coals** are those coals with a Gross Calorific Value (ISO 1928 standard), calculated to a "moist, ash free" basis (GCV (m, af), less than 24 MJ/kg and a Vitrinite mean Random Reflectance per cent, in oil, (Rro%) less than 0.6 %; **Higher-rank coals** (or "Hard coals") i.e. all Medium- and High-rank coals are those coals with: a GCV (m, af) equal to or greater than 24 MJ/kg or a GCV (m, af) less than 24 MJ/kg, **provided that** is equal to or greater than 0.6%. (*Analytical methods to be conform to ISO 1928, 7404-5, 1170,1018 standards*). **Low-rank coals** are subdivided into C, B and A categories or, alternatively, in the **Lignite** (Ortho- and Meta-) and **Sub-bituminous** categories. The boundaries between the above mentioned categories are established on the basis of GCV (m, af) leading to the following definitions: **Low-rank C+B coals or Lignites** are those coals with a GCV (m, af) less than 20 MJ/kg, in which **Low-rank C coals or Ortho-lignites** are those coals with a GCV (m, af) less than 15 MJ/kg . (*The lower rank limit of this category coincides with the lower limit of the classification and corresponds to the boundary between lignite and peat: less than 75% moisture content- to see ISO 1015 or 5068 standards*). **Low-rank B coals or Meta-lignites** are those coals with a GCV (m, af) equal to or greater than 15 MJ/kg, and less than 20 MJ/kg ; **Low-rank A coals or Sub-bituminous coals** are those coals with a GCV (m, af) equal to or greater than 20 MJ/kg and **provided that** Rro is less than 0.6% - similar subdivisions of the ASTM 388 .

Range of application, sampling, sample preparation: ISO 5069.

Basic parameters (*all analyses in accordance with the pertinent ISO standards*): **gross calorific value**, in Mj/kg, recalculated to dry, ash-free basis (daf) – Q_s^{daf} Mj/kg; **total moisture**, in percentage (mass), on as-received basis – W_t^{ar} %; **ash content**, in % (mass), recalculated to dry basis (db) – A^{db} %; **total sulphur content**, (mass), recalculated to dry basis (db) – S_t^{db} % .

Supplementary parameters: % mean random reflectance, in oil, (ISO 7404-5); petrographic composition (%), (ISO 7404-3); ash fusion temperatures, in °C (ISO 540); Q_i^{daf} (ISO 1928); C^{daf} % and H^{daf} % , (ISO 609 or 625); Cl % (ISO 352 or 587); P % (ISO 622); As % (ISO 601); pH (ISO 10390); V^{daf} % (ISO 5071-1); T_{sk}^{daf} % (ISO 647); Yield of toluene-soluble extract, in % (mass ISO 975); Acetone-soluble (mass -ISO 1017); HA % (ISO 5073); $(Na_2O+K_2O)_A^{db}$ % (ISO 1952 and 5072).

* Final draft version in document ENERGY/AC.4/1999/1 of the United Nations, Economic Commission for Europe, 20 September 2000, Bucharest, Romania.

MINERAL MICROINCLUSIONS IN THE PYRITE OF THE POTASSIC CORE OF VALEA MORII PORPHYRY COPPER ORE DEPOSIT, APUSENI MOUNTAINS, ROMANIA

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Introduction

Valea Morii ore deposit represents a complex porphyry copper - low - sulphidation epithermal system connected to Neogene subduction-related andesitic magmatism of the southern part of the Apuseni Mountains. It is located within a shallow subvolcanic body of amphibole and pyroxene andesite that intruded the older volcano-sedimentary and volcanic products.

The aim of this paper is to determine the chemical composition of the mineral microinclusions in the pyrite from the inner, potassic zone of the Valea Morii porphyry copper structure. This could help us, together the quartz fluid inclusion study, to get an insight into the magmatic-hydrothermal process evolution of this system.

Until now there are several studies performed on pyrite-hosted fluid inclusions using either SEM-EDS equipment (Hallbauer, Kabbler, 1982) or transmitted infrared light microscope (Richards, Kerrich, 1993 ; Luders, Ziemann, 1999; Kouzmanov et al., 1999).

SEM - EDAX Studies

Our recent SEM-EDAX study on mineral microinclusions contained in the pyrite and sphalerite from some porphyry copper and epithermal ore deposits of the Metaliferi Mountains (South Apuseni Mts.) including the Valea Morii deposit (Nedelcu et al., 1999) revealed the presence of complex chlorides of a varying chemical composition. Thus, in the pyrite of the Valea Morii porphyry copper ore deposit K - Fe and K - Fe - Cu chlorides as daughter phases have been determined.

In order to achieve the purpose of this study a single but very characteristic quartz-pyrite sample (VM 505) from the potassic core of the Valea Morii porphyry copper deposit (quarry level + 505) has been selected.

The SEM-EDAX study was performed in open cavities by splitting of 17 pyrite grains of sample VM 505.

The chemical composition of the mineral microinclusions was determined using REMMA - 202 electron microprobe equipped with OXFORD - EDAX analyzer and computed by means of

ISIS Program. The operation conditions were an accelerating voltage of 30 kV and a livetime of 50s for all analyzed elements. On the whole 41 mineral microinclusions were analyzed. They are represented by NaCl, KCl, Na(K)Cl, K (Na)Cl and CaCl₂, anhydrite, apatite (+ Cu), chlorapatite ($\pm$ Th), K phyllosilicates, plagioclase, Ca carbonates, Ti oxide (rutile) and silicate glass. These mineral microinclusions mainly appear as daughter phases trapped within the cavities usually laying parallel to the pyrite crystal growth zones. That means they represent primary inclusions. Frequently, the so-called "arborescent microstructures" (Nedelcu et al., 1998), either "dried fluid" (Hallbauer, Kabbale, 1982) or "decrepitation residues" (Richards, Kerrich, 1993) of complex chlorides, are developed within the pyrite crystals. Their formation is obviously due to the sudden decompression, spreading and precipitation as chlorides of fluid inclusions escaped during the opening of microcavities by crystal splitting, process similar to a "spray effect". Such aspects have been observed first by Bonev (1977), who considered that they represent in fact epitaxial parallel orientation of the fine cubic halide and sylvite crystals around the inclusions after the evaporation of the brine.

Conclusions

1. Pyrite is paragenetic with coarse quartz of the sample because of their intimate intergrowth. Since the coarse quartz veinlets are typical of porphyry systems it means that pyrite could have the same origin.

2. Most cavities are filled up to 90% in volume with chlorides and silicate glass microinclusions suggesting that they represent cogenetic salt-rich and silicate liquids as in quartz (Pintea, 1997).

3. Often, the narrow empty space between mineral microinclusions and cavity walls suggests the presence of a film of liquid and water vapor that fills the interstices as in case of crystallized melt inclusions (Bodnar, 1999).

4. The "arborescent microstructures" of complex chlorides observed within the pyrite crystals obviously represent a sudden epitaxial crystallization as chlorides of fluid inclusions escaped during the opening of microcavities by crystal splitting. Therefore they could be useful in a qualitative estimation of the magmatic fluid salinity.

5. Apatite inclusions mainly occur as chlorapatite that sometimes appears to be highly enriched in Th and less in Cu. Close association between apatite and Ti oxide (probably rutile) in the same sample could also be considered as a good indicator for the Valea Morii porphyry copper system according to Williams & Cesbron's data (1977).

6. Apatite and phyllosilicate association could in its turn prove the existence of volatile and hydrous phases probably as an effect of magma cooling and degassing.

7. Also, the anhydrite microinclusions emphasize a f_{O_2} increasing tendency during magmatic fluid evolution.

8. As a general remark the chlorine ubiquity in the mineral association of the Valea Morii deposit renders evident its role as a complexing ligand and transport agent of metals like Cu, Au, Fe in the porphyry copper system.

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SEISMIC INTERPRETATION AND HYDROCARBON PROSPECTIVE IN THE WEST OF THE MOLDAVIAN PLATFORM

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The Moldavian Platform, which is the oldest platform on the Romanian territory, constitutes the western part of the East European Platform. Its southern part is bordered by a major fault (Bistrita Fault), which separates it from the Scythian Platform, while westwards it is covered by the Flysch formations of the Carpathian orogen system.

The seismic prospecting has proved good records allowing the drawing-up of the maps at different levels and ensuring an accurate observation of the main fault routes. The isochronous map at the Badenian anhydrite level is the most relevant.

The faults display a NNW-SSE orientation, following the East Carpathian system, although some of them are being older. This main fault alignment was affected by another fault network with an E-W orientation that eastwards shifted on the former. Along these faults a downward bending of the platform towards the south could also be noticed. In spite of their old age, the faults were active up to the Neogene, fact proved by the thickening of the sedimentary cover.

The relations between the overthrusting plane of the Carpathian formations on the Moldavian Platform and the Straja - Paltinoasa - Valea - Seaca - Malini - Risca - Tg. Neamt major fault play an important role in the distribution of the structural lineaments.

Northwards, the Straja - Paltinoasa - Malini - Risca fault gets into contact with the thrust plane. The crossing of these major faults has delimited a distinctive structural zone (about 40 km long and 4.5 km wide) within which the tectonic stress has increased. The main faults also have a reduced offset and play a secondary roll in the redistribution of the fluids from reservoir rocks.

Southward, the Paltinoasa fault dips beneath the Peri-Carpathian Nappe. This zone had a complex structural evolution marked by tectonic stress oriented towards different planes and with variable intensity levels.

Another main fault with a complex evolution has developed to the east of the Paltinoasa fault and has got the attention by a wide bending to the west as well as by strike-slips up to 3 km in offset. The geological formations from the tectonic block situated in front of the fault have some structural uplifts that start to be noticed beginning with the Cretaceous up to the end of the Badenian.

The southeastern part of the study area gets the attention by the presence of a NW-SE fault with offsets of about 50-100 m, along which some monoclinical structures with easily folded features developed. They are accompanied by pinch-out of the Lower Sarmatian deposits that are the result of the synchronous sedimentation with structural evolution.

During the Sarmatian the sedimentation conditions changed and passed from a predominantly marine environment to a transition one, of the deltaic type, with lacustrine -

continental influences.

The seismic investigation allowed the delineation in the Sarmatian deposits of some deltaic systems on the Moldova Valley (Paleo-Moldova River) and north-east of the Bacau. The detailed analysis of the facies units divided on the seismic profiles allowed the reconstruction of the depositional environment, of the lithology and of the geological history.

The deltaic depositional systems are areas with a predominant supply of detrital sediments in the marine environment, summing up all the geological conditions that control the formation of the hydrocarbon accumulations.

The reservoirs consist exclusively of sands and sandstones, while the pelitic deposits of marine transgression play a major role both in hydrocarbon generation and in the formation of the seals.

The elucidation of the structural features of the study area with the help of the seismic prospecting has modified the older monoclinial aspect with a gradual sinking in steps towards the west. The accurate description of the route of the Peri-Carpathian Tectonic Line and of the main faults that affect the platform deposits, their consequences in the structural model, have opened new hydrocarbon perspectives and delineated same structural and stratigraphic traps.

THE COPPER ARSENIDES OCCURRENCE AT INTREGALDE, METALLFERI MOUNTAINS (ROMANIA)

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The copper arsenides mineralization at Intregalde village occurs in the Diesa Hill, at the spring of a small left tributary of the Galda valley, about 10 km east of the Bucium deposit. This belongs to the Neogene metallogenetic district of the Metaliferi Mountains. Sulfides, tellurides and Cu minerals (chalcopyrite, chalcocine, covellite, enargite and luzonite) constitute the Arama group veins.

Socolescu and Superceanu (1960) studied the copper mineralization in the Diesa Hill for the first time. They considered it as a "telethermal influence of the Musca type meso-epithermal enargite formation ($\text{Cu}_3\text{AsS}_4\text{-FeS}_2\text{-CuFeS}_2\text{-Au}$), hypogene oxydated, with totally loss of S and Fe, and copper arsenides forming". Microscopic evidence, etching test on polished section, X-ray powder diagrams and chemical assay effectuated by Socolescu and Superceanu show the presence of the minerals like domeykite and algonite; other two minerals, whitneyite and huntite, were identified by microscopic studies and spectrographical assay.

That occurrence was found again by the authors in 1997 (Fig.1).

Microscopic studies, X-ray powder diagram, chemical and spectral analyses effectuated by the authors confirm the presence of domeykite and algonite, which represent 90% of the mineral assemblage.

A small vein, consisting only of metallic minerals (domeykite, algonite, whitneyite, huntite, chalcocine, covellite, Au, and minerals belonging to weathering zone), without any trace of hydrothermal alteration, forms the entire mineralization. The vein thickness varies from 1 to 3 cm. The vein develops in Middle Cretaceous flysch gray-color sandstone on a NE-SW fracture. Ten meters westward films of malachite and diopside are observed but on Tiopului Valley, about 100 m below the Diesa Hill level, no signs of mineralization were observed.

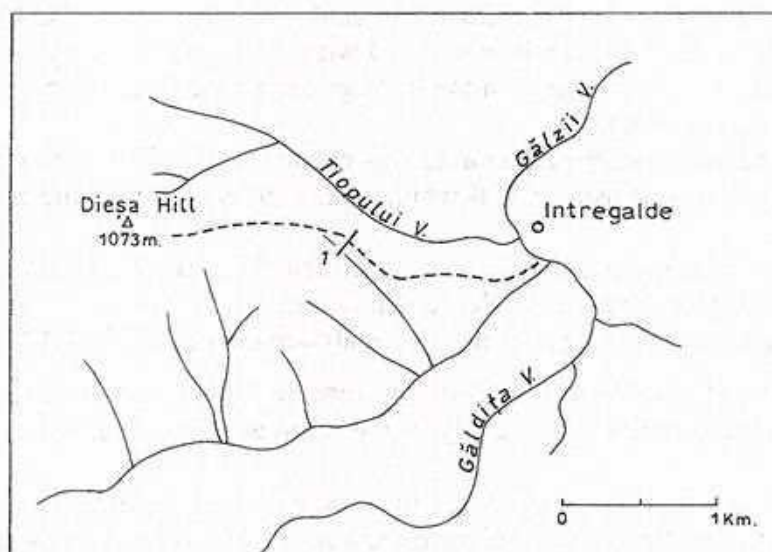
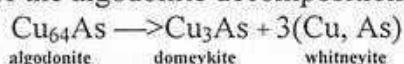


Fig.1 Sketch map of copper arsenides occurrence
1. Copper arsenides veinlet

The vein is made up of parallel or transversal and oblique bands, predominant of domeykite and algonite. The main mineral, domeykite (α and β modifications), is forming monomineral veinlets or is intimately intermixed with algonite. Sometime it surrounds the algonite, in nests elongated on the fracture plane.

Domeykite is still gray in colour, but tarnishes readily yellowish and subsequently iridescents and it has a high reflectivity (Socolescu, Superceanu, 1960). The α -domeykite is metastable, izotrope and more susceptible to etching with an acid solution $[(\text{NH}_4)_2\text{S}_2\text{O}_3 - 12\% \text{ and } \text{HNO}_3 - 2n\%]$ compared with the β domeykite. During the oil immersion the α domeykite has bluish reflections.

The α domeykite occurs as veinlets (0.5-2 mm), as irregular or elongated films, usually intergrown with the algonite and it is partial substituted by the β domeykite, chalcocine and cuprite. It is also developed like lamella or acicular shapes, sometime lenticular when it is the result of the algonite decomposition, according to the reaction:



This variety can be observed only after the etching test, when it forms triangle or leaf-shaped structures in the algonite groundmass.

