Romanian Journal of
MINERALOGY

continuation of

DĂRI DE SEAMĂ ALE ŞEDINŢELOR INSTITUTULUI DE GEOLOGIE ŞI GEOFIZICĂ
COMPTES RENDUS DES SÉANCES DE L'INSTITUT DE GÉOLOGIE ET GÉOPHYSIQUE
(1. Mineralogie-Petrologie)

Founded 1906 by the Geological Institute of Romania

ISSN 1220-5621

Vol. 76
Supplement Nr. 2

SECOND SYMPOSIUM ON MINERALOGY

5 – 11 July 1993, Timişoara

EXCURSION GUIDE

MINERAL OCCURRENCES IN SOUTHWESTERN BANAT, ROMANIA

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Viorica Iancu, I. Seghedi

I.G.G. 45° N 24° E

Institutul de Geologie şi Geofizica
Bucureşti – 1993

Romanian Journal of MINERALOGY
Published annually by the Institute of Geology and Geophysics, Bucharest
Director Ion Rădulescu

Editorial Office:
Institute of Geology and Geophysics
Str. Caransebeş 1
78 344 Bucureşti-32, Romania
Tel. 65 75 30; 65 66 25
Fax. 010-40-0-12 84 44

The manuscripts should be sent to the scientific editor and/or executive secretary and the correspondance concerning advertisements, announcements and subscriptions to the executive secretary.

This journal follows the rules of the Commission on New Minerals and Mineral Names of the IMA in all matters concerning mineral names and nomenclature.

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Romanian Journal of Geophysics

as well as other publications.

Classification index for libraries 55(058)

Printed by the Institute of Geology and Geophysics

MINERAL OCCURRENCES IN SOUTHWESTERN BANAT

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Introduction

The scope of this Guide is in part related to the interests of the 2nd National Symposium on Mineralogy. The mineralogists will use the occasion of the meeting to find out what the surrounding country has to show of interest to their science and equally, the petrologists will be concerned not only with the important mineral or rock occurrences, but with the complex structural framework of this region. The Guide cannot claim to cover the full strength and variety of southwestern Banat geological environment, but contributors have tried to give a line of conduct to the abundant and spectacular mineral occurrences in this area.

The first part of the Excursion Guide deals with general data concerning the main geological entities of the region. During the excursion, participants might realize that they meet surrounded by the decay of nineteenth-century housing and mining-ware. Indeed, Banat was an important center of mining activity and the first section of the Guide contains numerous informations about its past glories. The southwestern part of Banat is classical for the study of the thermal metamorphic and metasomatic rocks related to Late-Cretaceous—Paleogene magmatites which host most of the important mineral occurrences and therefore, special attention was paid to this topic.

The second section describes the stops scheduled for the excursions. Two different trips were organized. The first one will be devoted to several renowned mineral occurrences from Ocna de Fier and Oraviţa-Ciclova (excursion A.) and will include a short presentation of the unique Gruescu mineralogical collection which summarize the extremely rich skarn assemblages from southwestern Banat. The second one will stress upon petrological occurrences such as the Neogene basalts from Lucareţ and on the Alpine or pre-Alpine structures in Banat.

Part 1 - General Data

1. EARLY DAYS OF MINING AND GEOLOGICAL ACTIVITY IN SOUTHWESTERN BANAT

(Gh. Ilinca)

To an archaeologist, the landscape of southwestern Banat with its fertile lowlands, the natural shelters offered by the numerous caves in the mountains, and the abundant iron and copper ores outcrops, would be the obvious place to expect the discovery of ancient habitation traces. Not surprisingly, the oldest relics of human activity in the region date from 1900 - 1700 B.C., pointing to the transition phase between the New Stone Age and the Bronze Age. Pottery decorated with incised or relief markings, flint blades and axes, and hammered copper awls were found in a nomadic shepherd settlement at Colţan near Ocna de Fier. Mining during this period may not have been anything else but picking the native copper from natural outcrops, yet the smooth shaped tools show careful craftsmanship and speak about a rather prosperous society.

The Bronze Age (about 1800 - 1200 B.C.) saw the introduction of an occupation that was to have vital importance to the region thereafter: namely, agriculture. However, copper mining and processing continued as the finds at Bocşa, Ocna de Fier, Dognecea and Oraviţa confirm. Near the Iuliana quarry in Ocna de Fier, scanty remains of a foundry dating from this period and few of its products: sickles and bronze bracelets, were also found.

The transition to the Iron Age seems to have been beset without difficulties, at least not of a technical nature if only the plentiful iron ores occurring near the surface in the Ocna de Fier region are to be considered. As a matter of fact, the numerous Iron Age slag fields found near Bocşa Montană show an intensely sustained iron processing activity.

The existence of Roman mining within the boundaries of southwestern Banat has not been in doubt for at least two hundred years. The 18th century scholar and explorer Francesco Griselini referred to the existence of a Roman funeral plaque found near some mining wells at Moldova Nouă, most probably testifying to the Roman concern for the copper ores in the area. Indeed, after the war in 106 A.D., when emperor Traian conquered Dacia, the Roman's interest was principally centered on the exploitation of the renowned gold and other metal resources which were close at hand in the central part of the province. A votive plaque found near Zlatna (the former *Ampellum*) is interpreted by modern historians as a solemn oath to the gods for the success of the action:

IOV. INVENTORI
DITI. PATRI TERRAE MATRI
DETECTIS DACIAE THESAVRIS
DIVVS NERVA TRAIANVS
CAES. AUG.
VOTUM SOLVIT

Consequently, a *Collegium Aurarium* was settled in *Ampellum*, which was mainly intended to set technical and financial control over the gold and base metal extractions. With an appointed *procurator aurarium* chosen from Traian's former slaves, the *Collegium* managed to organize the ores extraction not only within *Dacia mediterraneaea* (today's Transylvania) but to expand its activity in *Dacia ripensis* (Banat) too. Here, they dealt mainly with copper ores, but gold, even in minor amounts, was not left apart. Traces of Roman mining were still visible until not so long ago at Craciul de Aur (in Ocna de Fier) where several small galleries and miner's rushlights were discovered. Nearby, at Berzovia (the former *Berzovis*), historical sources mention a celebrated *Schola fabrorum*, within which basic skills of metal processing were acquired.

Little is known about the post-Roman period, but for the later middle ages we have the assistance of some records surviving from 1552, which describe the intensive exploitations of gold in the so-called *Wolfganger Gebirge* and *Reicher Spitz* areas near Ocna de Fier-Dognecea zone.

Following the battle of Mohàcs in 1554, the 164 years during which Banat was a Turkish *pashalik*, witnessed only little or no progress at all in the ore extraction field. Facing a permanent state of war and showing scarce interest in economic development of the occupied territory, the Turks exerted practically no influence in the matter so that the ore pits supplied mainly the raw material for the domestic needs of the natives. Few iron slags and furnaces dating from this period, were found in the vicinity of Moravița Valley and in the Dealovăț Hill in Ocna de Fier. Austrian documents from the second half of the 1700s speak about the *Johanni* mine in Ocna de Fier which was exploited by the Turks and reopened in 1720 with the assistance of local miners who worked there during the occupation, for copper, lead and silver. However, judged by the appearances of the mine, it seemed that the works were older than the Turkish occupation testifying to a constant and sustained autochthonous activity. Even the very old toponym "Bocșa" (a locality near Ocna de Fier) originating in the term *bocșani* — charcoal makers — suggests a permanent need of partly burned wood for metal processing.