β -domeykite (hexagonal phase) is bluish in colour and it has a weak anisotropy. It is more resistant to etching than α -domeykite. Within the Cu-As system α -domeykite is the stable phase, resulting from α -domeykite at a temperature below 225° (Hansen, Anderco, 1958), conversion considered as a geothermometer (Skinner et al., 1963; Rhamdohr, 1974). Below 689° the algonite is decomposed in domeykite and whitneyite, process also emphasized by TDA analyses (Socolescu, Superceanu, 1960); in fact the algonite is stable even at room temperature, that is explained by self annealing and solid solution diffusion processes.

The α and β domeykite were identified by the X-ray analyses carried out by Socolescu and Superceanu, 1960, and the authors of this paper [d-2.074 Å (I), 1.949- (F,I), 1.848 Å (i); d-2.215 Å, 1.187 Å, 1.180 Å (I)].

The primary domeykite was produced probably by the high hypogene oxidation of the enargite.

The algonite (Cu_6As) is still gray to silver white and it shows a weak anisotropy after

the treatment of the polished section with nitric acid that clear away the CuAs film. In the compact ore the algodonite is intimately associated with the α and β domeykite, so that they are the dominant minerals. On the contrary, in the impregnation zone from the border of the vein the algodonite is the dominant mineral.

By the decomposition of the algodonite was created lamela-like domeykite, or needlelike with triangle structures or leaf aspects and whitneyite, both enclosed in the algodonite ground-mass.

As compared, with the occurrence at Mechernich (Germany), of hypogene genesis, the algodonite at Intregalde has a hypogene-telethermal feature.

RX powder diagrams revealed the presence of the algodonite [2.215 Å, 1.187 Å, 1.180 Å (I)].

The whitneyite (CuAs) is a solid solution, pink in colour and occurs sporadically, as a algodonite decomposition product, especially in the impregnation zone, where it surrounds the algodonite grains.

The huntelite (α Ag₃As) was identified by Socolescu and Superceanu on the basis of the microscopic studies (light bluish colour, high reflection, anisotropy, and polysynthetic twins) and of the presence of silver, spectrographically identified.

The chemical assay of the raw ore showed the following composition: 61.15-70.23 % Cu, 9.02-12.62 As (Socolescu, Superceanu, 1960) and 74,76 Cu %, 12,32 % As, 2,80 % S, 8.8 % C (LAG Prospectiuni SA, 2000).

The spectrographic assay, made up in the laboratory of the same company indicated the following element grades (ppm):

As	Cu	Sb	Pb	Cr	Ni	Bi	Ag	Mo	B
>3000	>3000	100	25	25	3	3	20	10	10

Hg, Ti, Sn, Ga, Ge, In, Cd, Be, Zn, Co and Ba showed values below the detection limit.

The supergene alteration generated cuprite, colomorphe, around the arsenides, and malachite, coveline, crisocola and diopside.

The copper arsenide mineralization at Intregalde has a similar paragenesis like those at Chile (Coquimbo) and it formed by the hypogene oxidation of S and Fe. It represents a late, low temperature phase of the metallogenesis related to the Neogene volcanism.

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NEW GEOLOGICAL AND GEOPHYSICAL DATA REGARDING THE VOLCANIC EDIFICE FANCEL-LAPUSNA (EAST CARPATHIANS, ROMANIA)

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The geological and geophysical prospecting activities carried out in 1988 in the Fancel-Lapusna area (Gurghiu Mountains, E Carpathians), aimed to identify the possible gold-silver mineralization.

The volcanic edifice Fancel-Lapusna (FL) is included in the volcanic Neogene Calimani-Gurghiu-Harghita (CGH) chain of the Romanian East Carpathians, a typical subduction product, composed mainly of calc-alkaline rocks. The lack of acid rocks as compared to other volcanic areas in Romania is a typical feature of the CGH chain. The structure and morphology of the CGH chains is dominated by an axial row of closely spaced, adjoined or partially overlapping andesite composite edifices with large and merged peripheral volcanic aprons that form a continuous edge especially along the western side of the chain. The stratovolcanoes are medium-sized with 1000 to 1500 m relative elevations, and slightly or moderately eroded (Szakacs, Seghedi, 1996). They usually consist of thick piles of basalt-andesite lava flows, andesite and dacite lava domes or domes complexes with thin interbedded pyroclastics (Szakacs, Seghedi, 1996). In their central part uncovered shallow intrusions with their related hydrothermal alteration zones are frequently present in erosionally extended central depressions of craterial origin. The age of the northern part of the chain (Calimani Mountains) is Miocene-Pliocene and the Gurghiu-Harghita Mountains are considered to be moulded during the Pliocene (Szakacs, Seghedi, 1996).

FL is volcanic edifice which dominates the northern part of the Gurghiu Mountains, in the East Carpathians. The geological-structural setting is represented by the presence of two morpho-structural units: the lower unit (an volcanoclastic one) Lower Miocene in age, and the upper unit (a stratovolcanic one), Miocene-Pliocene in age, consisting of lava flows, domes and pyroclastic products of prevailing pyroxene andesites and hornblende pyroxene andesites.

The acquired data were displayed by classical mapping (various maps) and by 3D modeling. In the 3D modeling, the geology and significant geophysical or geochemical anomalies were superposed on a Digital Elevation Model (DEM). This model was obtained by digitizing 1:10,000 scale maps.

The geophysical data have been integrated to the tectono-volcanic geological interpretation. A comparative analysis of the FL volcanic edifice was done, special attention being conferred to the hydrothermal alterations. The hydrothermal alterations are propylitic, potassic, intermediate argillic, advanced argillic and silifications (Meyer, Hemley, 1967; Stanciu, 1973; Stanciu, 1996).

A detailed study regarding the petrophysical properties of the outcropping rocks was performed, using rock samples collected in 1998 and samples previously collected from boreholes.

Gravity and magnetic prospecting in FL area evidenced:

Large maximum anomalies and various local gravity anomalies, by detailed gravity (165 station on sq. km) prospecting. The gravity anomaly is elliptical in shape, with its main axis trending WNW-ESE. It covers an area of 8 x 10 sq. km and is surrounded by a belt of increased horizontal gradient. Inside it, two maximal intensity anomalies occur, which partly correspond to

the structures Fancel Peak – Zambroi Peak and South Batrana Peak, both including small dioritic-andesitic intrusions.

According to the authors, the positive gravity anomaly is generated by the thickening of the compact lava flows in the central area of the volcanic structure, accompanied by andesitic subvolcanic bodies. Two bidimensional modeling (Botezatu, 1982; Suceava, Sava, 1974) of the anomalous sources approximate the measured effect.

Two minimum gravity anomalies within the central volcanic structure underline a supposed hydrothermal altered zone.

According to aeromagnetic data, two craterial volcanic structures, partly eroded, may be configured. They are reflected by groups of maximal anomalies with intensities ranging between 350 and 1,000 gamma, generated by andesite and diorite bodies, whose limits may be marked by a series of main fracture systems, followed by secondary discontinuities of small amplitude. In the central section of the two cited craterial structures, anomalous zones are outlined slightly negative (-50 to -200 γ), which probably reflect the existence of strongly hydrothermally altered rocks.

Various anomalies were identified by land magnetic survey (2500 station on sq. km).

Land magnetic data acquired on an area of aprox. 7 sq. km south of Batrana Peak reflected a separation between areas where fresh and propylitised andesites are spread and areas covered by hydrothermally altered andesites.

A low and uniform magnetic field corresponds to the hydrothermally altered areas (argillic alteration). In an area bounded by Eseniu Creek and Crucii Creek the magnetic data identified on a negative background (with values between -200 and -500 γ) low positive anomalies (+100, +200 γ) of small extent, corresponding to the argillic alteration. Another area, bounded by Gropsoara Creek and Fancelul Mic Creek, minimum magnetic domain reflects the effect of argillised andesites. Low radiometric and spectrometral anomalies (potassic component) mapped in this region but overlying the maximal magnetic anomalies, correlated with microscope studies explains the presence of potassic alteration in this area. The radiometric survey (5000 station on sq. km) contoured low values I γ anomalies varying between 5 and 9 $\mu\text{R/h}$, the average values being 6.5 to 7 $\mu\text{R/h}$.

Horizontal anomalous magnetic gradient belts outlined the presence of some radial and quasi-circular fracture lines which could show sector collapse areas in the structure.

Maximum IP anomalies, generated by the presence of pyrite in andesites as dissemination, were identified in the Lapusna Creek area by electrical survey (AB=1200m; MN=40; 20 m space). They are correlated with a minimum magnetic anomaly. Small areas with increased apparent resistivity that overlie the hydrothermal zones are related to silicified rocks.

The unaltered andesite rocks are marked out by the low IP values and resistivity fields.

After the integrated interpretation of the geological, geochemical and geophysical data, the connection between applied geophysics methods (Botezatu, 1982) and geological studies is established in order to obtain a comprehensive geo-structural and metallogenetical image.

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HEAVY METALS DISTRIBUTION IN DUST FROM THE CENTRAL PART OF BUCHAREST

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Introduction. This paper, based on a case study in the central part of Bucharest city, focuses on the local pollution as a serious environmental problem, generated by the anthropical activities due to the urbanization development, transportation and, secondary, industrial activity.

Bucharest is the most important city of Romania, located in the plain area. The atmosphere of central part of the town is loaded with particles of dust and noxious gases emitted, mainly, by urban transportation and other anthropical activities (constructions, energy plants, industrial activities etc.)

Among the multitude of pollution factors directly related with the human factors, the dust has been considered and analyzed as a results of natural or anthropical processes. Based on a mineralogical and geochemical study, the human influence on the dust, and consequently on the environment, could be established and evaluated.

Finally, the paper describes the strongly negative ecological impact generated by the demographic increase (>10,000 inhab./sq.km) and anthropical activities development directly affected and affecting the environment.

Samples prelevation. Particles of dust were sampled from important crossroads from the central part of the town. Some samples were also taken from inside buildings (indoor samples) in order to compare the dust particles composition with the outdoor samples.

Mineralogical data. Outdoor dust samples have been analyzed from the granulometric, morphomeric and morphoscopic point of view by means of optical microscope and SEM. For indoor dust morphoscopic and optic analyses (by optical microscope and SEM) were performed.

* Granulometric analyses showed that the outdoor dust is similar to argillaceous silt (Shapard and Link diagrams). The distribution is unimodal and asymmetric. Generally, the unimodal distribution shows that the samples derived from the same source. In this case, there are several sources, but the secondary populations overlap and superimpose the main populations. The thickness of the elastic material presents an asymmetric distribution. The cumulative curve indicates that the saltation was the main transport process and traction and suspension were the secondary ones.

* The morphometric analyses revealed that the mineral grains are subrounded with roundness index $Ro = 0.7 - 0.8$. This fact suggests a long period of transportation process.

* The morphoscopic analyses indicate that the evolution of mineral grains was made in several environments. Each of these environments imprinted specific characteristics to the grains: chemical, mechanical and biotic. In this case, the actions of the wind, the main transportation

factor, modified the mineral grains by impact structures, conchoidal ruptures, and V- and U-shaped cavities. These final structures are specific to low transportation energy.

* The microscopic analyses showed that outdoor samples of dust contain, on an average: 55 % transparent minerals (quartz, calcite, feldspars, muscovite), 8 % opaque minerals (göethite, limonite), 1 % heavy minerals (chlorite, biotite, zoizite, garnets, hornblende), 20 % argillaceous minerals, 10 % anthropical products (combustion products, glass fragments, textile fragments etc.) and 6 % vegetal fragments (spores, fungies, cuticles and other parts of plants). The indoor dust samples contained more organic and anthropical products (textile fragments, soot, ashes and vegetal fragments) than outdoor dust. Quartz, clay minerals, calcite and muscovite are minerals observed in indoor dust.

Geochemical data. The bulk chemical analyses have been obtained by ICP-AES and XRF. Outdoor and indoor dust samples had a high heavy metals content. The variation of the heavy metals contents in outdoor dust was: 102 ppm – 1800 ppm Pb, 184 ppm – 7500 ppm Zn, 35 ppm – 800 ppm Cu, 31.6 ppm – 750 ppm Cr, 8.99 ppm – 58.7 ppm Ni. It was observed that in the indoor dust the composition was higher than in outdoor samples for: Pb (248 ppm – 2289 ppm), Cu (423 ppm – 4225 ppm) and Ni (23.8 ppm – 77.2 ppm).

Conclusions

* A good correlation between Pb-Zn ($r=0.677$), Pb-Cr ($r=0.8137$) and Zn-Cr ($r=0.587$) was observed. This fact suggests the same sources for these elements. The difference up to the perfect correlation has been given by the other sources of heavy metals.

* There is a low correlation between the heavy metals from outdoor dust samples, a.g. Cu-Zn ($r=0.1215$), Cu-Pb ($r=0.2417$) and Cu-Cr ($r=0.199$). This fact reflects the different sources of these elements.

* In the central zone of the studied area, a good correlation has been observed between outdoor and indoor contents of the same elements ($r_{Pb}=0.823$, $r_{Zn}=0.976$, $r_{Cu}=0.998$, $r_{Cr}=0.903$, $r_{Ni}=0.294$). This fact reflects the same sources of these elements. The difference up to the perfect correlation results from specific indoor activities.

* The maximal distribution of heavy metals was observed in the central part of the studied area. Pb has the maximum concentration (>1500 ppm) in two zones: Independentei - Libertatii Blvd. and Unirii - Goga Blvd. In these areas the concentrations were more than the maximum admitted concentration (MAC). Zn presents the maximum concentration values (>7000 ppm) on the Calea Victoriei alignment. In this area the maximum concentrations were in two crossroads Kogalniceanu Blvd.- Calea Victoriei and Independentei - Victoriei Blvd. The maximal value of Cu concentration (>3500 ppm) was registered in Dacia Blvd. - Calea Mosilor crossroad. Cr concentration value exceeded the MAC in two points on the Calea Victoriei alignment: Dacia Blvd. - Victoriei (>500 ppm) and Independentei Blvd. - Libertatii Blvd. crossroads.

The different locations of these maximal distributions have been given by the anthropical activities specific to these areas superimposed on the industrial pollution of the zone. For the central part of Bucharest the characteristic phenomena is a baric microdepression given by the difference of temperature between the central part of the town and the surrounding districts. This fact facilitates the appearance of a convection circuit in the atmospheric flow, which transports the industrial pollutants from surrounding industrial areas to the central part of the town. Besides, in the central area of Bucharest most streets are "canyon type" (the roads width is lower than the height of the buildings). This fact modifies the meteorological parameters (wind velocity and direction) thus the dispersion degree of pollution is disturbed. In the central part of Bucharest

the traffic has the highest density thus the people who live and work here are permanently exposed to pollution.

The environmental pollution effects. *The pollution influence on the climate change.* The pollution in Bucharest with suspension powders favors the following phenomena in the atmosphere: *air opacity, nebulous manifestation, temperature increase* and occurrence of "glass-house" effect. In the region the important quantities of powders and pollutants determine the *photochemical fog*. The wind in the area is relatively slow, the average wind velocity varying between 1.4m/s and 2.5m/s. These small values show low ventilation, the dilution capacity on the air being reduced. As regards the thermal stratification, this is stable, determining a wave-shaped zone of pollutants, the noxious substances being stagnated above the city.

The pollution influence on human health. The pollution combined with local and specific climatic factors produces higher concentration of certain elements, thus generating functional disorders of the organisms and negative influences on the human factor in the area. By the direct action of the dust on the human health, the following effects can happen: headaches, sneezing, coughing, nausea, fatigue, skin rashes, nose, throat and eyes irritations. The danger is greater, if the dust has the heavy metals concentration and other harmful elements for human health above MAC.

* A future trend of the local policy is the environmental rehabilitation. The first stage of this process is based on healthier relations between humans and environment, according to the legislation.

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HYDROGEOCHEMICAL EVALUATION OF HYDROCARBONS AND IODINE FROM THE MEOTIAN AND SARMATIAN SEDIMENTS AT THE CONTACT OF THE MOESIAN PLATFORM AND THE GETIC DEPRESSION, MATASARI – BAL TENI – TIC LENI – SLATINA AREA

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Hydrogeochemical and seismological research suggested a facies variation from north to south, from the depression to the platform zone. The Getic Depression area seems to be characterized mostly by pelitic sediments with some psammitic rock intercalations.

The platform zone is characterized by almost continuous alternations of pelitic and psammitic layers. The intermediate zone seems to consist prevalently of neritic-littoral sediments.

The north plunging of the pre-Tertiary and subsequent sediments from the platform zone take place slowly up to a certain latitude. Farther to the north the plunging is more rapid and the influences are strongly expressed both in the behavior of the aquifers under depositary conditions and on the chemistry of the oil field waters from the Meotian - Sarmatian sediments. The aquifers are under reduction conditions and in a close system from the hydrogeological point of view containing waters with a high mineralization degree and chemically metamorphosed.

The oil deposit fluids accumulated in Sarmatian and Meotian sediments of the region represent a typical example of the role of depositary environment of organic matters, the nature and origins of sedimentation basin waters, where the bitumenization processes took place. The waters of these Sarmatian and Meotian sedimentation basins are isolated, without any circulation, during the filling of the basins and are kept as connate waters in genesis aquiclude deposits and in primary - secondary accumulation aquifers inside an aquifer complex.

Related to the hydrogeological and especially hydrogeochemical characteristics the aquifers are hydrogeologically closed, under reduction conditions, without hydrogeological accessibility, in most propitious conditions of genesis, accumulation and conservation of fluid oil deposits with different types of oil field waters.

One type of oil field waters is the organic type resulting from the decay of proper organic matter that generated the hydrocarbons. In this type of oil field waters the iodine concentration is above 100mg/l and the concentration of ammonium, resulting from the reduction of the nitrate oxidants organic compounds and of the soil organic matter is above 150 mg/l.

Another type of oil field waters is mainly marine and subsidiary old continentally infiltration waters. This is composed, besides organic micro-compounds, of iodine with a concentration below 100 mg/l, and ammonium with 50 -100 mg/l concentrations, of direct micro-compounds associated with hydrocarbons, naftenic acids, fenols, benzene, hydrogen sulphide and light and heavy gaseous hydrocarbons – methane, ethane, propane, iso-butane, butane, pentane.

Without a significant importance there are mixed waters in chemical metamorphosed processes, with aggressive CO₂, minor quantities of sulphates, atmospheric and biogenic nitrate, bromine, iodine and ammonium with minor concentrations, mainly under 10 and even 2 mg/l.

From the hydrogeochemical point of view the oil field fluids are located in two main types of aquifers:

- aquifers hydrogeologically closed from reduction environments, eutrophics, without hydrogeological accessibility, in the most favorable conditions of genesis, accumulation and conservation of fluids;
- aquifers without a stable hydrodynamics, where there are water exchanges inside the sedimentation basins and between the aquifers without hydrogeological accessibility, in favourable conditions of migration, accumulation and conservation of fluids.

Inside the area under study, Meotian and Sarmatian sediments, oil-generating rocks are considered the aquiclude pelitic rocks, marlstones being the most representative.

They were considered as oil-generating rocks on mineralogical and petrographical criteria, black colour and bitumen content. These physical characteristics are suited mostly to the platform sediments, beneath the depression, considered with an oil-generating role.

Mainly burial depth and temperature of the sediments determine the transformation of organic matter in hydrocarbons and organic waters. Therefore the oil and gas from Sarmatian and Pleistocene sediments of the Moesian Platform beneath the depression can be considered as autochthonous.

Most of the hydrocarbon accumulations are located in granular collector-type rocks, primary gas cap zones less. The oil and gas deposits are stratiform, arched and cut by faults, both in platform and depression, with all types of closures – tectonical, stratigraphical or lithological. The tectonical closure is the main type.

The hydrocarbons are usually located in aquifers of the same layer or natural reservoir or in different layers of the same complex: continuous stratigraphic formations with local discordances.

From the hydrogeochemical point of view, good hydrogeological conditions and presence of all direct and specific micro-compounds, five zones are interesting for hydrocarbons, bromine and especially iodine in the Sarmatian sediments: Balteni – Barbatesti - Carbonești, Gradistea – Zătreni - Romanesti, Bibesti - Bulbuceni, Mitrofani - Campu Mare and Varteju – Bradesti - Racari.

In the Meotian sediments the interesting zones for gas and oil accumulations are: Varteju – Lacusteni - Iancu Jianu, Varteju – Lacusteni - Campu Mare – Dragasani, but also Balteni and Socu zones that have very good conditions from the hydrogeological point of view.

It is to note that in both Sarmatian and Meotian, environments of accumulation and conservation, an active anaerobic bacterial decay of the organic matter mixed with fine sediments took place.

The accumulation and diagenesis of organic sediments took place slowly because sedimentary formations were mostly continuous, in a closed hydrogeological regime, this statement being supported by the values of the genesis hydrogeochemical coefficient, Na/Cl (0,8-1). A slight fluid dispersion was possible in the absence of a thick impermeable layer able to retain the fluids in reduction conditions.

The high values of hydrodynamics coefficients of metamorphic processes, such as Ca/Mg , $(Cl-Na)/Mg$ (2-6), in the zone bordering to the north and the south the intermediary zone between the Getic Depression and the Moesian Platform support these findings.

CHEMICAL ANALYSES OF FLUID INCLUSIONS BY SEM/EDA, IN THE GOLD-QUARTZ VEINS, LEAOTA MOUNTAINS

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Eadington (1974, in Haynes, 1988) proposed that qualitative, and in some cases semiquantitative, compositional data could be obtained by Energy Dispersive Analysis (EDA) of salt residues, called decrepitates.

The results of analyses performed by Haynes et al. (1988) of natural quartz containing synthetic inclusions of known compositions in the systems $NaCl-KCl$, $NaCl-CaCl_2$ and $NaCl-KCl-CaCl_2$ show that the compositions of moderately to highly saline fluid inclusions can be determined semi-quantitatively by SEM/EDA of the solid residue produced during thermal decrepitation.

Fluids released during decrepitation were deposited either in discrete mounds of presumed single inclusions origin (Fig. 1a) or in linear trails (Fig. 1b).

Decrepitates that formed along fractures where planes of secondary inclusions broke to the surface and do not show chemical homogeneity (Fig. 2).

Non-homogeneous salts are also produced when samples are left for several days between decrepitation and analysis. Inhomogeneity of this type can be avoided by analyzing samples, few hours after decrepitation.

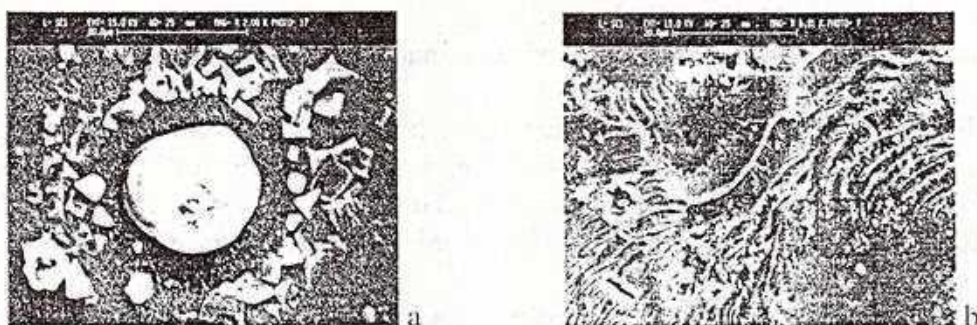


Fig.1. Scanning electron photomicrographs of fluid inclusion-derived decrepitate salts.
a. Decrepitate of presumed single inclusion origin (sample no. cs165, Ghimbav Valley).
b. Fracture-aligned linear decrepitate (sample no. 21.a, Caselor Valley)

Rapid evaporations and precipitation, which characterized decrepitation of individual inclusions, may be essential in preventing differentiation and redistribution of elements within the solid residue and thus, preserving chemical homogeneity in the decrepitate.

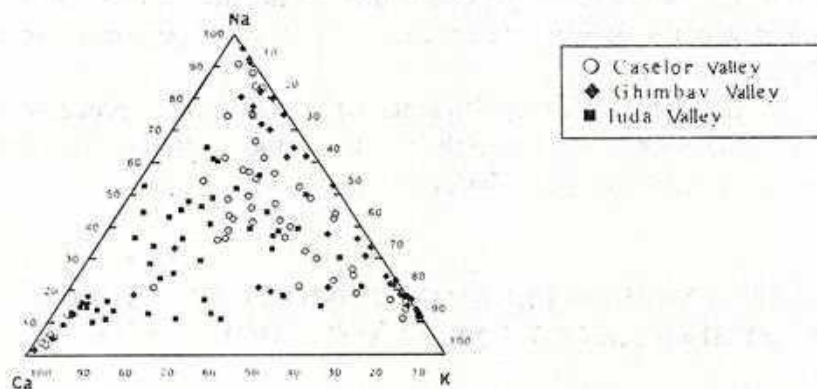


Fig.2. The relative ratio of the major cations Na, K and Ca in three samples of the Leauta Mountains.

After decrepitation, inclusion contents are separated into volatile and non-volatile fractions. Estimating inclusion chemistry by SEM/EDA of the solid non-volatile fraction involves that none of the salt component is lost during decrepitation through vaporization. Differences in the volatility of the various solutes in the inclusion fluids may be a problem when decrepitation temperatures over 450°C are employed.

For this reason, decrepitation was performed at temperatures ranging between 350 and 450.

Decrepitate size is a function of inclusion size and salinity:

$$0,0145sr_i^3 = r_d^3$$

Where: s = salinity, r_i = inclusion radius, r_d = decrepitate radius.

The study of Haynes et al. (1988) indicates an optimum decrepitate diameter in the range of 10-30 μm .

Prior to thermal decrepitation and SEM/EDA, the inclusions were subjected to traditional heating/freezing runs.

Fluid inclusion petrography and microthermometry show that the main stage vein minerals precipitated from a homogeneous fluid composed of H_2O , CO_2 and salts.

The microthermometric results suggest that NaCl and KCl are the dominant salts in the aqueous phase ($H_2O - NaCl$ eutectic at $-21,2^{\circ}C$, $H_2O - NaCl - KCl$ eutectic at $-23,5^{\circ}C$; Borisenko, 1977).

This microthermometric measurements are in accord with chemistry data obtained from SEM/EDA (Figs. 2, 3).

An exception is the sample from the Iuda Valley, where the dominant salt in aqueous phase is $CaCl_2$ (Fig. 2). For this sample the ratio of $Cl/S < 1$ (Fig. 4).

For the fluid inclusions from this veins, also the microthermometrical data are different (the temperature of homogenization is higher).

It is no gold deposition connected to this type of fluid.

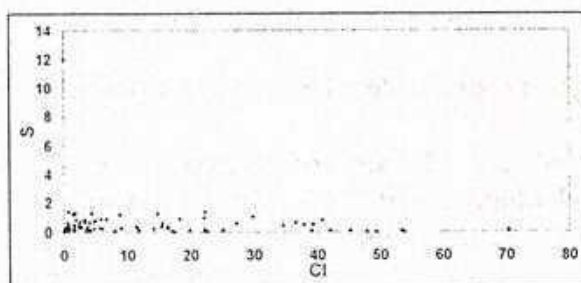


Fig.3 Cl versus S in samples from Caselor and Ghimbav Valley

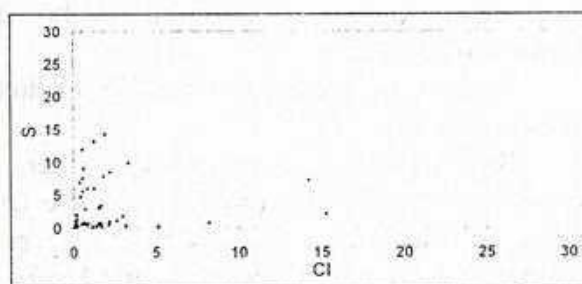


Fig.4 Cl versus S in samples from Iuda Valley

Conclusion

The gold was transported in chlorate complexes by fluids with NaCl and KCl the dominant salts in the aqueous phase.

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NEW PHASE IN THE COMPANY DEVELOPMENT - INVOLVEMENT IN ENVIRONMENTAL PROTECTION IMPACT STUDIES AND ENVIRONMENTAL AUDIT PREPARATION

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The Ministry of Environment, organized as per Government Decision 983/1990, approves *The norms regarding the content of the technical documentation necessary for obtaining the environmental agreement* and *The List of activities for which an environmental study is to be submitted along with the documentation for requesting the environmental agreement*.

Until then, *the Technical execution projects and the Reports regarding the seismic prospecting* used to treat the ecological aspects of the field activity only from the organizational, administrative point of view, in order to obtain environmental agreements according to Order 212/1981 of the National Council for Environmental Protection.

A team of professionals of the Geologic-Geophysics Department of the Hydrocarbon Section has prepared the first answers to the requests of the newly set up Territorial Agency for Environmental Protection. Initially it was endeavored to solve the problems seemed to impeditment the beginning of the field works because the seismic prospecting was not included in the list approved by Decision 113 of 26 November 1990.

The Environmental Protection Law (no. 137, published in the Official Monitor, part I, no. 304, of 30 December 1995) is the first normative act involving the geologic prospecting, not the seismic prospecting in particular, among the activities for which the environmental agreement is necessary to be obtained.

It is still for the Environment Protection Agencies to decide whether the Impact Study is or is not necessary.

Based on the provisions of Order 125 of the Ministry of Waters, Forests and Environmental Protection (published in the Official Monitor part I, no. 73, of 11 April 1996) various documentation files have been prepared and submitted to the Environmental Protection Agencies which issued a *Technical and Methodological Guide for environmental protection* and have requested that the documentation to include the Impact Study in order to issue the Environmental Agreement or Authorization.

Due to the non-unitary interpretation of the legal provisions by these agencies, an important group of approximately 30 geophysicists, geochemists, and geologists have attended a training course in 1997 at the *Institute of Research for Environmental Engineering* in Bucharest. Finalized with a graduation certificate, the training endeavored to resolve with more authority the problems related to obtaining the agreement necessary for beginning the field activity of seismic prospecting.

The legal documentation at the Ministry of Waters, Forests and Environmental Protection in January 1997 was presented in 1997 in front of the *Commission for certification* and the result was that the Certificates EIM-1-124/103 and BM-1-103/104 to the company Prospectiuni SA - as **Impact Studies Maker and Environmental Auditor** for activities in the field of **energy (production), wastes and packaging disposal and other works** which led to including our company on the list of Agencies of Environmental Protection on the date of 6 May 1997.

The requests of the Agencies of Environmental Protection were satisfied; however, the preparation of the impact studies for its own activity was ceased by the cumulative effect of various normative acts issued subsequently by the Ministry of Waters, Forest and Environmental Protection.