After the peace treaty of Passarowitz in 1718, Banat came under Austrian rule which put the province on the threshold of a period of extraordinary expansion. The prime task now was to restore the mining industry; an aim which was largely completed by about 1720 under Charles VI who organized four *Mountainous Offices* in Dognecea, Oravița, Sasca and Moldova, in order to cover the major productive areas. Yet, the availability of skilled miners was scarce among local inhabitants essentially engaged in agricultural production, and the newly established mining school in Oravița produced mainly executive staff unable to meet the demand for people effectively working in the mines. Such were the circumstances that induced emperor Charles VI to enact major privileges for the miners in Banat and to grant "all the possible exemptions form taxations" if someone was to get willingly engaged in mining work. These measures were intended to attract people from the neighboring provinces, but unfortunately, they didn't resulted immediately in providing the desired source of operatives, since many newcomers from Carinthia, Kraina, Steiermark and Tirol were geologists, engineers or civil servants. Nevertheless, the ore extraction begun to acquire industrial characteristics and the southwestern part of Banat witnessed a period of phenomenal development which established the territory of the four *Mountainous Offices* almost as a rival to Timișoara (the capital of Banat) in the determination of fiscal policy. It depended a good deal on improved communications and on heavy and continual capital investment. New metal processing centers were established in Bocșa, Dognecea and Oravița. The outputs were chiefly iron, copper and lead, and some of the ores were send to Annaberg for the extraction of silver. The metals were heavily exported to Constantinopole, Venice, Triest, Poland, Latvia etc. Again, mine operatives were insufficient, but soon, a major immigration from Oltenia and Muntenia has started, bringing thousands of people to work in the mines or foundries and providing a readily available, yet unstable source of workers. " As soon as they earn 50-100 florins, and it is quite easily to make this money in a very short time, many *bufeni* (the name given to immigrants coming from Oltenia) fled the province, and thus, a great deal of money is lost for the country" wrote Johann Jakob Ehrler (1774) in a discussion upon the utility of using foreign workers inside the Empire. According to the author, by that time, Banat produced about 280 tons of copper, 1680 tons of iron and 170 kg of silver per annum..."and things would be even better if an increased number of subjects would acquire the skills necessary in ore extraction". Old documents mention that gold was extracted, too; several mines were opened for gold at Bocşa, Lescoviţa-Zlatiţa, Oraviţa and Sasca, but seemingly, they have been unproductive. Local authorities were equally concerned with alluvial gold deposits connected with Caraş, Nera and Bârzava rivers, which were regularly exploited in those days by groups of nomadic gypsies, but they failed in their attempt to expand this occupation with advantage. Gold indications described by the gypsies were elusive, production was low and unstable, largely depending on rainfall *etc*. Still, the main goal of mining industry in Banat was copper. Mining plans and sketches available in Romanian archives display hundreds of copper mines in a puzzling pattern of galleries and wells. One of them, the mine *Simon und Juda* in Ocna de Fier, was described by Ignaz von Born (1774) as being the richest in Europe: "...all its galleries go in pure copper ore with no sterile, whatsoever". There was in the middle of a new and lasting period of economic progress. Some idea of the expansion of mining industry in southwestern Banat may be gauged from the fact that the currencies supplied from the Empire were quite insufficient for the local needs so that a mint has to be established in Ciclova (a suburb of Oraviţa at the time) where copper coins with a distinctive "O" — for Oraviţa, were issued. A former village with only 77 houses recorded by an official census in 1717, Oraviţa became the economic and financial capital of Banat and the first town within the present borders of Romania to enjoy some technical and cultural achievements like railroads and theatres.

Mineralogical and geological descriptions of Banat had already begun to appear. It is entirely to the credit of pioneers like Ignaz von Born, Francesco Griselini or Johann Jakob Ehrler that the information they put on record tell more about the mineralogical richness of this territory than one can see today. Though somehow naive (for example, Griselini failed to notice the presence of magmatic rocks connected with ores), their studies attempted not only to give a comprehensive inventory of minerals and rocks, but to explain the genesis of the ore deposits, too. Mentions such as *Crystallis spatosa acaulis, crystallis pyramidalibus trinquetris, Cuprum vitratum, violaceum et caeruleum aut rubrum, Granati martialis crystallisatus dodecaedrus obscuroflavus et nigrescens, Asbestus fibris durioribus parallelis, cum granato martialis* or *Mica martialis drusica, squamis concentratis* are perhaps the first mineralogical descriptions ever made here. Noteworthy are the later works of Bernhard von Cotta (1864) who was the first to describe the Alpine intrusive rocks in Banat, which he called *banatites*, and to recognize their consanguinity. His studies upon the Fe-Cu-Pb-Zn skarn deposits of Dognecea, Ocna de Fier and other mines in the Banat area are the first widely cited papers to define a class of "contact-deposits" found at the contact of igneous intrusions of banatites and limestones where "garnet-rock" is found (Burt, 1982).

A new conflict with the Turks in 1837 brought the mining industry of Banat to a standstill and its inhabitants were further impoverished by war taxation. An outbreak of plague in 1840 added to their miseries. Many officials and colonists fled the province and the mining directories have ceased to function. Thereafter, the activity resumed, the *Offices* were re-established, but much apathy became apparent due to the post-war economic crisis and the central authorities from Vienna could no longer manage the mines directly. Thus, the mining fields were leased to individuals *(Allgewerkschaft)* or to co-operative societies *(Grubengewerkschaft)* which eventually became independent under the form of a so-called "free and self-supporting exploitation".

After the social and political movements of 1848, owing to persistent financial crisis, the Austrian authorities have decided to licence some forests, railroads and mines. As a result, the *Kaiserliche und Königliche Privilegirte Staatseisenbahngesellschaft* (STEG) was founded in 1855; a powerful organization which ignored the traditional co-operative system of the leaseholders and even their right to posses mining fields. Though it aroused no open protest from the mine owners, STEG induced heavy bankruptcy among them and soon the small mines have disappeared. However, ore production managed by STEG has continuously increased thereafter, reaching its climax to the end of the 1800s, when about 93% of the iron and coal consumed in Transylvania was supplied by this company. Estimates of 1897 show that Banat produced 146,150 tons of iron, which was ten times the quantity extracted in 1855. Other metals were (in 1870): Au — 36 kg, Ag — 425 kg, Cu — 107 tons, Pb — 21 tons.

In 1920, STEG was taken over by a Romanian company: *Uzinele şi Domeniile Reşiţa* (UDR) which was interested mainly in the iron ores from Ocna de Fier and in the coal deposits from Lupac, Doman, Secu and Anina — very close at hand supplies for the steel works in Reşiţa.

The rest is comparatively recent history. During the 1970s, remainings of the metal resources were still extensivelly exploited, but afterwards, many of the southwestern Banat ore deposits became to small and to poor to supply an ever increasingly requesting industry. However, geological researches have been carried out continuously since then and literature records many and important contributions to the knowledge of this territory. Had the works of the living be permitted much more space would have been required.

2. GENERAL GEOLOGY AND STRUCTURAL FRAMEWORK *(Viorica Iancu)*

The main geological entities in Banat are: a) Neogene-Quaternary sedimentary rocks, b) Neogene basalts, c) Upper Cretaceous-Lower Paleocene banatitic magmatites, d) Metasomatic and metallogenetic products (related to banatites), e) Mesozoic (Triassic-Upper Cretaceous) sedimentary cover, f) Upper Carboniferous-Permian formations and g) Pre-Carboniferous basement.

From a structural point of view the following Alpine units can be distinguished:

— post-tectonic sedimentary cover and associated basalts;

— post-Laramian banatitic magmatites;

— post-Laramian (Upper Senonian-Paleocene) cover, including the volcano-sedimentary formation from the southern part of Poiana Ruscă massif (Maastrichtian);

— post-Austrian banatitic magmatites;

— post-Austrian (Vraconian-Cenomanian to Lower-Middle Campanian) sedimentary cover;

— pre-Austrian Mesozoic cover (Jurassic-Lower to Middle Cretaceous);

— Variscan molasse deposits (Upper Carboniferous-Permian);

— pre-Carboniferous basement;

At regional scale (South Carpathians) one can identify two major Laramian nappes *i.e.*, the Timiş-Boia unit (which includes the northern and western parts of Poiana Ruscă massif) and the Lotru-Bistra unit (Iancu, 1986a; Balintoni *et al.*, 1989). In Banat (Valepai-Buziaş region), the Timiş-Boia Nappe may be referred to as the "Upper Supragetic Unit". The Austrian nappes from the Banat region are: Bocşa, Tâlva Drenii, Moniom — the "Lower Supragetic Units" (Iancu, 1986a), Reşiţa (Năstăseanu, 1978), Sasca-Gornjak (Săndulescu, 1975) and the Getic Nappe (Murgoci, 1905; Codarcea, 1940). The later three nappes are commonly referred to as the "Getic Units". All the above-mentioned units are parts within the large, Laramian Lotru-Bistra Nappe. The structure of the Austrian nappes differs from one to each other with respect to the distribution of :

— pre-Austrian Mesozoic cover (Jurassic-Lower to Middle Cretaceous);

— variscan molasse deposits (Upper Carboniferous-Permian);

— pre-Carboniferous basement.

a. Supragetic Units. The Bocşa, Tâlva Drenii and Moniom Nappes contain scarce remnants of Variscan molasse represented by continental-lacustrine conglomerates and sands, and discontinuous thin Mesozoic formations with gaps in-between *i.e.*, lacunar, condensed cover of ridge type (Năstăseanu *et al.*, 1981). As compared to the thick sedimentary sequences from the Reşiţa through, this Mesozoic cover reflects facial relations due to differentiated sedimentation within the ridges (basement nappes) (Codarcea and Pop, 1970). Therefore, the Supragetic Nappes preserve Jurassic conglomerates and sands, and Upper Jurassic-Lower Cretaceous limestones as isolated occurrences within a narrow synclinal structure.

The pre-Carboniferous basement of the Supragetic Units consists of metamorphic rocks of Paleozoic and Precambrian age, grouped as follows:

— Bocşa Nappe: Caraş Group (Lower to Middle Paleozoic) and Bocşiţa-Drimoxa Formation (Precambrian);

— Tâlva Drenii Nappe: Tâlva Drenii Formation (Precambrian);

— Moniom Nappe: Moniom Group (Upper Devonian - Lower Carboniferous).

b. Getic Units. Precambrian and Paleozoic basement of the Getic Nappe supports a relatively thick molasse sequence of Upper Carboniferous-Permian age which is well embodied in the Reşiţa Nappe and within the anticlinal structures of the Reşiţa-Moldova Nouă synclinorium.

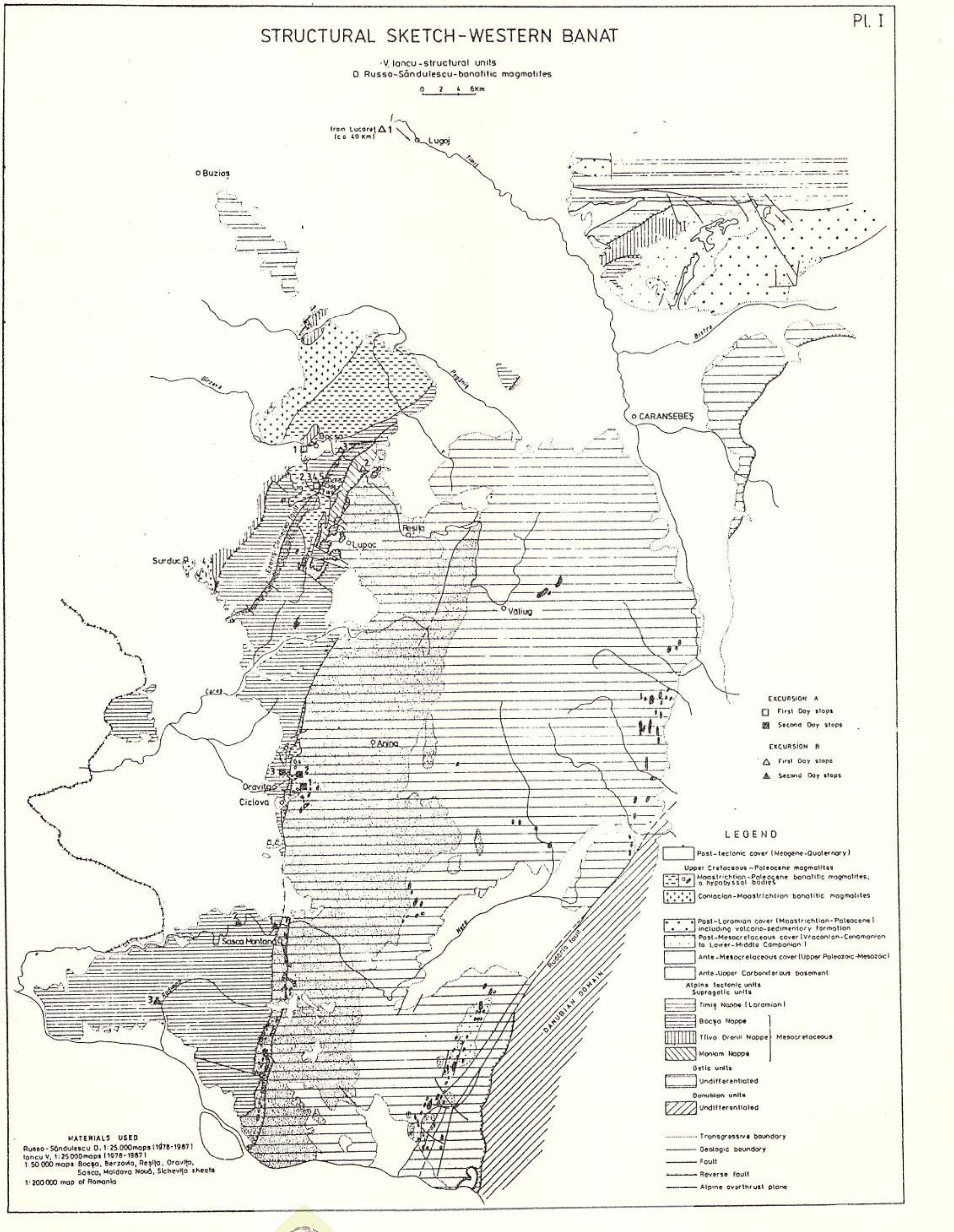
In the northern part of the Reşiţa-Moldova Nouă synclinorium, the molasse deposits consist of Upper Carboniferous, coarse-grained continental-lacustrine rocks (Doman, Lupacu Bătrân and Lupac Beds), a black argillaceous formation and a red sandy-conglomerate formation of Lower Permian age (Năstăseanu *et al.*, 1981).