ADVANCED AQUATIC TECHNOLOGY ASSOCIATION prepared in 1993 for AMOCO ROMANIA which was going to start working in the BUZAU area an Impact Study of seismic prospecting on the environment which actually represents also a sort of guide for many agencies of environmental protection in the country. The Americans declared what they will do, where, when, how and with what risks for the surrounding population. In the mean time they prepared their team which was going to work here, not to be surprised by the difficulties which could be incurred. The strict non-seismic aspects, treated like in an encyclopedia, the multitude of maps, the drawings, the measurement tables, the various domains related to our activities have

created an overview of the area.

Taking this study as a model, we have accomplished the first frames for the impact studies in the prospecting areas in that year.

First, we thought it would be better to prepare studies for each area in particular and only if this was requested from the territory. Four such impact studies have been realized and from these studies, 16 excerpts have been drawn for personalized areas which have been presented to the Environmental Protection Agency.

We have assessed that much information was redundant, irrespective of the working area and we have agreed that these studies have been performed according to large geological units: Getic, Moldavian, Pannonian, Transylvanian Depression, Moesian Platform and North Dobrogean Cape.

Twelve such impact studies have been effectuated between 1994 and 1995 for many working areas and they have submitted to 25 Agencies of Environmental Protection.

Necessities regarding follow up and control have led to the conclusion that these impact studies should be achieved according to beneficiaries, which have also been presented to the Agencies of Environmental Protection and we have obtained the first environmental agreements.

Many trips were necessary as well as a significant work of presentation and promotion of the activity of seismic prospecting in order to obtain a more correct interpretation of the environmental legislation in order to choose a better way to assess the qualities of seismic prospecting and environmental protection. Personalized impact studies have been effectuated for the territorial agencies of environmental protection.

Recently we intend to research the legal possibilities for the Agencies for Environmental Protection to accept the Impact Studies for the activity of seismic prospecting, wherever it is developed in the country, and to obtain a general environmental agreement for the whole year.

Only 28 such impact studies have been carried out between 1997 and 1999 for the working area and they have submitted to 45 Agencies of Environmental Protection.

On 7 April 1999, according to the provisions of Order 125/1996 the documentation necessary for renewal of the certification as Impact Studies Maker and Environmental Auditor is submitted and presented to the Commission for certification of MWFEP (MAPPM) and we have obtained it.

Today, we are in the position of environmental auditors with experience, participating even in the interpretation of the Environmental Law in relation with the seismic prospecting for the territorial agencies.

We have also participated in the Environmental Audit - level zero, prepared by the company *NHN Ecoinvest srl* and we have obtained the environmental agreement for privatization purposes.

SOME ASPECTS CONCERNING THE FORMATION EVALUATION OF THE QUATERNARY AQUIFER COMPLEX, IN NORTH DOBROGEA USING D.C. RESISTIVITY DATA

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For an area located in North Dobrogea, on the Taita Valley, some old VES data (1985, with another initial purpose) were re-processed and maps of the geoelectrical parameters were sketched. Their hydrogeological interpretation allowed the selection of sectors with the most promising prospect for ground water of the aquifer linked in the Quaternary sediments (Rosca, 2000).

In these sediments, where the alluviums are prevailing, the facies change rapidly. Thus, the clay material, that is present either as beds with limited expansion or as disseminations, may influence negatively the aquifer production. Though on the 1:50.000 - 1:25.000 scales, the VES data allowed to make a satisfactory selection of the most promising sectors for ground water, the final decision to perform a new drill hole must be taken only after analyzing the real hydrogeological conditions at that location.

As, most of times, there is a lack of information concerning the direct hydrogeological observations, they may be replaced, at least partially, by a vertical electric sounding carried out on the projected drill hole location, by the evaluation of the formations revealed by VES. This implies the using of terms and, to some extent, the calculation procedures employed in hydrocarbon reservoir engineering, with peculiarities that are specific of the aquifer complex. The paper presents some aspects concerning the procedure of aquifer formation evaluation using the VES data and "in situ" measurements that were acquired in 1985.

The formation evaluation consisted in the estimation of the true resistivity of the rock (ρ), the resistivity of clean, loose, saturated rock (ρ_0), the formation factor (F), the porosity (Φ), the content of clay (c), the resistivity index (I_p) and the water saturation of the rock (S_w). The resistivities of the saturation water (ρ_w) were obtained on water samples.

The Formation Factor. The electrical resistivity of the rocks is given mainly by the resistivity of the water that is contained in the pores of the rock, by the porosity and by the structure and the shape of the pores. The pore structure is difficult to approximate in terms of conventional geometry and the efforts to describe it had only a moderate success. In the specific case of the Quaternary clastic sediments, the pore structure is described as intergranular spaces.

Though by laboratory measurements and even by calculations various formulas were obtained, the actual opinion (Keller, 1988) is that the most satisfactory expression to describe a saturated rock resistivity is Archie's formula: $F = \rho_0 / \rho_w = a / \Phi^m$ (Cretu, 1981), where a = coefficient given by the lithology of the rock; m = the porosity exponent or the cementation factor; the other symbols are as in the 1st paragraph. Nomograms for saturated, loose, clastic rocks ($a = 1-1.65$; $m = 1.3 - 2.15$) were used.

In the case of Quaternary alluvia, loess, and loess like rocks in this region, before the porosity determination from the formation factor, another operation must be accomplished. This is based upon the fact that the alluvium sediments consist of clastic rocks (sands, gravels, pebbles, cobbles, boulders) interbedded in a clayey complex, a more or less graded facies variation between these types of rocks existing, as well. There is no evident sorting of material in the

clastic rocks. The clay may be disseminated in the clastic rock, or inserted between the clastic rocks beds. Often, these sediments are a mixture of clastic elements with different dimensions and in various proportions of clastic elements and clay. On higher land areas, upon the alluviums complex and, also as insertions in it, loess and loess-like rocks and a few fossil soil layers are present.

Since the VES method includes several beds (clastic rocks + clays) in a single electrically equivalent layer, the resistivities of the saturated clastic rocks insertions (ρ_s) were obtained with the formula $1/\rho = (c/\rho_c) + [(1-c)/\rho_s]$ (Georgescu, 1982), where: ρ = the resistivity of the unconsolidated, saturated formation; ρ_c = the resistivity of the clay fraction; c = the estimated content (in %) of clay. For the ρ_s determination, several nomograms were computed ($\rho_c = 10 - 30 \Omega m$; $a = 1 - 90 \%$). Only now the formula (1) may be used to calculate F and Φ .

The effective porosity. The dimensions of the constituting elements as well as the presence of clayey minerals have a major significance upon the water retention capacity of the Quaternary formations. This capacity lowers with the decreasing of the dimensions of the constituent elements and, also, with the increasing of the clay content. For some rocks the water retention capacity may reach to higher values (23 % - for fine sand; 40 % - for sandy clay). These values must be extracted from the total porosities when estimating the ground water supply.

The water saturation. The above-presented items refer to 100 %-saturated rocks located under the hydrostatic level. Upon it, the pores are only partially saturated and this situation may be noticed by the behavior of the rocks resistivity.

The water saturation of the rocks may be obtained with the formula: $S_w^n = \rho_0 / \rho_1$ (Keller, George, 1988) where n = saturation exponent.

The resistivity index is: $I_p = \rho_1 / \rho_0$ (Rosca, 2000) with the symbols in the 1st paragraph. Named also humidity index, it offers informations concerning the upper resistant cover consisting in the unsaturated rocks layer that covers the aquifer complex; also, I_p allows the identification of the hydrostatic level on the VES curve.

The calculations for VES performed in the water wells close proximity revealed that:

- the collectors have porosities $\Phi = 25 - 45 \%$;
- the effective porosities are $\Phi = 20 - 40 \%$ for large elements gravels, reaching to $\Phi = 15 - 35 \%$, even lower, for fine sands; the loess has effective porosities $\Phi = 5 - 25 \%$, depending mainly on the clay content, being thus, many times, a weak collector;
- the water saturation calculations for the upper unsaturated layer (dry cover) showed $S_w = 40 - 80 \%$; the larger values of S_w were noticed after significant rains or as the result of the water spread by the irrigation system during the field data acquisition;
- comparing the unsaturated formations resistivities (the resistant cover) with the resistivities of the rocks within the aquifer complex (conductive complex), usually: $I_p = 1.2 - 2.3$ and seldom $I_p > 3$;
- the lower limit of the of upper unsaturated layer revealed by VES data is usually smaller than the water table depth, possibly due to the capillary fringe.
- the formation evaluation from VES data may be a valuable tool in the estimation of the prospect for ground water in a certain sector, though this evaluation is not as accurate as that obtained by the calculations using the geophysical well logging data;
- the final results will prove to be satisfactory only if the VES center will coincide or will be in the close proximity of the projected well location.

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THERMOCHEMICAL TREATMENT OF QUARTZ

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Thermochemical processes for purifying quartz are focused mainly on decrepitation (heating quartz to a temperature of at least 573°C, corresponding to $\alpha \rightarrow \beta$ quartz transition, and then suddenly cooling in water) followed by acid dissolution.

This flowsheet has been applied in some laboratory researches but the obtained results presented in the literature are not conclusives.

The aim of this paper is to carefully verify this flowsheet. The applied flowsheet comprises the following steps: crushing < 6 mm; magnetic separation; heating at 600 or 900°C with or without NaCl; cooling in water; drying; grinding for 15 minutes; hot HCl solution treatment; screening. Three quartz samples from three quartz deposits (Uricani, Ilova,

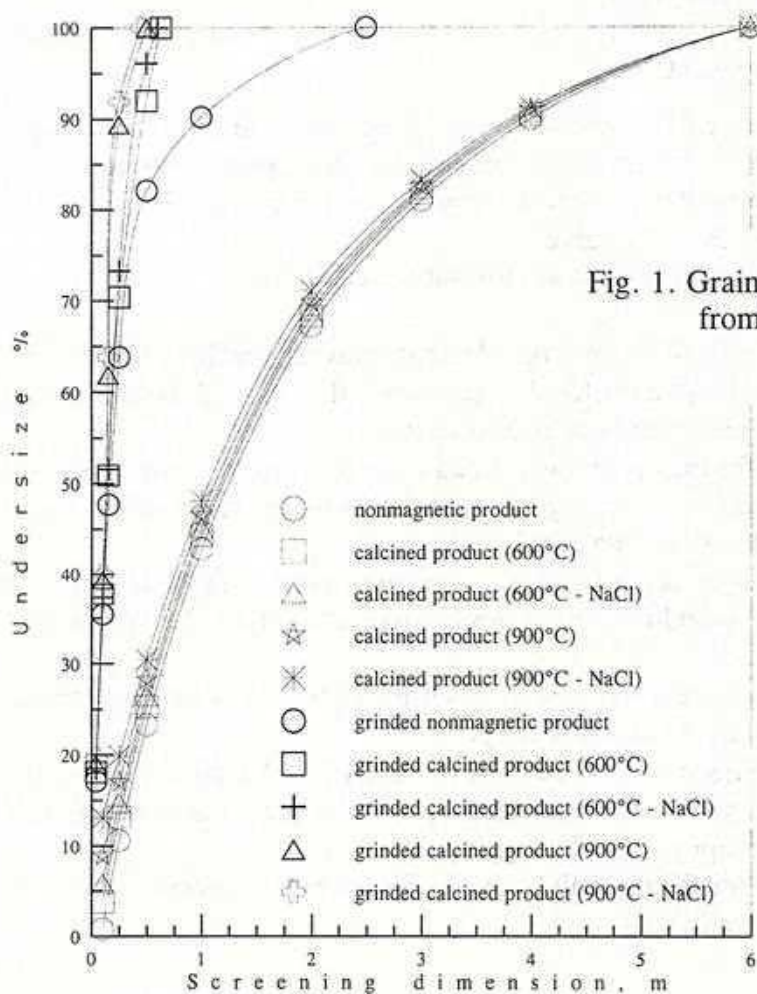


Fig. 1. Grain size curves of the obtained products from quartz sample of Uricani.

Varciorova) were used for the tests. The all obtained products were analyzed to determine their grain sizes and chemical composition (by AAS method). The obtained results are similarly for all three samples. The results obtained with the sample of Uricani are presented in this paper. The grain size curves of the obtained products are presented in Figure 1. From this figure some ascertainments can be made, as follows: grain size of the quartz does not change by heating at 600 or 900 °C followed by cooling in water; NaCl has no any influence on the grain size of the decrepitated quartz; grain size of the grinded calcined quartz is finner than that of the grinded uncalcined quartz (nonmagnetic product), the bigger the calcination temperature the finner the grain size of the grinded calcined quartz(grinding in the same conditions).It follows that the decrepitation of quartz does not change significantly its grain size, although some volume expansion, lowering of hardness and increasing of grindability are produced. This is the explanation of finner grain size of the calcined quartz.

Table 1. Contents of impurities of the obtained products.

P r o d u c t			Massic distribution, %	C o n t e n t, p p m							
				Al	Fe	Ca	Mg	Na	K	Mn	Total
Sample			100,0	131	320	45	18,5	28,5	32,0	6,0	581,0
Nonmagnetic			91,9	128	243	45	17,9	30,1	33,9	7,0	504,9
Calcined		600 °C	91,9	127	242	36	17,7	30,1	33,8	6,9	493,5
		900 °C	91,9	125	239	35	17,2	29,8	33,8	6,8	486,6
Purified	600°C	+0,04mm	75,3	102	79	15	7,8	22,3	23,2	4,6	253,9
		- 0,04mm	16,6	179	650	49	33,2	49,0	50,6	15,5	1026,3
		Total	91,9	116	182	21	12,4	27,1	28,1	6,6	393,2
	900 °C	+0,04mm	74,9	93	73	10	6,0	22,1	21,1	4,5	229,7
		- 0,04mm	17,0	206	646	59	35,7	48,6	58,4	15,3	1069,0
		Total	91,9	114	179	19	11,5	27,0	28,0	6,5	385,0
			°C	Al	Fe	Ca	Mg	Na	K	Mn	Average
Solubilisation degree, %			600	7,3	24,8	41,7	29,9	9,0	16,9	4,3	20,3
			900	9,1	25,1	45,7	33,1	9,4	17,2	4,4	20,9

The authors are pleased to acknowledge the contribution to this paper (chemical analyses) by Mrs. Julieta Rusu and Mrs. Paula Gheorghiu (S.C. Prospecțiuni S.A., Bucuresti).

The contents of impurities of the obtained products are presented in Table 1. From these data the following remarks can be made: Fe and Al are the most important impurities present in the sample; the total content of impurities from the sample can be lowered by magnetic separation from 581 ppm to 505 ppm; by calcining the nonmagnetic product the total content of impurities is lowered insignificantly (from 505 ppm to 494-487 ppm); the total content of impurities of the calcined product is lowered after grinding and HCl treatment to 393-385 ppm, the most important lowering being for Fe; by screening the purified product at 0,04 mm, the fraction bigger than 0,04 mm has the lowest total content of impurities of 254-230 ppm, the most important lowerings are for contents of Ca, Mg and Fe (the solubilisation degree is of 41,7-

45,7%, 29,9-33,1%, 24,8-25,1%, respectively). It follows that the decrepitation of quartz does not changes significantly the chemical composition of the quartz, only hot HCl treatment of grinded calcined quartz lowers significantly the contents of Ca, Mg, and Fe. The smallest solubilisation degrees are for Mn (4,3-4,3%), Al (7,3-9,1%), Na (9-9,4%). From the above presented results it follows that the decrepitation of quartz does not change significantly neither its grain size or its chemical composition but improves in a great measure its grindability. Hot HCl treatment of the grinded calcined quartz produces some lowering of contents of Ca, Mg and Fe, but no more than 46%.

Thermochemical treatment of quartz is a very expensive purification method and produces only a partially purification of some of the impurities present in quartz.