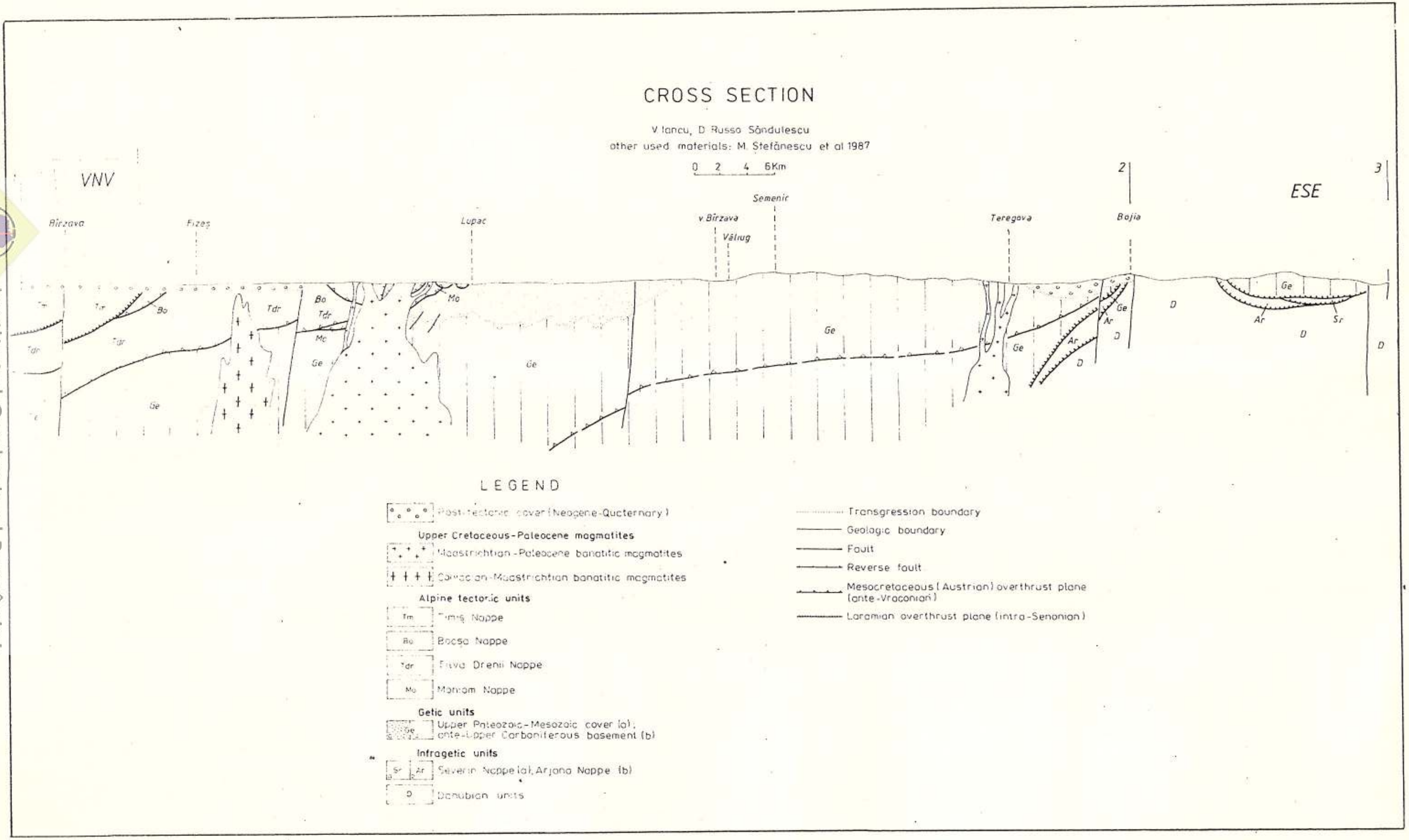
The Mesozoic cover of the Getic Nappes outcrops only in the Sasca-Gornjak Nappe and it contains Triassic quartzitic conglomerates, dolomites with thin micaceous sandstones beds and limestones. Triassic deposits are followed by a thick megasequence covering the Jurassic-Cretaceous interval, but well developed deposits of this age are preserved only in the Reşiţa-Moldova Nouă zone. This sequence represents the main host rock for the banatitic magmatites and related thermal-metasomatic activity.

Lower Jurassic consists of detrital continental-lacustrine formations (Gresten facies) represented by conglomerates grading into metrically bedded, alternating microconglomerates and siliceous or carbonatic sandstones (Năstăseanu *et al.*, 1981). At different levels, they contain interbedded black clays and coal lenses.

Middle Jurassic exhibits a central and a marginal facies and lies conformably over Lower Jurassic rocks from the deepest through area. Central facies contain: bituminous shales, marls with brachiopodes, bivalves and ammonites, grey calcareous clays grading into argillaceous limestones which support the Gumpina Limestones (Callovian) represented by calcarenites with ellipsoidal cherts. Marginal facies is represented by microconglomerates, spathic calcarenites (Bajocian- Bathonian), followed by spathic limestones with crinoidal entroques or glauconitic calcarenites.

Upper Jurassic appears mainly in carbonaceous facies and includes: marls (Tămaşa Marls) or encrinitic limestones, overlain by well bedded, cherty limestones (Valea Aninei Limestones), greenish-grey nodular limestones (Brădet Limestones), intraclastic limestones with radiolarian skeletal fragments and yellowish-white


Pl. I
STRUCTURAL SKETCH-WESTERN BANAT
V. Iancu-structural units
D. Russo-Sândulescu-banatitic magmatites
0 2 4 6Km
from Lucareț Δ1 (c.a 40 Km)
Lugoj
Timiș
Buziaș
Bîrzava
Pogăniș
Bistra
CARANSEBEȘ
Bocșa
Reșița
Lupac
Surduc
Văliug
Caraș
Anina
Oravița
Ciclova
Sasca Montană
Nera
Rudăria fault
DANUBIAN DOMAIN
EXCURSION A
First Day stops
Second Day stops
EXCURSION B
First Day stops
Second Day stops
LEGEND
Post-tectonic cover (Neogene-Quaternary)
Upper Cretaceous-Paleocene magmatites
Maastrichtian-Paleocene banatitic magmatites; a. hypabyssal bodies
Coniacian-Maastrichtian banatitic magmatites
Post-Laramian cover (Maastrichtian-Paleocene) including volcano-sedimentary formation
Post-Mesocretaceous cover (Vraconian-Cenomanian to Lower-Middle Campanian)
Ante-Mesocretaceous cover (Upper Paleozoic-Mesozoic)
Ante-Upper Carboniferous basement
Alpine tectonic units
Supragetic units
Timiș Nappe (Laramian)
Bocșa Nappe
Tîlva Orenii Nappe
Mesocretaceous
Maniam Nappe
Getic units
Undifferentiated
Danubian units
Undifferentiated
Transgressive boundary
Geologic boundary
Fault
Reverse fault
Alpine overthrust plane
MATERIALS USED
Russo-Sândulescu D. 1:25.000 maps (1978-1987)
Iancu V, 1:25000 maps (1978-1987)
1:50 000 maps: Bocșa, Berzovia, Reșița, Oravița, Sasca, Moldova Nouă, Sichevița sheets
1:200 000 map of Romania


CROSS SECTION
V Iancu, D Russo Săndulescu
other used materials: M. Stefănescu et al 1987
0 2 4 6Km
VNV
ESE
2
3
Bîrzava
Fizeş
Lupac
v Bîrzava
Văliug
Semenic
Teregova
Bojia
Tm
Tdr
Bo
Mo
Mc
Ge
Ar
Sr
D
LEGEND
Post-tectonic cover (Neogene-Quaternary)
Upper Cretaceous-Paleocene magmatites
Maastrichtian-Paleocene banatitic magmatites
Coniacian-Maastrichtian banatitic magmatites
Alpine tectonic units
Timiş Nappe
Bocşa Nappe
Fiva Drenii Nappe
Moniom Nappe
Getic units
Upper Paleozoic-Mesozoic cover (a); ante-Upper Carboniferous basement (b)
Infragetic units
Severin Nappe (a), Arjana Nappe (b)
Danubian units
Transgression boundary
Geologic boundary
Fault
Reverse fault
Mesocretaceous (Austrian) overthrust plane (ante-Vraconian)
Laramian overthrust plane (intra-Senonian)

micritic or biomicritic limestones with intraclastic or pelletal levels (Marila Limestones).

Pre-Albian Cretaceous (Jurassic-Lower Cretaceous cycle) has a predominantly carbonaceous character: marly limestones (Crivina Marls) conformably overlain by alternating decimetric marly limestones and metric limestones with abundant concretionary cherts. They are followed by organogenous limestones in Urgonian facies (Plopa Limestones). Plopa limestones (Barremian-Lower Aptian) may overlain unconformably older formations from the ridge areas. Upper Aptian, Urgonian limestones grade into oncoidic limestones with frequently interbedded marls with orbitolins and are unconformably overlain by glauconitic sandstones (Gura Golumbului Beds) and isolated sandstone or conglomerate occurrences.

Upper Cretaceous, post-Austrian cover reflects an important change in sedimentation conditions. Rocks of this age are discontinuously preserved in the Valepai and Şopot zones. Cenomanian-Turonian-Lower Senonian deposits consist of sandy conglomerates and calcarenites grading into marly sandstones and argillaceous limestones; Senonian (Lower to Middle Campanian) detrital rocks lie transgressively over the crystalline basement.

In the southern part of the Poiana Ruscă massif, post-Laramian cover (Maastrichtian-Paleocene) overlay pre-Maastrichtian Mesozoic deposits belonging to the post-Austrian cover as well as Austrian nappes.

3. PRE-ALPINE BASEMENT OF THE SUPRAGETIC UNITS. LITHOLOGIC AND STRUCTURAL DATA *(Viorica Iancu)*

This chapter is intended to summarize the lithological and petrographical features of the pre-Carboniferous basement from the Supragetic units which are largely different for each Alpine Nappe, and to stress upon the the complex relationship between Paleozoic and Precambrian rock sequences as reflected by the internal structure of these units. Detailed lithological-petrographical and geochemical data of some Paleozoic sequences from Banat are given by Iancu (1993, present Symposium) and Mărunţiu *et al.* (1993, present Symposium).

The main rock complexes and sequences of Paleozoic and Precambrian age are:

— Tâlva Drenii Formation (Precambrian);

— Bocşiţa-Drimoxa Formation (Precambrian);

— Caraş Group (Lower to middle Paleozoic) which includes volcano sedimentary Naidaş-Rafnic Formation, terrigenous Dogenecea-Zlatiţa Formation and quartzitic Tâlva Mare Formation;

— Moniom Group (Upper Devonian-Lower Carboniferous) which includes volcano-sedimentary Valea Satului Formation and terrigenous Cârşie Formation.

a. Tâlva Drenii Formation. In the outcroping area of this unit, the petrographical content is dominated by micaceous plagiogneisses and biotite-garnet-bearing plagiogneisses with thin bands of marbles (Valeapai region); an important feature of this sequence is the presence of lenticular-ocular gneisses with K-feldspar megablasts.

Mineral assemblages and superposed parageneses and associated microstructures, point to a polymetamorphic evolution which took place during two dynamothermal events (M1, M2), under the amphibolite facies conditions.

At regional scale, these rocks may be included in the Precambrian Cumpăna Group, within which remnants of granuloblastic rocks exhibiting mineral relics of granulitic facies (older than M1) are preserved.

b. Bocşiţa-Drimoxa Formation. It is included in the Bocşa Nappe and contains a polymetamorphic, monotonous sequence consisting of: micaceous plagiogneisses, quartzitic plagiogneisses and quartzites with subordinate amounts of garnet-bearing micaschists, amphibolites (garnet-bearing amphibolites or metagabbros), quartzo-feldspathic gneisses forming metric or decametric bodies with planar or lenticular ocular microstructures.

Polymetamorph evolution is pointed out by the existence of relic structures (S1 foliations and F1 folds) and paragenesis with almandine, biotite, oligoclase-andezine (M1 event), followed by retrograde restructuration (S2 and F2) under greenschists facies: chlorite, muscovite, quartz, albite and epidote-clinozoisite (M2 dynamo-thermal event).

The Precambrian age of Tâlva Drenii and Bocşiţa-Drimoxa formations may be inferred from regional correlations with similar geological entities from the Getic domain and from differentiation *vs.* adiacent Paleozoic sequences.

c. Caraş Group. Lithologic and lithostratigraphic division of the Caraş Group (Lower to Midde Paleozoic), which develops within the Bocşa Nappe, is based on correlation of lithologic entities from Caraş Valley (Constantinof, 1980; Iancu and Mărunţiu, 1993) and Locva massif (Maier, 1974; Iancu, 1986b). It includes the following formations:

— volcano-sedimentary Naidaş-Rafnic Fm., consisting of metapsamitic and metavolcanic basic rocks (metadolerites, metabasalts and metatuffs) closely associated to acid metavolcanic rocks (metatuffs and metariolites). Subordinately there appear metapelitic rocks and small bodies of metagabbros and metaperidotites.;

— terrigenous Dognecea-Zlatiţa Fm., is represented by metapelito-psamitic rocks locally enriched in graphite with associated basic and acid metavolcanic rocks and minor carbonaceous lenses;

— quartzitic Tâlva Mare Fm., contains white quartzites and micaceous quartzo-feldspathic rocks.

All formations contain scarce palynoprotistologic forms pointing to a Lower Paleozoic (Cambrian-Ordovician-Silurian) age (Visarion and Iancu, 1986).

Mineral and paragenetic assemblages reflect a green schists to epidote-amphibolite facies level metamorphism: chlorite (stilpnomelane) to garnet or biotite zones (M1) and a partial isofacial re-organization (M2 event).

Mineral parageneses of the basic rocks include chlorite, albite (mainly porphyroblastic, interkinematic), epidote-clinozoisite, amphiboles and locally, garnets or biotite, whereas the acid rocks display quartz, albite, muscovite, stilpnomelane, chlorite and biotite. The same mineral phases are present in the metapelitic rocks.

All the above-mentioned assemblages are in relation with S1 planes and F1 fold generation of the M1 regional event. S2 anf F2 deformational elements are connected with superposed dynamo-thermal re-structuration and also with the simple shear processes during Variscan tectogenetic events. Recent geochemical data concerning the bimodal basic-acid magmatic association in the Naidaş-Rafnic Fm. (Mărunţiu *et al.*, 1993, present Symposium) give evidence for an intracontinental, distensional magmatic activity. Subsequently, the magmatites undergone compressional thermo-dynamic evolution (M1, M2).

d. Moniom Group. Within the Alpine Moniom Nappe outcrop two lithological entities separated by a pre-Alpine (Variscan) shear zone:

— volcano-sedimentary Valea Satului Fm. (Upper Devonian-Lower Carboniferous), represented by metapelitic-metasiltitic rocks associated with metaaglomerates, basic metatuffs, metatuffitic rocks and acid metatuffs; scarce and little bodies of granodioritic and gabbroic rocks are present at different levels;

— terrigenous Cârşie Fm. consists of metapsephitic, metapsamitic and metapelitc rocks.

The entire rock sequence preserve inherited magmatic and sedimentary minerals and structures: tectonitic elements (S1 cleavages and foliations, F1 folds). Metamorphic blastesis points to a dynamo-thermal evolution ranging from anchimetamorphic to green schists facies, which took place during the Sudetic phase of the Variscan tectogenesis.

4. LATE - CRETACEOUS — PALEOGENE MAGMATITES: THE "BANATITES"

(Doina Russo-Săndulescu)

The most representative Alpine magmatic event in the western part of South Carpathians took place in a relatively large time interval, *i.e.* Late-Cretaceous — Paleogene and it corresponded to a complex history of intrusive emplacement and volcano-magmatic activity. Generally, the products of this important magmatic phase are called with the collective term "banatites", after Cotta (1864) who firstly described at *locus tipicus* — Banat, a consanguineous series of intrusive rocks exhibiting a wide variety of mineralogical and structural features. Actually, this term designate a magmatic province extended from Apuseni Mts. and Banat — in Romania, to Eastern Serbia and Srednogorie — in Bulgaria.