HIGH SULFIDATION EPITHERMAL GOLD MINERALIZATION IN THE FANCEL-LAPUSNA CALDERA, EAST CARPATHIANS, ROMANIA

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The Fancel-Lapusna caldera is the second largest volcano in the Calimani-Gurghiu-Harghita volcanic chain. The caldera is a roughly semicircular depression, open southward, with an E-W diameter of ca. 10-km. It has formed ca. 7 million years ago as a consequence of a voluminous explosive eruption, which interrupted the growth of a large composite cone. During the cone-building stage rock composition evolved from basaltic andesites to dacites. Further andesitic-dacitic domes emplaced along the caldera rim belong to post-caldera activity. The interior of the present-day caldera depression exposes pre-caldera volcanoclastics and unroofed intrusive bodies. According to petrographical and new K-Ar dating, some intrusions predate (>9.5 Ma) all products of the volcano and some have been assigned to post-caldera stage (represented by diorites and granodiorites), suggesting resurgent updoming of the central part of the edifice. Significant hydrothermal alterations are restricted to the interior of the caldera, mostly centered on the intrusions with two main areas: one in the west and other in the east. Types of hydrothermal alterations include propylitic, argillic, silicic and carbonatic. Roughly concentric silica and argillic alteration developed on the background of previous propylitic alteration. The presence of several centers of silica alteration suggests that the main pathways controlled the circulation of the late stage, low-temperature hydrothermal solutions, corresponding to independent intrusions inside the caldera. Preliminary soil sampling at the interior of caldera show two large gold anomalies centered on the most intensive silica-argillic alteration areas (with gold up to 123 ppb). Field observations corroborated with drill-core observations of alteration-mineralization pattern show a complex zonal arrangement centered on the eastern post-caldera intrusions. In an earlier intrusive stage (andesitic-dioritic), hydrothermal magmatic solutions gave rise to propylitic alterations. In the latest post-caldera stage of intrusions the hydrothermal solutions developed a complex alteration zonality: in the central part biotitic, enveloped at the upper part by a chloritic, as a transition to former propylitic alteration. The uppermost envelope belongs to argillic and silicic alterations which were recognized to

represent high sulfidation epithermal system. Mineralization patterns follow the hydrothermal alteration zonality. Metallic minerals occur in an intricate network of veinlets and as impregnation in the hydrothermally altered host rock, suggesting the presence of a stockwork type mineralization. Copper mineralization is centered on the biotitic zone (chalcopyrite+magnetite>pyrite). Base-metal mineralization (pyrite+sphalerite+galena) is superimposed mainly on the chloritic and argillic zone. Gold mineralization (pyrite) is mostly centered on silicic alteration. Alteration-mineralization displays additional complexities, related to multiple intrusion events, brecciation and consequent multiphase overprinting.

WATER CHEMISTRY AND HYDROCHEMICAL PROCESSES ASSESSMENT IN ZONES WITH LAND SLIP IN BUZAU AND VRANCEA, SE ROMANIA

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Water contribution to land slip occurrence is controlled by general hydrological survey components. The terrains affected by land slip in the Buzau and Vrancea counties show a poor vegetal cover and specific morphological characteristics which can favour water infiltrations in the underground. The ways that facilitate water infiltration and circulation in the underground - even in case of terrains where clays prevail - are fissures specific to dry clays or are related to the slip plane, either in the detaching zone (slip front), or on sides (lateral "crevasse"), or on the slipped surface, by unevening. The contribution of precipitations in underground can have a significant role, not an accidental one, land slip being related to periods with precipitations rich in intensity and/or duration.

The direct effect of water infiltration through the deposits caught in the slip causes the going up of hydrostatic level, having many consequences in terms of slope stability, among which the diminution of the cohesion in the mineral particles inner part and among minerals, with the flowing particles involving.

Several targets have been followed:

- the differentiation of origin or chemical reaction of waters from active and passive zones;
- the simulation of chemical processes that determines potential differences between waters that characterize active zones, over those from passive zones.

The mineral paragenesis was determined in two cases:

- in strict conformity with the elements analyzed in the laboratory;
- by introduction in calculation of Al^{3+} , with a concentration within limit allowed by total compensation of electrical balance ($\sum anion_{mE/l} - \sum cation_{mE/l}$).

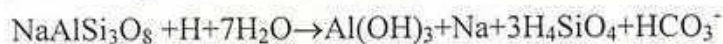
Over the passive zones, the waters from active zones present a surplus of mineralization that appears mainly by silicates alteration. This process is an non-congruent dissolution, because secondary alteration products appear, as well: silicates, hydrates, simple or hydrate carbonates, hydroxides, more easily soluble forms, and it is accompanied by HCO_3 and silica (H_4SiO_4) release in water. This aspect is pointed out by rising of saturation indices at minerals from specified categories and at colloidal or amorphous silica forms. This difference was pointed out by joining of indices corresponding to a semi-stable zone with indices corresponding to passive zone.

The alteration minerals appear in several stages, as a result of some reactions modes, impossible to control based on the present data. In some references (Harder, 1976), mentioned by Appelo and Postma (1994), Mg^{2+} is an element of first importance in forming clay, low temperature minerals.

By simulating the diopside ($CaMgSi_2O_6$) dissolution, up to equilibrium, with a given solution, one can remark its significant contribution to the mineral paragenesis. Following the diopside dissolution, carbonates result in secondary minerals.

The subsequent dissolution of dolomite determines supersaturation with calcium and its precipitation under the form of calcite.

This reaction effect is noticed in $Si_{dolomite} < Si_{calcite}$ reaction. Except for pyroxene dissolution, the non-congruent dissolution of feldspates is also possible, resulting alteration minerals, under different acidity conditions:



Following the reactions, Na^+ (in case of albite) or Ca^{2+} (in case of anortite), silica and HCO_3^- are released in water. The cation can be retained in gibbsite and/or kaolinite, minerals insoluble in the pH (6,6 < pH < 7,6) interval, found in chemical analyses. In case of Al^{3+} dabbling it was simulated the mineral paragenesis from the supersaturation of minerals in a state, fact that confirms these minerals insolubility.

The alteration processes take place at the limit aired/flooded zone, under conditions of partial pressure of CO_2 , within $10^{-2.5} - 10^{-1.5}$ atm. The dissolution of carbonic gas in water allows the acidization necessary to the carrying on of the described processes. This fact is indirectly shown by the relatively great values of the resulting HCO_3^- .

For the water from stable zones the HCO_3^- analyzed concentrations vary between 683.3 - 1000.4 ppm, except for an. 12 (spring next to active zone, q, 0.1 l/s), with $HCO_3^- = 341,6$ ppm). The laboratory analyses indicated pH_{max} 7.6, pointing out that the critical value for kaolin is pH = 8, after which this mineral becomes unstable and is dissolved.

The existence of sorption (adsorption and ionic exchange) processes can explain silica hydrating and the presence of hydrate carbonates associated or not with acid carbonate forms and, also, apart from the salts and carbonates dissolution, they can contribute to the prevalence of Na^+ and Ca^{2+} cationes in the analyzed waters. As concerns the increase of the vulnerability over the slip process, it is interesting to mention that the magnesium silica alteration determines a Mg^{2+} and Si^{4+} availability in water. Under low acidity conditions, and mainly in the presence of mica, these cations participate in ionic exchanges and create the possibility of montmorillonite clays occurrence. The typical example consists in the process of substitution of aluminum by the silicium in the muscovite network (illite forming), substitution of K^+ cation by Mg^{2+} (within illite) and Mg^{2+} cation hydration (montmorillonite forming).

The alteration final products, either of clay (kaolinite) or hydroxide character (gibbsite), are insoluble within (6.6 - 7.6) pH interval, that characterize the studied waters, but the alcalinity increase (pH > 8) should contribute to the decrease of the cohesion forms by kaolin dissolution.

The alteration intermediate products (mica, carbonates), by their absorption capacity and/or ion exchange, contribute to the diminution of cohesion forms by hydration.

In the presence of Mg^{2+} and Si^{4+} cations, available by pyroxene (diopside) dissolution, mica can turn into montmorillonite, clay mineral among those with lowest resistance and flow limit, because of its greatest hydration potential.

The aggressiveness difference between the waters that characterize the active zones over the passive ones is due to a difference between an underground circulation at superficial level reduced, from the active zones, and an almost stagnant state of water from the passive zones.

The difference of chemical reaction between the analyzed waters is pointed out by the values of minerals saturation indices, obtained by hydrochemical modelling and also by the trend of majoritary ions grouping on Piper's diagram and it represents a slip vulnerability indicator.

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MINOR ELEMENTS IN PEGMATITE MUSCOVITE OF THE SOMEȘUL RECE-IARA VALLEY PEGMATITE DISTRICT

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The pegmatite bodies of Someșul Rece-Iara Valley Pegmatite District are hosted by medium-grade metamorphic rocks of the Somes Series (gneiss, migmatites, leptynites, rarely quartzite and amphibolites), enclosed to the west and south by the Muntele Mare Granite body. The mineralogy of pegmatites is simple (quartz, K-feldspars, Ca-Na-feldspars, muscovite and, as subordinate minerals, biotite, tourmaline, garnets); the chemical features show a granite-like composition. Despite this composition, the genesis of pegmatites seems to be metamorphic (Mârza, 1980; Stumbea, 2000).

Muscovite occurs as both coarse-grained (100 cm²) and fine-grained crystals; metasomatic changes have been reported in our former studies (Stumbea, 1999). A geochemical approach on this mineral – in terms of major elements – revealed substitution processes undergone by muscovite: alkali-deficiency substitution, Tschermak substitution, phengite substitution, di- and trioctahedral substitution (Stumbea, 1997).

The geochemical characterisation of muscovite at the level of minor elements is based on a large enough number of analytical techniques: electron microprobe analysis (performed on a CAMECA SX 50), emission spectrography (performed on a PGS-2 JENA), ICP-MS (performed on a Perkin-Elmer 6000 ICP-MS).

In order to find out the way that the amounts of Sn, Ti, Ga and Nb range in respect of the occurrence position in the perimeter we followed the amount values after a SW-NE direction, that means parallel with the anticlinal fold pointed out by Dimitrescu (1994). This approach revealed geochemical anomalies for the four minor elements as follows: positive anomalies for Sn, Ga, Nb and a negative anomaly for Ti; these anomalies superpose each other and they are located in the upper course of the Iara Valley, middle courses of Șoimului and Calului valleys and in the Crișeni area, respectively (Fig. 1). Moreover, similar anomalies have been drawn out for some major and minor elements in pegmatites and in pegmatite-forming minerals as well, by the last researches carried out in the area (Stumbea, 2000).

We believe that this geochemical behaviour can be put down to the development of some late stages (pneumatolytic-hydrothermal) in the evolution of the pegmatite-generating process. In our opinion, most of pegmatite bodies in the Someșul Rece-Iara Valley Pegmatite District rose as a result of metamorphic differentiation process. The geochemical anomalies drawn out in this area, however, might be the evidence of some anatectic events, that melted the

metamorphic rocks; this melt acts as a magmatic system, evolving toward magmatic differentiation process, with the whole suite of post-pegmatite stages: pneumatolytic and hydrothermal stages.

The minor elements concentration values (k) measured for pegmatite muscovite of Someșul Rece-Iara Valley Pegmatite District (Table 1) reveal the part played by this mineral in the Sn, Ga, Nb, Be and Li accumulation. On the other hand, the significant accumulation of all minor elements in muscovite samples from pegmatite bodies hosted by granites is obvious.

Generally, the amount of most minor elements we have followed in the muscovite of Someșul Rece-Iara Valley Pegmatite District (Mn, Sn, Ti, Nb, Ga, Cu, Pb) matches to those published by Murariu (1979) for occurrences in the Rodna Mountains, by Murariu and Maria Dumitrescu (1976) for occurrences in the Preluca Mountains and by Hann (1987) for occurrences in the South Carpathians.

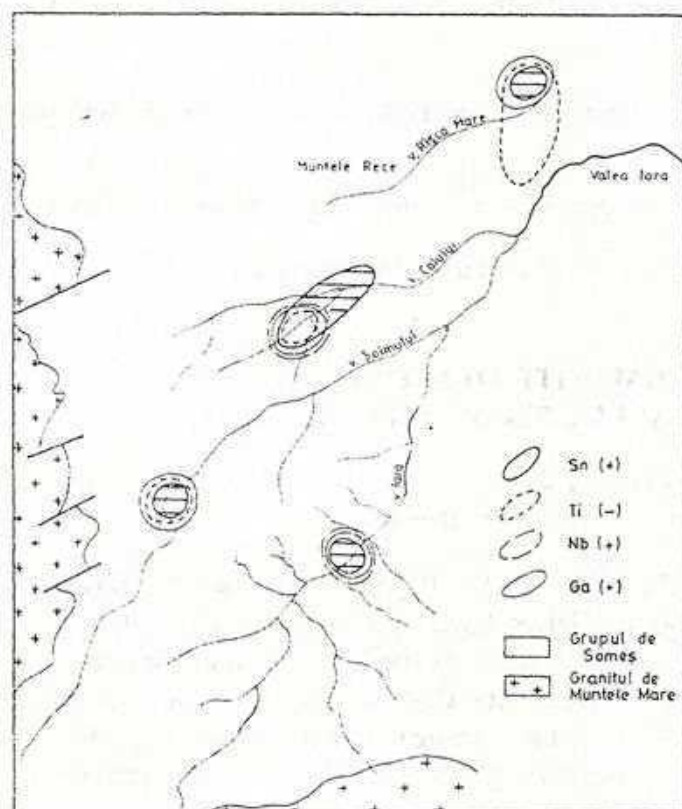


Fig. 1 Sn, Ti, Ga and Nb geochemical anomalies for pegmatite muscovites in the Someșul Rece-Iara Valley Pegmatite District (from Stumbea, 2000)

Table 1 Minor elements concentration values (k) in pegmatite muscovites in the Someșul Rece-Iara Valley Pegmatite District

Element	Sn	Nb	Be	Li	Ga
Prm	84	4.10	3.55	3.42	3.16
Prg	141	6.70	5.55	3.75	4.40
Element	Pb	Mn	Cu	Ti	Rb
Prm	03,0	0.25	0.20	0.20	
Prg	0.07-0.52	0.30	0.80	0.18	

Prm-muscovite of pegmatites hosted by metamorphic rocks; Prg-muscovite of pegmatites hosted by granites

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A PROPOSAL FOR A GEOCHEMICAL MAP OF ROMANIA

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These days pollution problems, national priorities in the world, as well as the necessity of base metal contents knowledge in environment, determined many countries or international organizations to promote regional geochemical mapping programs.

These maps illustrate the distribution in surface, in different sampling targets, of different metals with economic concentration or environmental value very useful in the following domains:

- petrogenetical districts limitation, with low elementary variability, from metallogenetical districts with high natural variability;
- rich content heavy metals values zones limitation caused by pollution;
- useful base data for epidemic statistic studies concerning some degenerative human, animals or crops diseases.

In the last decade the environmental protection and rational utilization concept, as a fundamental component of development projects, was determined on a national and international level. Thus, to adopt the scientific fundamental measures for lithosphere and hydrosphere protection, UNESCO and UNEP promoted two interdisciplinary projects:

- The protection of lithosphere as an environment component (1979-1984);
- Geology and environment (1984).