The available petrochemical, geophysical and radiometric ages data as well as the relationships between the igneous rocks and their host formations or major tectonic units from South Carpathians allow "banatites" to be ascribed to two main magmatic stages, each one with different petrogenetical characters (Russo-Săndulescu *et al.*, 1984):

A — Coniacian-Maastrichtian stage (K/Ar radiometric ages between 87 and 68 m.y.). It is related to the crustal shortenings and subductions subsequent to the Mesocretaceous tectogenesis (the first important compressive tectogenesis in the South Carpathians). In western Banat, this stage is represented by polyphasic plutons with evidence for the existence of intermediate magma chambers in incipient extensional, yet relatively "quiescent" tectonic regime (gabbros with initial cumulate crystallization).

B — Maastrichtian-Eocene stage (K/Ar ages of 65-42 m.y.). Magma generation during this stage followed the Endcretaceous tectogenesis (intra-Maastrichtian?) and it may be connected to the subduction of oceanic-type crust corresponding to the Severin Domain and possibly to the intermediate-type crust of the Arjana intracontinental rift.

The products of this stage are very widely spread in the western part of South Carpathians and they partially cross the plutons of the Coniacian-Maastrichtian phase.

The occurrences of Late Cretaceous-Paleogene igneous rocks in Banat are very well embodied in the northern side of Timiş Valley, in the Poiana Ruscă Mts., where both extrusive and intrusive magmatic outputs are conserved. Within a large territory extended between Timiş Valley and the Danube there is evidence for an intensive intrusive activity which apparently lasted a large period of time. Presumably, volcanism here was either absent or all its products were erroded.

According to the radiometric ages (Table 1), the following systematics of the Late-Cretaceous — Paleogene magmatite outcrops, borehole occurrences and geophysical discloses, may be considered:

(1) — **"Plutonic banatitic zone"** (P.B.Z.) with two maxima of intrusion emplacement in stages A and B, predominantly extending within the Supragetic Nappes or exceeding a little the front of these tectonic units.

(2) — **"Hypabissal banatitic zone"** (H.B.Z.) restricted to the Getic Nappe area, where geophysical data shown that the small banatitic intrusions do not correlate with a deep plutonic-type structure (Andrei *et al.*, 1989). According to their K/Ar ages and the relationships with sedimentary deposits of Şopot zone, these magmatites correspond ot the B stage.

(3) — **"Volcano - plutonic complex of Poiana Ruscă Mts."** (V.-P. C. P. R.). In the Rusca Montană basin there are conserved volcano-sedimentary formations of Maastrichtian-Paleocene age. Large intrusive bodies and dykes cutting these formations and the post-Maastrichtian tectonic contact (Tincova Massif) may be observed, too.

A synthesis of the above-mentioned facts is given in Table 1.

Table 1. The main features of the banatitic intrusions from south of Timiş Valley.

Stage	Phase	Zone	Intrusions	K-Ar age (m.y.)	Main petrographic types	Remarks
B Maastrichtian -Paleogene	III	H.B.Z. P.B.Z.	vein rocks subsequent to the granodioritic massifs	—	-rhyolitic - granophyres. -andesitic dykes	- porphyric texture
	II	HBZ	- Lăpuşnicu Mare, - Purcariu-Nasovăţ, - Teregova	45-65	-porphyric quartz- monzodiorites -porphyric granodiorites	- recurent zoned plg - bi + ho
		P.B.Z.	- Sasca-Moldova Nouă, - Oraviţa-Ciclova, - Bocşa3-Ocna de Fier-Dognecea - Surduc3	— 42-62 48-65 55-62	-granodiorites ± tonalites	- the most representative banatitic massifs -recurent zoned plg (An_{45-35}) - bi+ho
	I		- Ciclova - Ocna de Fier	—	- quartz monzodiorites - diorite-gabbros	- porphyric and micro-crystalline body or enclaves within the phase II (granodiorites) - ho + bi ± px
A Coniacian - Maastrichtian	II	P.B.Z.	- Bocşa2 - Surduc2	80 68	- granite- - monzonites - potassic syenites	poikilitic textures of orthoclase + cpx corroded by ho+bi
	I		- Bocşa1 - Surduc1	81 75-68	- quartz- monzodiorites with "schlieren" of gabbro-diorites.	inherited minerals from nodules+plg (An_{55-32}) + orthoclase + cpx + opx + bi ± ho
					Layered cumulate of gabbro and anorthosite (nodules)	plg(An_{82-84}) + ol (Fo_{83}) + cpx + Fe-Ti oxides ± bi

Abbreviations: plg - plagioclase, bi - biotite, opx - orthopyroxene, cpx - clinopyroxene, ho - hornblende, ol - olivine

5. CONTACT METAMORPHISM RELATED TO LATE-CRETACEOUS — PALEOGENE MAGMATISM *(Gh. Ilinca)*

Calc-silicate rocks with a broad range of textures, and compostions accompany most of the banatitic intrusions in Romania. However, this chapter is confined to several major plutons in southwestern Banat: Dognecea-Ocna de Fier, Oraviţa-Ciclova, Sasca Montană and Moldova Nouă, where they penetrate complex, mixed host rocks, namely crystalline schists, terrigenous sediments, and especially carbonate sequences. Contact aureoles from these areas occupy extensive zones around the magmatic bodies which belong to the B stage (see previous chapter). Minor occurrences (*e.g.* Surduc) are related to the A stage banatites.

Recrystallization processes commonly resulted in micro- or mesoblastic calcic or dolomitic marbles and relatively homogeneous, medium-grained calc-silicate hornfels with *grossularite+calcite* or *diopside+calcite*. Siliceous and aluminous hornfels with *biotite-* or *quartz*-dominant assemblages or with *andalusite+cordierite* ± *corundum* and *actinolite+clorite+epidote* ± *zoisite* are also present, yet at least in part, their mineralogical composition might point as well to superposed hydrothermal alteration. Locally (*e.g.* Ocna de Fier and Dognecea), there is evidence for a re-distribution of chemical components within the affected limestones which was induced by thermal metamorphism. Therefore, calcic marbles show greater purity towards the internal zones of the aureole where lower contents of C correlate with highly oxidizing conditions (Vlad, 1974).

Skarns in southwestern Banat were classified or examined according to various criteria, including structural types, replaced rock type, chemical or mineralogical composition. Thus, Cioflica and Vlad (1973) distinguished two main structural types, *i.e.*, *(1) the Ocna de Fier type* and *(2) the Moldova Nouă type*.

The Ocna de Fier type. Skarns are controlled by the contact of the Ocna de Fier-Dognecea pluton with carbonate rocks and form discontinuous bands, irregular- or tabular-shaped bodies and metasomatic veins. A relatively homogeneous carbonate paleosome favoured diffusion, rather than infiltrative exchange as the major metasomatic process involved. Metasomatic asymmetrical zoning is obvious: an inner zone with andradite-dominant assemblages, locally rimmed by wollastonitites and an outer zone with pyroxenic skarns — diopside at Ocna de Fier and Mn-hedenbergite at Dognecea (Vlad, 1974).

The Moldova Nouă type. It develops at Moldova Nouă, Sasca Montană and partially at Oravița-Ciclova, where skarns are controlled mainly by contact zones between subvolcanic bodies and carbonate rocks. They occur commonly as lenses with branching apophyses in the vicinity of the igneous bodies apices. Skarns of this type display no striking mineral zoning, but some authors (Gheorghițescu, 1972) speak about a crypto-zoning within the garnetiferous skarns due to an increase of andradite contents towards the carbonate rocks.

Peculiar morphological aspects deviating from this scheme are ubiquitous, however. At Oravița, in Ogașul Rândunicii zone, garnet-meionite skarns occur as veins or sygmoidal bodies within the crystaline schists of Bocșița-Drimoxa Formation. In Coșovița Hill (Oravița), where no contact zones of a large igneous body is obvious, skarns form a continuous band between limestones and crystalline schists of Caraș Group.

As regards the replaced rock type, exoskarns are by far predominant, but well developed endoskarn assemblages were described, too. At Ciclova, the skarn-forming fluids significantly affected the igneous rocks, thus converting them into *grossularite+vesuvianite+Fe-diopside+phlogopite* skarns, locally accompanied by periskarns with *Fe-augite-orthoclase-titanite-grossularite* (Cioflica *et al.*, 1980). At Surduc, small bodies of endoskarns with *andradite+hedenbergite+prehnite* were described in relation with gabbros belonging to the A stage (Russo-Săndulescu, verbal communication).

Calcic skarns are preponderent, yet typical magnesian sequences with *forsterite+chondrodite+ diopside ± phlogopite, clintonite, tremolite* were observed in all major skarn occurences in Banat. Most magnesian skarns formed in sedimentary dolostones or magnesian limestones. An alternative hypothesis concerning the Ocna de Fier Mg-skarns is that they formed after hydrothermal dolomitization of limestones (Kissling, 1967). Here, magnesian skarns are typically associated with boron minerals such as *ludwigite* and *szajbelyite*.

As recorded by the literature devoted to skarns in southwestern Banat, specific mineralogical features served as an additional aid in classification and in defining the environments of their formation. Noteworthy in this respect are the *Fe-Mn pyroxenes* of the hedenbergite-johannsenite series, together with the abbundant *Mn-ilvaite* from Dognecea zone (Vlad, 1969). The increase of hedenbergite-johannsenite *vs.* the decrease in diopside content corresponds here to a wider development of Pb-Zn ores, which generally agrees with the trend described by Einaudi and Burt (1982) for an extensive suite of economic skarn deposits all over the world.

High temperature skarn assemblages cotaining *diopside-gehlenite* occur only at Ogașul Crișenilor-Oravița (Constantinescu *et al.*, 1988b) where they are related to igneous rocks with a marked basic character (gabbros, diorites). Superposed skarn mineral patterns of this aureole describe a progressive sequence with *diopside I-gehlenite* and a regressive one with *wollastonite-diopside II-grandite-vesuvianite-clintonite*.

Some skarn deposits (*e.g.*, Ciclova, Sasca Montană) display an unusual content of Al, in which case vesuvianite occurs in considerable amounts, locally forming monomineralic zones with spectacular pegmatite-like crystals. It commonly replaces diopside, wollastonite and garnet and points rather to a significant Al mobility towards the late phases of metamorphism than to an Al-rich host rock.

Regional zoning of magmatic occurrences with their associated skarn and ore deposits in Banat in terms of plate tectonics setting has been recently examined by Vlad (1993). Refinement of available data concerning exoskarn host rock and local zoning, distance from productive intrusion, skarn type, skarn formation and mineralogical composition pointed to three main units which will be summarized as follows.

A. The Marginal Unit (Moldova Nouă-Sasca Montană) contain distal (around apophyses of the intrusion) dark skarns with *grandite* and subordinately *vesuvianite, Fe-diopside, wollastonite* and *scapolite*. Garnet *vs.* pyroxene ratio is about 10/1. Exoskarn host rock is commonly apo-limestone marble and its zoning is not well expressed, but the sequence *grandite*$_{75\text{-}85\ and}$-*Fe-diopside ± wolasstonite-marble* may be considered as characteristic. Skarn formation was monoascendant under relatively oxidizing/alkaline conditions.

B. The Median (Intermediate) Unit (Oravița-Ciclova) contain both proximal (around plutons) and distal (along lithologic discontinuities and/or fractures in intruded rocks) skarns with lower values of garnet *vs.* pyroxene ratio (5/1 in proximal skarns to 3/1 in distal skarns). Skarns formation was polyascendant in an oxidizing/alkaline regime. Zoning is well expressed at least for the proximal skarns: *grandite*$_{65\ and}$-*Fe-diopside ± wollastonite-marble*. Distal skarns display a superposed zoning: a) *diopside-grandite*$_{45\ and}$*±vesuvianit±diopside-grandite*$_{50\ and}$-*grandite*$_{76\ and}$-*marble* (in the skarns located at the contact between hornfels and marbles); b) *diopside-grandite*$_{45\text{-}39\ and}$-*diopside-scapolite+diopside-*

diopside-diopside+scapolite (in metasomatic veins located in hornfels). Exoskarn host rocks are either apo-limestone marbles or recrystallized carbonate-pelite sequences.

C. The Inner Unit (Dognecea-Ocna deFier) display proximal (around plutons) and distal (at the contact between crystalline schists and marbles) skarns with *grandite + diopside - hedenbergite - johannsenite+ wollastonite + Mn-ilvaite*. Garnet *vs.* pyroxene ratio ranges from 3/1 in proximal skarns to 1/5 in distal skarns. Skarn formation was monoascendant under relatively oxidizing/alkaline conditions for proximal skarns and reducing/acide for the distal ones. Zoning is particularly well expressed: a) *grandite*$_{83-89\ and}$ *- manganoan Fe-diopside - marble* (in proximal skarns); b) *grandite*$_{89-94\ and}$ *- manganoan Fe-diopside - Mn-hedenbergite* to *Fe-johannsenite - Mn-ilvaite (wollastonite) - marble* (in distal skarns).

A continuum between skarns and hydrothermal alterations is specific to all the described occurrences, but the effects of hydro-metasomatism are usually extended beyond the limits of skarn zones. Hydrothermal retrograde processes affecting garnets and vesuvianite, commonly result in *epidote+chlorite±carbonates, quartz* whereas pyroxenes breakdown to form *tremolite-actinolite + serpentine + talc*.

High temperature hydrothermal assemblages with *tourmaline+quartz ± orthoclase, magnetite* were described in relation to porphyritic granodiorite intrusions from Oravița (Popescu and Constantinescu, 1977; Constantinescu *et al.*, 1988a) and from Sasca Montană (Constantinescu, 1980).

More abbundant are the assemblages comprised of a) *K-feldspar + biotite ± quartz, muscovite (potasic facies)*, b) *epidote + actinolite + chlorite + quartz + calcite (propylitic facies)*, and c) *sericite + quartz ± chlorite, calcite, pyrite (phyllic facies)* which are frequently related to ore deposits. Rich epithermal alteration with *zeolites (laumontite, stilibite, thomsonite, chabasite etc.), gypsum, anhydrite, chalcedony* and *opal* are also present.

6. ORE DEPOSITS *(Gh. Ilinca)*

Important ore deposits in southwestern Banat are exclusivelly related to banatitic magmatites and their associated skarn and hydrothermal alteration environments. With respect to the three units described in the previous chapter a regional zoning of the ore deposits from the four major banatitic occurrences: Moldova Nouă, Sasca Montană, Oravița-Ciclova and Dognecea-Ocna de Fier, is conspicuous (Vlad, 1993):

— the skarn-porphyry environment is characteristic to the Marginal and Intermediate units, whereas skarns of the internal unit resulted in a non-porphyry milieu;

— the sequence of banatites and skarn mineralization, followed from the Marginal to the Internal unit is Cu-Mo (Moldova Nouă, Sasca Montană) — Cu-Mo-W (Oravița- Ciclova) — Fe / Pb,Zn (Ocna de Fier-Dognecea).