The major conclusion of the projects is that the environment utilization has to control the geological and geochemical circumstances which interfere with the upper part of the lithosphere. The best results in this respect of some national specialized institutions was the elaboration of geological atlases and maps on various scales (Austria, Finland, Norway, Germany, United Kingdom, Sweden etc.). Unitary projected, those researches followed many elements or components in different targets (rocks, soils, superficial and underground waters, stream sediments from rivers and lakes, or vegetation), at sampling scales to cover the largest part or entire territory of a country. Generally, the regional geochemical maps elaboration was

coordinated in the last decade by the European Geological Research Forum (FOREGS), by a special domain work group (RGM). This group elaborated a three-year (1988-1990) project for drawing up regional geochemical maps by using a low density of collecting samples. This program objectives were to prepare elaboration of a regional geochemical maps set for the whole Western Europe and to establish the limits of using only the samples from sediments to working out these maps.

Although our program for drawing up regional geochemical maps is not yet integrated in the European institutions, the achievements are, at least, noteworthy. During six years, there were collected from an about 5,800 sq. km area a number of 23,500 soil samples, 8,750 rock samples, 3,852 samples from the fine fraction of the present sediments, 3,250 plant samples and 1,340 samples from springs and active water flows.

All the samples were analyzed for 20 elements by spectral methods (in emission, absorption or plasm I.C.P.), and the data were interpreted according to applied geochemistry criteria. Using heavy metals values, the maps of their distribution in the sampled media were drawn up.

The field working methods were based on the recommendations of Lowering et al. (1950), Rope, Howks and Weeb (1981), Garrett and Nichol (1967), Grigorion and Bens (1967), Morozov and Sokilov (1981) concerning sampling representativity and reproductibility aspects. The data obtained as a result of heavy metals distribution processing and comparison on sampled areas are extremely suggestive and important for the further regional geochemical maps drawing up programs.

Thus, the following were established:

- the main mineralized and potentially mineralized areas were delimited, using lithogeochemical, pedogeochemical and stream-sediment samples;
- the contaminated areas were outlined, mainly by mining work, using stream-sediment and water samples;
- the plants biogeochemical changes, due to the excessive presence of some heavy metals, were performed;
- the geochemical migration aspects, in different media, of some noxious metals (Pb, Cd, As) could be compared;
- an optimal, strict and efficient methodology for elaboration of a geochemical maps atlas for the whole Romanian territory was established.

ELECTROGRAPHIC IMAGES OF MINERALS AND ROCKS

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The luminous images of the minerals and rocks have been recorded on blue sensitive, Rx films in the laboratory, by subjecting the sample to the high voltage electric field and medium/high frequencies. The electric field received its energy from the power source by charging; by discharging as monoimpulse it transforms it into luminous and thermal energy.

The studied minerals (rocks) belong to the rocks with ionic conduction. At least for these rocks, the electrographic differentiation is based on the solid-fluid-gas relation, within the context of the interaction phenomena with the energetic radiation.

In case of the studied rocks the luminous effects depend mostly on the presence of aqueous solutions. In the absence of free water, which means a reduced porosity of the rock, the luminous manifestations are much diminished finally even a lack of image being observed. The higher the capacity of water retaining in pores (adsorption) is the higher the information content of the electrographic images obtained.

From the chemical point of view, water is an ideal ampholite, being both acid and basic at the same time. The hydrated study rocks (Pl. I 6-7) rendered evident spatially equilibrated luminous effects both in the distribution of the anodic streamers and in that of the catodic ones.

The dielectric constant, electric conductivity and pH of the water, in correlation with the hydrolysis constant, stability constant and stability product define mainly the capacity of the rock to yield luminescence.

The electroluminescence of the minerals (rocks) can partially be modified if the quality of water (fluids) contained in pores changes.

In the tests carried out by us we used distilled water ($\epsilon \sim 80$, $\delta = 2 \cdot 10^{-3}$ mho, pH ~ 6.7) and aqueous acid solutions consisting of distilled water and chlorhidric acid (pH 4) or basic aqueous solutions formed of distilled water and sodium hydroxide (pH ~ 8.5).

The electrographs obtained for the rocks treated with acid solutions (pH 4) showed that the ampleness and amplitude of the luminescences are changing (as compared to the same hydrated rocks, pH 6.7), generally in the sense of their amplification. In case of the rocks treated with basic solutions (pH 8.5) the modification of the luminescences is not univoque; however, the diminishing of the luminescence is generally observed.

In case of the oil-bearing rocks the situation is different, that is no luminescence occurs, even if the rocks are in native state or hydrated. When treated with acid solution (HCl), typical luminous structures occur both on the contour and inside the sample at discharge in divergent electric field.

In conclusion, by treating the rocks with acid or basic solutions one can either strengthen the luminous effects or, on the contrary, diminish the luminescence. Only the free water (pH 6-7) determines on/in the hydrophite porous body of the rocks equilibrated electric and luminous structures.



*Fig. 1 Moistured alabaster
positive (+) and negative (-)
electrographical images
(the cut form with 4X4X1.5 cm sizes)*

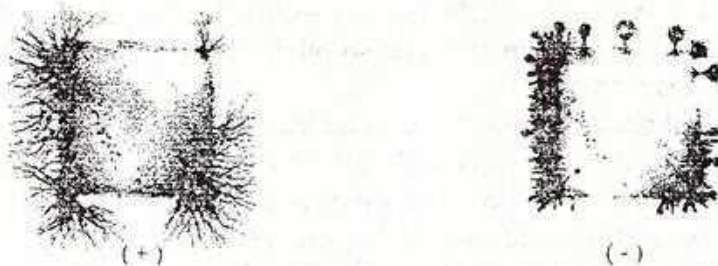


Fig. 2 Moistured sandstone positive (+) and negative (-) electrographical images.

Technical aspects of experimental investigations:

1. Laboratory standard conditions:

Temperature $\sim \pm 5^{\circ}\text{C}$; Temperature of water solutions: $18 \pm 2^{\circ}\text{C}$

Pressure: 760 ± 10 mm/Hg; Humidity: 9.42—17.32 g/m.

2. Typology of samples

	Samples	Locality	Mineral assemblage, physical and chemical specific features
1	Sandstone	Mehadia	Quartz, micas, feldspar, Fe-hydroxides. Total porosity -0.43-0.73%; absorbness of water -0.16-0.38%; SiO_2 -67.44%; Al_2O_3 -14.58%; Fe_2O_3 -4.03%; MgO -3.13%; CaO -2.2%; Na_2O -4.89%; K_2O -2.1%
2	Granular gypsum	Pucioasa	Gypsum, anhydrite, quartz, argillaceous minerals, chlorite. Total porosity 10.89-11.29%, aparent porosity absorbness $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ -95.15%; SiO_2 -0.62%; Al_2O_3 -0.35%; water -3.10%
3	Granular gypsum	Pucioasa	Gypsum, anhydrite, clay
4	Talcose schist	Lelese	Talc, chlorite, opal, antigorite, chrysotile, calcite. CaO -33.1%; MgO -14.1%; SiO_2 -28.4%
5	Salt	Praid Slanic	Halite + argillaceous minerals + chrysotile, calcite. Gaseous hydrocarbons. NaCl -96-98%
6	Zeolitic tuff	Apuseni Mts.	Calcite, quartz, albite, zeolites, chlorites-illite, argillaceous minerals (montmorillonite)
7	Magnesite	Tisovita	Magnesite, hydromagnesite, chrysotile; MgO -34.74%; SiO_2 -29.55%;
8	Sandstone with oil	Lucacesti well 145	Quartz, micas, heavy minerals

OUTLINING OF A NEW SALT ACCUMULATION EAST OF GURA-SLANIC, TARGU OCNA DEPOSIT

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Exploration by wells of a salt accumulation generally involves continuous mechanical sampling and chemical analyses of cores to determine their NaCl content. Thus, a continuous geochemical profile in salt is obtained, giving information about salt quality (particularly NaCl content). As continuous mechanical sampling and chemical analyses are very expensive, this study proposes a new method to achieve continuous geochemical profiles in salt proceeding from the relationship between gamma natural log and NaCl content.

The study area is placed in vicinity of Gura Slănic, Târgu Ocna salt deposit where eight exploration wells were drilled. In four of those wells mechanical continuous sampling was performed, and in all of them usual borehole-geophysics (i.e. caliper, electrical standard log, natural gamma log and neutron-gamma log) was carried out (Fig. 1). From our experiments the best correlation between NaCl content and log recordings in salt appears for natural gamma log. The way of calculating NaCl content using these logs is, as follows:

(1) fix an origin point, and through this point draw a "basis line" so that further measurements refer to this line;

(2) measure values of curve minimum amplitude ($I_{\min}$) and maximum amplitude ($I_{\max}$) recorded in salt;

Well S12 Est

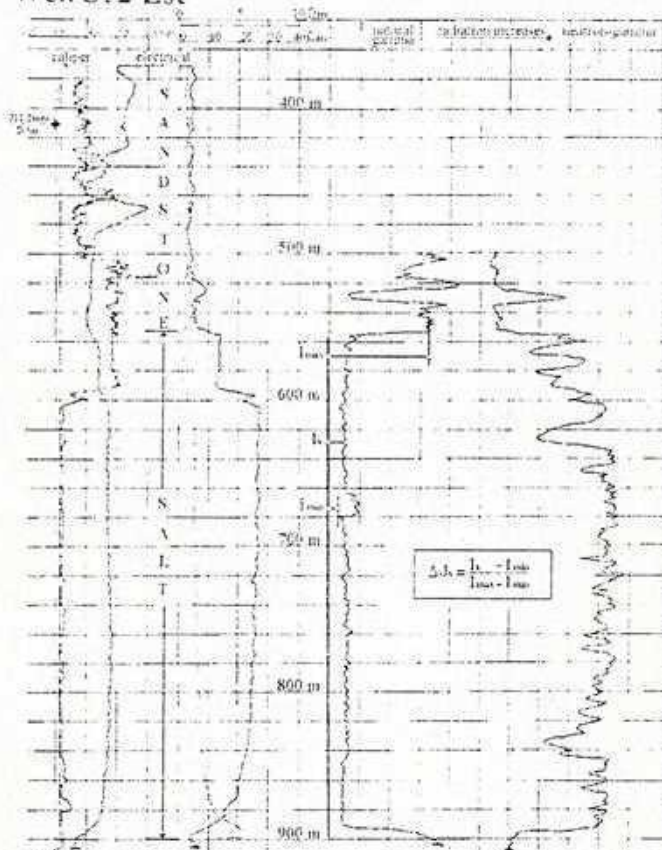


Figure 1. Calculation of relative size (ΔJ) of natural gamma radiation.

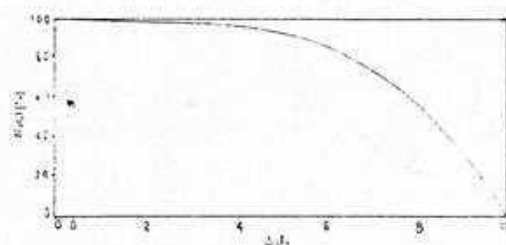


Figure 2. Relationship between NaCl content and relative size of natural gamma radiation.

(3) calculate relative size of natural gamma radiation ΔJ_x , with relation:

$$\Delta J_x = (I_x - I_{\min}) / (I_{\max} - I_{\min}) \quad (1)$$

where I_x is gamma radiation value at given depth ;

(4) use the value of ΔJ_x in graph from Figure 2, which shows the relationship between ΔJ_x and NaCl content, to de-termine the corresponding value of NaCl content.

Using of relative size of natural gamma radiation (dimensionless) allows us to avoid drawbacks due to using of different units for gamma log (impulses per minute or API units), radiation background and tool type. This way NaCl can be established in wells where no continuous mechanical sampling was available. To verify method accuracy we compared NaCl contents from chemical analyses with those calculated by our method, for four wells in which both geochemical profile and natural gamma log were available. A very good correlation can be observed as residuals analysis gives a mean residual error of 0.73% and a standard deviation of 1.23%. Use of this method allows us to draw up geochemical profiles in wells where these are missing. Using overall data maps for various horizons and sections with NaCl content isolines have been drawn up. Such a section is shown in Figure 3.

In order to calculate salt geological reserve a map with the Salt Formation thickness was drawn up and correlated with maps and sections with NaCl content isolines.

In order to support manager decision salt reserve has been calculated using "Monte Carlo" simulation method. Risk assessment curve resulting from this method, in terms of risk and geological reserve (Fig. 4), shows that for a minimum risk of less than 10% a reliable value for geological reserve between 206.4 and 412.3 billion tones is obtained.

Summarizing, this study achieved a new method to estimate NaCl content using natural gamma log, which facilitates calculation of geological reserve for a new salt accumulation placed east of Gura Slănic, Târgu Ocna salt deposit.

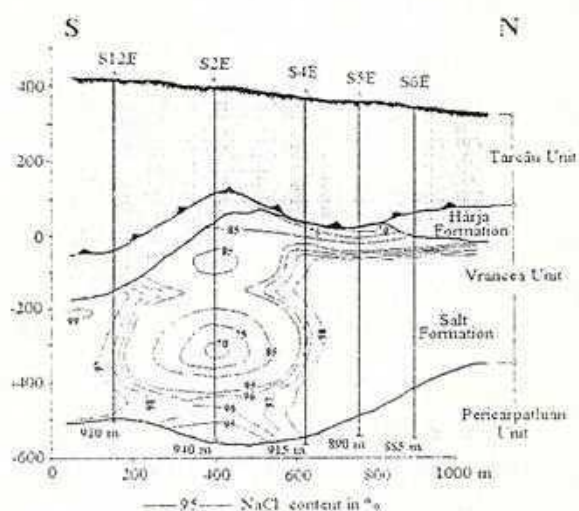


Figure 3. Geochemical section through the new salt accumulation, east of Gura Slănic.

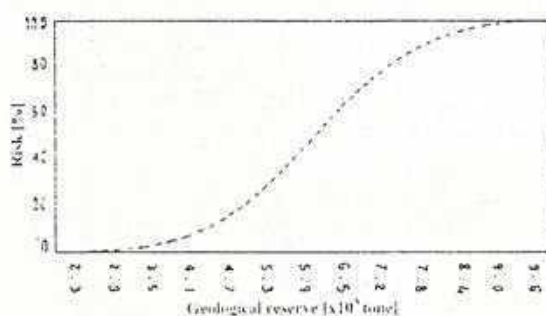


Figure 4. Risk assessment curve for calculated salt geological reserve.

GEOPHYSICAL CONTRIBUTIONS TO UNRAVELLING SOME TECTONIC AND METALLOGENETIC STRUCTURAL ASPECTS IN THE OAS-GUTĂI-TIBLES MOUNTAINS AREA

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The paper presents the results of geophysical and geological data integrate interpretation performed by the author in time, within the Oas-Gutai-Tibles Mountains Neogene volcanic chain, referring to the pre-Neogene basement structure and tectonics of the region, to the structure of buried Neogene volcanite in the Livada zone and to the geoelectrical methods contributions to the vein mineralization research, with examples on the Căvnic-Roata mineralized structure.

The Oas-Gutai-Tibles Mountains represent the north-west segment of the Neogene volcanic range of the East Carpathians on the Romanian territory.

According to Kovacs' model (in press), the volcanic segment of the Oas-Gutai Mountains was generated by magmatic processes from the Alcăpa microplate (partly also in Tisia-Getia) due to European plate subduction below it. The beginning of the volcanism took place at about 7-6 M.a., from the beginning of the Miocene subduction (22 - 20 M.a., in the Burdigalian, respectively). The volcanism in the Oas-Gutai-Tibles Mountains took place during the oceanic lithosphere subsidence and using-up, having the climax a little earlier than the continental plates collision (considered to occur at about 10 - 9 M.a.). It has a calc-alkaline character, specific to subduction zones.

The general geological structure of the Oas-Gutai-Tibles Mountains includes, apart from volcanites and sedimentary formations of the Neogene adjacent basins, structural units of the prevolcanic basement. These are part of the Transcarpathian flysch zone (Dumitrescu, 1962). This name was assigned to an area located between the Baicului-Ticău-Preluca crystalline islands in the South and East Carpathians Crystalline-Mesozoic zone to the north and east. It is made up of several tectonic units, considered as nappes of Lower Miocene age - Piennine nappes - represented by Babesti-Ticovo Nappe, Kricevo Nappe, Botizei Nappe, Piennine klippe, wildflysch nappe, Petrova (Magurs) Nappe, all these overthrusting the posttectogenetic cover of the units with Cretaceous tectogenesis (Inner and Middle Dacides).

Associated to the volcanic arch are the hydrothermal deposits that represent one of the largest zone with metallogenetic potential in Europe - Baia Mare region. The hydrothermal mineralizations are of epithermal type, mostly polymetallic, but also gold at the upper part. The structural control of the mineralizations is tectonic and magmatic. The tectonic one is made up of the Carlibaba - Carei transcrustal fault and the strain fractures related to it (NE-SW and NW-SE). The structural-magmatic control is given by the batholite from the southern zone of the Gutai Mountains (to the extent this can be definitely proved) and by the complex volcanic structures, with associated intrusions. The mineralizations are of vein type and only subordinately of pipe breccia type. The vein has some hundred meters in length, up to 5 km, and a thickness of 0.5-8 meters; the vertical extension is ranges between 300 and 1000 meters.

Within the Oas-Gutai-Tibles Mountains area, in the last 40 years the whole range of geophysical survey (gravity, air- and ground magnetism, air- and ground radiometry, electrometry, magneto-telluric logging, refraction and reflexion seismometry) was applied. In different stages, there were performed works on the geophysical data available at the respective

time including a series of structural and metallogenetic interpretative models. Also, there were performed 2D and 3D physical-mathematical modellings of the gravity and magnetic data presenting quantitative models in terms of structure of batholite in the southern part of the Gutai Mountains, of igneous rocks in the Livada zone, as well as the structure of crystalline and pre-Badenian sedimentary formations, of volcanics and Neogene sedimentary formations.

The present paper presents a series of the author's interpretative models, referring to the crystalline and pre-Badenian sedimentary formations structure, 2D gravity data modelling, on some seismic data from Livada zone directions, as well as a series of metallogene aspects deduced from geoelectric data interpretation in the Cavic-Roata zone and the adjacent areas.

The pre-Badenian basement structure is illustrated on maps with isobaths of the crystalline basement relief and of the pre-Neogene sedimentary formations relief (upper limit of the Paleogene), respectively. These images were obtained on the basis of 3D gravity modelling and of integrate interpretation of gravity and seismic data, in correlation with the results of the mining and drilling works.

Essentially, the structural maps quantitatively show the very complicated morphology of the crystalline basement and pre-Neogene formations relief, because of an intense partition of the formations, in blocks, with relatively up and down moved positions, among which more ample or reduced unevenings, with more or less steep slopes, occurred. The pre-Neogene basement partition was made according to three fracture systems, directed as follows: E-W, representing underlatitudinal fractures field with turnings towards ENE-WSW and, sometimes, WNW-ESE, out of which the most important is the Carlibaba-Carei line, NW-SE, representing G13 line (Gavat, 1963) fractures field and the new ones, directed NE-SW. Initially, the correlated action of the two first fracture systems caused or enhanced the axial up and down movements, often with outstanding extensions on the line, with general E-W directions in the central-western part of the area, and with NW-SE ones in the eastern part.

Subsequently, the fracture system with a NE-SW trending brought about the oblique-transversal fracture of the blocks individualized in the first stage of partition, giving to the pre-Neogene basement a mosaic aspect.

Referring to the buried volcanics, 3D magnetic data modelling (Crahmaliuc, 1998) presumes that in the Livada zone there are acid igneous rocks, intruded in crystalline formations, with a series of summits that also pierce Paleogene formations. The 2D gravity and magnetic data modelling on the path of some seismic lines crossing E-W and N-S this plutonite area, proves that, actually, there is an acid lava flow that moulds Paleogene and/or Badenian formations relief, specifying also the main volcanic systems that generated it. The unravelling of the deep evolution of the microdioritic subvolcanic intrusive body at Tamaseni, as well as the pointing out of other microdioritic subvolcanic bodies in the Dealul Mic - Turulung zone, was also possible.

An important role in the vein mineralizations research was played by geoelectric studies, by induced polarization and apparent resistivity methods, that often represent direct methods of outlining such mineralizations. For example, we mention the geoelectric research results in the Cavnic - Roate zone. It is a case study commenting the interpretative hypotheses at the date of performing these researches, in comparison with the results of the checking-up by mining works and drillings carried out subsequently.

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STREAM-SEDIMENTS IN THE TÂRSA-OBÂRSA ZONE (APUSENI MOUNTAINS, ROMANIA)

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Natural processes as erosion, conveyance, accumulation and concentration of mineral associations from a subaerial area into the hydrographic network represent a facility used in the geological survey by simple methods, as *dosca* and *pan concentration* and *stream-sediment sampling*, both scanning with high fidelity the gold and base metals deposits and their associated facies.

In 1998, we tried to establish the presence of alluvial gold by sluicing with *dosca* and *pan* in the Târsa-Obârșă area, Banatitic Province (Gaina Massif, Bihor Mountains). Besides, we sampled stream-sediments on a depth less than 0.30 m, and the fraction less than 1 mm was assayed for gold and spectral for other few elements.

This method of sampling stream-sediments at depth greater than usual offers more valuable information about the distribution of gold, which tends to concentrate in deep alluvial structures (recent unsorted sediments, small sand bank left above water surface after annual flood, gravel in the rim of minor riverbed etc).

The study of heavy minerals concentrate at binoculars revealed mineral associations as a result of worn-away primary lithofacies. They appear intermingled and reflect local geostructural configurations, as bellow:

- The chlorite, milky quartz, muscovite, magnetite, ilmenite, sphene, apatite come from denudation of green schist facies which lies in Ariesul Mic basin;

- The translucent and milky quartz, garnet, amphibole, biotite, tourmaline, etc., are the result of amphibolitic facies erosion, reiterated in the Upper Cretaceous sandstone, lain in the central-southern part of perimeter and in the Neogene deposits of the south-west side;

- The sugary cavernous quartz, the opalescent and the milky ones, feldspars, amphiboles, pyroxenes, zircon, apatite, sphene, magnetite, etc. proceed from felsic igneous rocks of the Banatitic Province;

- The amphiboles, pyroxenes, glauconite, calcite, ilmenite, magnetite issue from ophiolites occurring in the Obârșă and Ociu valleys;

- The translucent quartz, carbonates, epidote, sphene, magnetite, ilmenite, pyrite, etc., belong to the hornfels occurring in the Ociu, Obârșă, Vâlcele, Piuă, Tomnatec, Giurgești valleys;

- The euhedral garnets, frequently aggregated, brown, black and green colored, milky quartz, magnetite, sulfides - occurring on the northern rim of Obârșă Banatite stock - come from

skarns;

- The milky quartz, the microsugary and the euhedral ones, calcite, tourmaline, magnetite, ilmenite, iron hydroxides, sulfides gold, etc., represent the entire association denudated from hydrothermal structures of the area and constitutes the main aim of our research. Based on local variations, the following sectors could be separated:

Râul Mic, in which base-metal sulphides (Cu, Pb $\pm$ Zn) prevail;

Rotunda – Divaia – Divaia - Toha - Dobranii (Ariesul Mic), with much alluvial gold and less metal sulfides and silver;

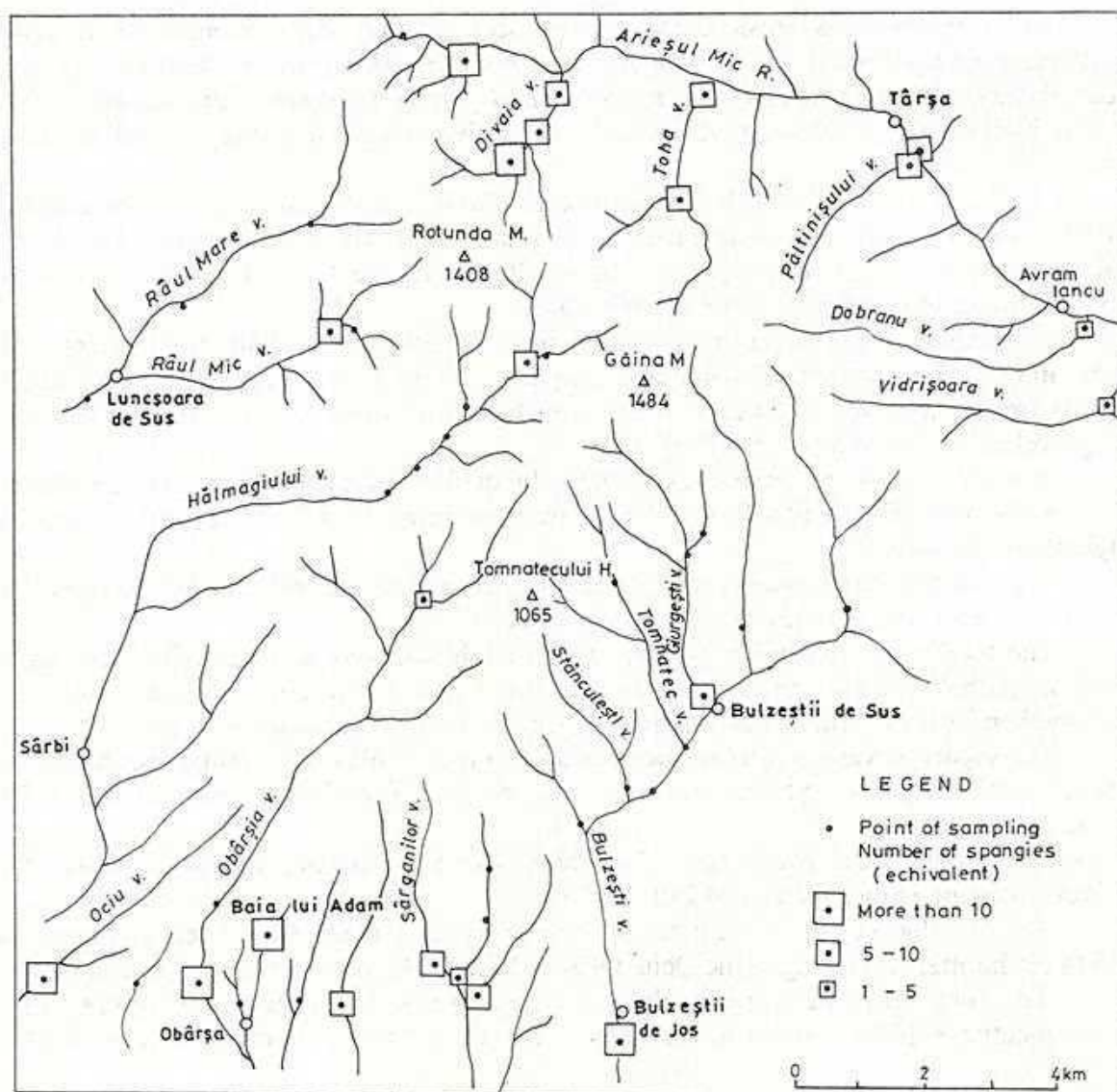
Tomnatec Valley - Giurgesti Valley, with Pb, Zn, sulphides and silver;

Bulzesti valley-down-stream, with much gold and less pyrite, silver, concretionary lead;

Darjanilor Valley - Obârșă Valley - Vâlcele Creek - Piua Creek - Baia lui Adam, with pyrite and gold in alluvia and in an old waste-dump;

Ociu Valley - Certej Creek - Tarnita, with pyrite, sporadically galena, sphalerite and much alluvial gold.

Figure 1, representing the distribution of alluvial gold, reveals clusters of samples with a high content in the north and south of the area.



As for the origin of alluvial gold, the autochthonous character is obviously given by the hiatus of the Neogene transgression over the Cretaceous deposits or over the crystalline formations within the area (this one could have released, by erosion, an allochthonous gold belonging to the southern Neogene metallogenic province).

The morphologic features of gold, dominated by subisometric granular shapes, slightly elongated and flattened, smaller (0.1-0.5mm), but with complex, amoebic, bigger shapes (Baia lui Adam, Divaia, Toha, Bulzești down-stream), or even like grains preserving the outline of a crystal (Baia lui Adam) plead for a weak transport or even a break of it (Baia lui Adam case).

Nevertheless, it is possible that the alluvial gold at Golfesti (Ociu Valley), at the south-western limit of the area, much quantitatively and with large size of grains (3-4 mm), found in the contact zone with the Neogene formations, to have an allochthonous feature in relation with the Banatitic province.

The distribution of the metal contents in alluvial samples (unconcentrated, taken at depth of 0.30 m) charged the elements: Au, Ag, As, Cu, Pb, Zn.

High contents of Cu, Pb and Zn have been noticed in the north-western part of the area (Râul Mic - Divaia Valley - Ariesul Mic - Halmagel Valley), marking a well-known sector mineralized with metal sulfides and gold (Râul Mic) and new ones (Divaia Valley - Ariesul Mic - Halmagel Valley), previously recorded only by silver sulphides mineralization occurring at the issue of the Halmagel valley.

The contents in As and Au have different distributions in relation with Cu, Pb, Zn ones and each other. High contents of gold have been pointed out in the northern part, in Divaia Valley, Toha, Paltinis, Dobranii, Ariesul Mic, and lesser in the south, in the Obarsa Valley, Inelului Creek and Stanculesti Creek.

The study of alluvia concentrates in the central-eastern part of the Bihor Mountains completes the images of the Banatite metallogenesis with a developed stage of macroscopic free gold.

The authors' experience gathered in the last years in gold survey domain, beside the actual technology of the unit, suggests the adoption of methods - geological, geochemical, geophysical - gradually and efficiently blended. The progressive survey, by the complex study of alluvia (stream sediments, heavy minerals concentrating on dosca and pan, inventory of metallogenic litters) leads to the fast identification of sectors with metallogenetic processes. Then, geological and geochemical survey focused on these sectors could bring new data for the future particular steps of detailed research just on these well-established structures.

THE MIOCENE ROTATION OF THE FORELAND IN FRONT OF THE SOUTH-EAST CARPATHIAN BEND

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The numerous papers published so far concerning the tectonic evolution of the Carpathians have failed to explain satisfactorily the formation of the important bend as well as its great subsidence.

The presence of some thrust faults in the foreland (end Badenian - Early Sarmatian) genetically related to two major strike-slip faults, the change of direction of some former

foreland structures, the coeval formation of compressional structures and extensional ones, account for the clockwise rotation model of the block confined between Intramoesian, Peceneaga-Camena and Trotus faults (the last fault is indicated only as position because it was not involved in the deformation at that time).

The occurrence of block rotations inside a shear zone is well known. Obviously, due to the space problems needed by the accommodation of rotations, the corners of the block involved in rotation determine compressions; "triangle" extension zones appear, as well.

During the end Badenian - Sarmatian the Moesian Platform underwent a strike-slip deformation carried out on NW-SE fault system.

Since the motion along the Intramoesian fault (see also the figure) was greater than that on Peceneaga-Camena fault and due to the rheology difference between the Moesian Platform and North-Dobrogea Promontory, the rotation of the block and the areal distribution of the zones which experienced extension and compression, respectively, were controlled in the eastern part by a couple of antithetic shears (senestral).

The north-eastern and south-western corners experienced compressions accommodation by two thrust fault systems in Birlad zone and Lipia-Conduratu, respectively (the latter is covered to the north-west by the Subcarpathian Nappe).

The western edge of the block recorded the greatest subsidence and corresponds to Sarmato-Pliocene Zone, the model of rotation explaining well this important accommodation space for the sediments.

Although the thrust system did not record reactivation after that time, the fact that Intramoesian fault is being active at present could account for some earthquakes recorded in Vrancea area.

THE EVOLUTION OF THE LITA - NENCIULESTI - TALPA FAULT SYSTEM AND THEIR INFLUENCE FOR THE SEDIMENTARY SEQUENCES AND HYDROCARBON POTENTIAL

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This paper presents the Lita - Nenciulesti - Talpa fault system evolution and its implication in the Upper Jurassic - Albian sedimentation.

This fault system is situated in the central area of the Moesian Platform, partially superposed on the so-called Rosiori-Alexandria Depression. It was recognised and tracked discontinuously many years ago, but the existing papers did not try to point out its character.

Further more, many paper on facies distribution have been published on this area but exclusively based on well data.

The Lita - Nenciulesti - Talpa fault system has a roughly semicircular SW - NE shape and cuts Permo - Triassic or older up to Miocene - Pliocene ones suggesting that they could be active to data.

The features of this fault system suggest a strike slip type with left-lateral movement.

The evolution of this fault system influenced the sedimentation especially for Upper Jurassic - Neocomian time. The area on the foot well block was favorable to reef and another carbonate build - ups all along the fault trend during Lower Cretaceous.

The area on the hanging well block was favorable for a turbidite facies and to fan depositional system sedimentation on the same time.

The long time evolution of the fault system influenced, may be favourably the hydrocarbon potential of the areas situated around them.

GEOLOGICAL, TECTONIC AND METALLOGENETIC SYNTHESIS OF THE EAST CARPATHIANS CRYSTALLINE-MESOZOIC ZONE (ROMANIA)

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The lithostratigraphic successions of metamorphic formations in the Central-East Carpathians are distributed to five base lithostratigraphical groups (litho-groups): Bretila, Rebra, Negrisoara, Tulghes and Rodna. The Rodna Group, according to Balintoni (1997), comprises the Rusaia, Repedea and Cimpoiasa Variscan series in the Rodna Mountains. Some metamorphical rock successions with limited extensions, like Argestru, Tibau and Steghioara series, are located in zones with strong distortions in the Bucovinian and Subbucovinian nappes basement. Chiril, Mandra, Poiana Grebin and Balaj series, present only in the western part of the Rarau Prealpine Nappe occurrence, in the Bucovinian Alpine Nappe, are considered as parts strongly distorted in the Rarau Prealpine Nappe basement (Voda, Balintoni, 1994).

Structurally, the general background is that described in the papers published by Sandulescu (1984) and Balintoni (1997), extended also in the Maramures Mountains. There were considered the frontal digitations of the Bucovinian Nappe: Sadova, Tarnita, Grebin, Chicera. The Subbucovinic Nappe digitations, delimited in the Bistrita Mountains (Krautner et al., 1990; Podasca, Moga, 1992; Voda, Munteanu, 1995), named Sveiteria, Dadu-Orata, Tonca, Litu and Stanei Valley, are considered stemming from the inner (western) part of the Subbucovinian domain, next to the domain from which Bucovinian Nappe frontal digitations came.

The East Carpathians Crystalline-Mesozoic Zone is partitioned by important transversal faults, with detachments of complex evolution, inclusively before the Mesocretaceous tectogenesis. With obvious effects there are: Vaser Fault, Dragos-Voda Fault, Somesului Fault, Crucea-Zugreni Fault and Darmoxa-Grinties Fault.

Noteworthy is the observing of Miocene retro-overthrust (retro-chevauchement) zone limitation in the Maramures Mountains at the tectonic compartment limited by Dragos Voda Fault and Vaserului Fault.

South of the Darmoxa-Grinties Fault, Putna Prealpine Nappe in the Bucovinian Nappe bed is made up of the Tulghes Group successions, having different features and limited as prealpine overthrust nappe: Sandominic Nappe and Balan Nappe (Krautner et al., 1988) in the South Gheorgheni region. More complicated is the situation of the units made up of formations of the Tulghes Group in the Tulghes zone, where there several structural units were delimited: Banatul Mare, Corbu, Sandominic (Ionescu, 1999). Under similar conditions, in the Harlagia zone, two structural prealpine units were considered as being digitations of the Putna Prealpine Nappe in the Bucovinian Alpine Nappe bed. The interpretation uniformizing imposes consideration of the Balan Nappe and Sandominic Nappe as Putna Nappe (Voda, Munteanu, 1998) prealpine digitations, upper and lower, respectively.

Recent results obtained by drillings at Sarul Dornei, where, under the Borcut-Ulm Infrabucovinian Nappe, inferior to the Iacobeni Infrabucovinian Nappe, was intercepted a slightly metamorphosed formation, Variscan, easily correlatable with the upper part of the Rusaia Series, determined a new analysis of the Infrabucovinian structural units situation. There are, for the first time, expressed relations between the Infrabucovinian units with Permian and Mesozoic sedimentary covers and those in the Rodna Mountains, without Mesozoic sedimentary covers and having not demonstrated the alpine age. Thus, in the Vatra Dornei - Sarul Dornei zone, the geometric arrangement of the structural units known under the Subbucovinian Nappe is (from top to bottom): Iacobeni Nappe, Borcut-Ulm Nappe, Sar Nappe (in drillings). At Rusaia, Iacobeni and Borcut-Ulm the Infrabucovinian Nappes are missing, as well as in the Rodna Mountains. These spatial relations argue an external initial position for the structural units with Variscan covers, at least over the Iacobeni and Borcut-Ulm domains. It is possible that the position of the Rodna Mountains type units should mark a prealpine relationship, of other type than those recognized in the Bucovinian and Subbucovinian protodomains.

The East Carpathians Crystalline-Mesozoic Zone metallogenesis shows multiple aspects. The most important metallogenetic processes are those in correlation with the basinal context of successions containing syngenetic ores. Thus, the Vaslabeni Carbonatic Formation, of the Rebra Group, contains Valea Blaznei Pb-Zn mineralizations (Udubasa et al., 1983), formed under conditions of carbonatic sediments on a passive continental margin zone. The well-known sulphide mineralizations of the Tulghes Group, from Baia Borsa, Fundu Moldovei, Lesu Ursului and Balan, as well as manganese (Dadu-Orata-Oita; Iacobeni; Dealul Rusului) and baryte (Holdita-Brosteni) mineralizations can reflect a metallogenesis related to the basinal evolution in subduction context, of back arc type basin. The relationship between mineralization and rhyolitic volcanism is of geotectonic context; the acid volcanism products come from the arc, whereby the ore deposit is fallen out in a marginal basin.

Another chapter is represented by the epigenetic alpine mineralizations - related to the contraction period from Upper Triassic - Middle-Upper Jurassic, effect of the Transylvanian Ocean, eastern zone and Outer Dacides opening. There are especially known the mineralizations of the Bucovinian Nappe and Subbucovinian Nappe, of baryte (Ostra, Pintec, Pangarati), of baryte, sulphides, carbonates and iron oxides (Gemenea, Slatioara, Delnita), sulphides (Paltin, Fluturica), uranium (Crucea, Tulghes) and those of Mo, TR, Pb, Zn etc., related to the Ditrau alkaline massif.

In the presented metallogenetical systematizing, the mineralizations of "shear zone" type, in course of research at Sarul Dornei and Cosnita, in the Infrabucovinian Nappes of Borcut-Ulm and Iacobeni, are inserted for the first time in the East Carpathians.

AREAS OF PARTICULAR GEODYNAMIC INTEREST IN ROMANIA AND ECONOMIC IMPLICATIONS OF THEIR STUDY

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Interest in the present Romanian geodynamic research, knowledge of earthquakes consequences and places of occurrence and reduction of losses provoked by them, constitute the object of the work we are proposing.

Being under compression from the Pontic area towards Dobrogea and the East Carpathians bend, and crossed through the centre of Transylvania and Banat by the suture of the Tethys Ocean, our country's territory is a place of occurrence of many earthquakes, sometimes of high magnitudes, reaching disaster proportions.

The huge objectives of industrial civilization (the Cernavoda nuclear power station, big plants, big pipelines, big bridges, big blocks of flats damaged by previous seisms, showing a high risk of collapsing), are extremely vulnerable to earthquakes.

Earthquake causes are only partially - and in a general way - known. With the means at his disposal, man cannot stop their occurrence. But the better known and understood the mentioned phenomena are, the smaller place remains for hazard and the possibility is growing, through an adequate information, to reduce the losses of lives and the material damages they can provoke.

Taking into account the major importance of the earthquakes for our country in general, the Institute of Geodynamics carries out systematic studies in the framework of the Caldarusani-Tulnici Astrogeodynamics Polygon, which has, located in its northwestern area (Vrancea seismogenic area), more than 200 marks of special construction, forming an ensemble of micropolygons; in the framework of this ensemble, the space-time evolution of some of the parameters causally related to the cumulating/occurrence of strong Vrancea earthquakes is monitored.

The results of the research carried out up to now and their social-economic implications are presented in the proposed paper

ELASTIC PARAMETERS OF ROCKS SITUATED AT 5-7 KM DEPTH IN THE CĂLDĂRUȘANI-TULNICI GEODYNAMIC POLYGON

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On the basis of various physical measurements carried out in very deep wells a method for determining the main stress magnitudes was elaborated by the "Sabba S. Ștefănescu" Institute of Geodynamics of the Romanian Academy.

Using such a method a stress study was undertaken within the Căldărușani-Tulnici Geodynamic Polygon (depth interval 5,000 - 7,000 m) whose results were discussed on the occasion of the International Geophysical Conference (April, 2000, Bucharest - Romania).

In an attempt to improve the classical determination of horizontal components - stress

orientation using the so-called "breakout method", we inserted in this concept as a basic rule the compulsory evaluation of differential and effective stresses in order to be sure if the borehole ellipticity is related or not to the far field stress.

Such a task induced the necessity to know the elastic rock characteristic features and this new field of research and applications started one year ago within the Institute of Geodynamics.

As a basis for understanding the relation between elastic characteristics and borehole physical measurements, it seems appropriate to review a few fundamental physical principles and define terms that must necessarily be used.

We established, right from the start, an approximation regarding the real rock behaviour by assuming that a "rock" is a homogeneous and isotropic elastic medium.

A lot of previous works have confirmed that "dynamic" elastic parameters inferred from borehole measurements are greater than those derived in the "static" laboratory conditions. Rock samples dislocated from in situ conditions and tested at given applied stresses for determining their strain evolution, indicated lower values of elastic parameters.

In our study, regardless of differences between physical measurements (electric, radioactive, acoustic, thermal, etc.) the rock is characterized by the following three components:

- the solid matter of which the matrix skeleton is built
- the empty void space of porous rock
- the filling fluid within the void space of skeleton.

According to Hook's law we used in our study the following basic relations between wave velocity, density and corresponding moduli for isotropic and homogeneous media:

$$V_c = \sqrt{M/\rho}, \quad V_s = \sqrt{G/\rho} \quad \text{where}$$

(V_c) and (V_s) = velocities of compressional and shear waves

(ρ) = rock bulk density

(M) and (G) = compressional and shear wave moduli.

These two basic moduli were mathematically linked to the following rock elastic parameters:

- Bulk Modulus representing the applied stress to the volumetric strain (K)
- Shear Modulus representing the applied stress to the shear strain (G)
- Poisson Ratio representing the lateral strain to the longitudinal strain (μ)
- Young Modulus representing the applied stress to the normal strain (E)
- Bulk Compressibility representing the volumetric deformation to the applied stress (C_B)
- Rock Compressibility representing the change in volume of the rock skeleton as a result of a change in applied stress (C_R).

The basic equations, their interrelations, as well as the equations in "well logging terms" (i.e.: velocities and bulk densities) are also completely presented in our paper.

At the same time, according to Terzaghi - Biot - Gassman theory, the significance of Biot constant (α) and confining coefficient (W) were developed.

The needed value of confining coefficient was established using the log inferred - Poisson Ratio, while the rock compressibility was considered (for the depth interval 5,000 - 7,000 m in which the rock void ratio is extremely low) to be zero.

This seems to be true since in that case the intrinsic compressibility of the solid rock material and the compressibility of the rock skeleton are nearly equal.

The Căldărușani-Tulnici Geodynamic Polygon represents a 30,000 km² area, whose shape is more or less a quadrilater delimited by the meridians of 26° and 27°30' and the parallels of

44°30' and 46°, incorporating in its north-western sector the Vrancea zone, where most of the high magnitude earthquakes are generated.

The Pliocene to Paleozoic sedimentary fill in the Geodynamic Polygon subsurface has in some places up to 10 km thickness and belongs to the following two geological units: the East Carpathian Bend Zone and the Moesian Platform.

The main lithological types in the depth interval 5,000 - 7,000 m are the clastics and the carbonates represented by grainstones, wackestones and boundstones, whose void ratios are less than 0.06, excepting the high overpressured rock in which it grows up to 0.12.

As a general rule in the above-mentioned depth interval, the compaction of rocks reached a high degree, while the rock intergranular porosity and non fissured permeability are drastically reduced.

More than 20 deep wells were selected and analysed in our study. Most of the geophysical investigations are coming from the depth interval 5,000 - 7,000 m and include the customary well logging operations: electric resistivity, natural gamma ray radioactivity, neutron/density logs and compressional wave velocity.

In order to overcome the lack of shear wave velocity or density logs in some cases, we appealed to Schlumberger's procedures of curve reconstruction using Wyllie/Raymer/Pickett equations as well as to the "0.25 power" relation. For the same purpose, we elaborated a special dependence graph relating the $\gamma = (V_C / V_S)$ to the Poisson ratio taking the lithological type as a variable.

The lithological types in which (γ) approaches the value of 2 or more are the feldspathic waxes and the arkosic arenites undergoing a slowness in their chemical maturity and/or submitted to high burial rate during the time.

The dynamic elastic moduli and related parameters were evaluated in different compartments of the Geodynamic Polygon.

A table with elastic moduli values obtained in the Geodynamic Polygon is drawn.

Age	JURASSIC	TRIASSIC	CARBONIF.	DEVONIAN
Time (10 ⁶ years)	143 - 205.7	209.6 - 248.2	290 - 354	354 - 417
Depth (m)	6,100	6,500	6,200	5,980
Δt_c ($\mu s/ft$)	87	66	69	70
V_C/V_S	2.03	1.67	1.78	1.76
ρ (gr/cm ³)	2.57	2.67	2.73	2.69
G (G Pa)	7.59	20.34	16.36	16.62
K (G Pa)	21.16	28.86	32.38	42.90
E (G Pa)	20.28	49.31	42.90	41.93
μ	0.34	0.21	0.28	0.26

The calculated values have demonstrated that the elastic moduli are highly dependent on rock porosity and texture, temperature, fluid and solid compressibilities and matrix stress.

As a general rule in the deep subsurface conditions where the rock stiffness is high enough the moduli values increase as porosity decrease and matrix stress increases.

Poisson ratio being an exception, tends to decrease as a function of rock stiffness but in many cases it increases or remains constant.

Both compressional and share wave velocities decrease with temperature elevation but the influence of stress seems to prevail in the very deep sub-surface conditions.

The compressibilities of rock skeleton and fluids follow the same trend as a function of depth but a pronounced reduction in elastic moduli was noticed, caused by gas presence in the rock void spaces.



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