In addition to this interpretation it might be stressed that the the Oravița-Ciclova zone is set apart by a significant participation of Bi minerals which are almost ubiquitous within the copper-dominant assemblages. In subordinate amounts, Bi minerals were reported in all the southwestern Banat ore deposits.

Some specific features of the three zones will be summarized further on.

A. Marginal Unit (Moldova Nouă-Sasca Montană). It contains both significant porphyry Cu - Mo deposits and copper-dominant mineralization located in hydrothermally altered calcic skarns.

Noteworthy is the quartz-diorite body from Suvorov-Valea Mare which represents the most typical Laramian porphyry copper occurrence in Romania (Cioflica and Vlad, 1980). It displays a characteristic hydrothermal alteration zoning (Lowel and Guilbert model) and Cu-Mo stockwork mineralization. The main productive sequence here, is related to the phyllic alteration and consists of veinlets and impregnations with pyrite, chalcopyrite, sphalerite, molybdenite and tetrahedrite.

Within the skarns, chalcopyrite and pyrite prevail but some amounts of iron oxides, pyrrhotite, sphalerite, tetrahedrite, galena and Bi-sulphosalts, occurr, too.

Largely similar in some respects are the copper-rich ore deposits associated with the skarns from Sasca Montană. Here, porphyry-type ore concentrations with magnetite and molybdenite are only locally developed within the granodioritic intrusions. Chalcopyrite, pyrite, chalcocite, bornite, digenite and idaite are the most typical members of the ore assemblages. Scarce sulphosalts such as jamesonite, boulangerite and geocronite appear in places, as well as enargite, linnaeite-siegenite and members of the fahlore group. Fine veinlets containing iron-poor sphalerite and galena occur mostly within the recrystallized limestones. Specular hematite is sometimes contained by the skarn-hosted ores (Constantinescu and Udubașa, 1982). Recent research by Șimon (in Cioflica *et al.*, 1992) have revealed a relatively rich Bi mineral assemblage: bismuthinite, cosalite, kobellite, emplectite, wittichenite, pekoite and krupkaite. Bi minerals occur in association with pyrite, chalcopyrite, tetrahedrite, enargite, sphalerite and galena. Sometimes they are found within the Cu-Mo sequences superposed on skarns.

B. The Intermediate unit (Ciclova-Oravița. Porphyry copper mineralization is restricted to the upper parts of a quartz-diorite apophysis from Ciclova area, within which quartzose-phyllic alteration is superimposed upon pervasive potassic alteration (Cioflica and Vlad 1981). North to Oravița Valley, the marginal parts of the Maidan porphyritic granodiorite intrusion are locally affected by a Cu-Mo stockwork mineralization: veinlets of chalcopyrite, pyrite and molybdenite associated with calcite and zeolites. Outside the veinlets, the bulk host rock is however, remarkably unaltered. Most probably, it represents the root zone of an erroded Cu-Mo porphyry (Cioflica and Vlad, 1980).

More significant are the ores related to mixed phyllic-potassic or propylitic alterations which affect both banatites and contact metamorphism products (skarns, hornfels and marbles). The polyascendant character of the ore deposition in the Oravița - Ciclova area is conspicuous. Specific relationship between the superposed paragenesis point to the following global scheme of evolution.

— STAGE 1 (Fe ± Co, As). The sequence started with Fe oxides (hematite, magnetite) which were gradually substituted by pyrrhotite and pyrite, pointing to a continous increase of sulphur fugacity. Significant amounts of arsenopyrite and minor cobaltite acompany the Fe sulphides.

— STAGE 2 (Bi ± Pb, Zn, Cu, Ag, Te). Mainly Pb-Bi sulphosalts represented by galenobismutite, cosalite, lillianite and scarce pavonite were formed. Locally, in the northern part of the area, typical members of this stage are bismuthinite, native bismuth and tetradymite. Seemingly, isolated galena grains and sphalerite containing chalcopyrite+mackinawite exsolution blebs are contemporary to this stage.

— STAGE 3 (Cu ± Bi,W,Mo). Is the main ore deposition event and it corresponds to a strong copper metasomatism which significantly affects the previously formed ore minerals. Chalcopyrite commonly pseudomorphs pyrite and may locally contain cubanite lamellae of obvious metasomatic origin. The effect on Pb-Bi sulphosalts is yet more striking. Mutual boundaries between chalcopyrite and galenobismutite or cosalite show reaction products like wittchenite, hammarite, krupkaite and emplectite. In the northern part of the area, bismuthinite replacement by chalcopyrite results in myrmekitic intergrowths. Most probably, gold, scheelite, molybdenite and various fahlores including tetrahedrite, enargite and luzonite, and some minor quantities of wittichenite were formed during this stage.

It should be mentioned however, that the stages of polyascendant evolution of the Oravița-Ciclova ore deposits were differently depicted by various authors (Popescu and Constantinescu, 1977; Cioflica and Vlad, 1981, Constantinescu *et al.*, 1988a).

C. Internal Unit (Dognecea - Ocna de Fier). According to Vlad (1974, 1993), the marked metasomatic zoning of the skarns occurring in this area, closely reflects in the distribution of different ore types. Thus, proximal andradite-diopside skarns host an iron oxide-dominant mineralization with magnetite, hematite, and associated boron minerals (ludwigite, szajbelyite) or sulphides (chalcopyrite, pyrite, sphalerite and galena). Small lenses of up to 1-2 m in length, containg a rich assemblage of Bi sulphosalts and seleniferous minerals occur in places, within bulk oxidic ores: guanajuatite, junoite, gustavite, bismuthinite, teradymite, pavonite (Constantinescu and Ciobanu, 1993, present Symposium). In this respect, it may be stressed that Ocna de Fier is the only known occurrence in Romania in which Se minerals were described. Previous research of similar environment by Loczka (1925), Koch (1948), Petrulian *et al.* (1979) revealed: galenobismutite, cosalite, matildite, bismuthinite, wittichenite, and some minor, doubtful phases resembling klaprothite and rezbanyite.

Within the distal skarns with andradite, wollastonite, Mn-hedenbergite and Mn-ilvaite, mainly base suphide occur: galena, sphalerite, pyrite, chlcopyrite with subordinate amounts of magnetite, hematite, arsenopyrite and Bi sulphosalts.

7. ALKALI - BASALTIC VOLCANISM IN BANAT *(I. Seghedi)*

There are two main occurrences of alkali-basaltic rocks in Banat at the southwestern margin of the Pannonian basin. The most important of them is located between Lucareț and Sanovița villages and forms a plateau-like relief culminating in Piatra Roșie (Red Rock) hill at 211 m a.s.l. The second and smaller arises up to 60-80 m from the plain level (208 at a.s.l.) in Sumeg hill, south of Gătaia village.

Late Tertiary post-orogenic alkaline basalts are well known along the western part of Pannonian basin in numerous occurrences in Eastern Austria and Western Hungary (Embey-Isztin *et al.*, in press) while the above-mentioned occurrences in Banat are the only known outcrops at the eastern edge of the basin. They are similar to the South-east Transylvanian Perșani basalts (Savu *et al.*, in press, Downes *et al.*, in press).

The volcanism is related to an extensional tectonic period at the end of Pliocene resulting in the main systems of fractures in Banat : the Recaș - Cuiaș ENE-WSW trending fractures (Andrei and Cristescu, 1966) and a NNE-SSW fold between Lipova, Lucareț and Gătaia, as it was suggested by Mateescu (1937).

Part 2 - Stops description

1. EXCURSION A.

First day — General remarks *(Şt. Marincea, Gh. Ilinca)*

The first day is devoted to the long-known skarn occurrence from Ocna de Fier. Although the literature often speaks about "Dognecea-Ocna de Fier" banatites, skarns or skarn deposits, the southern part of the area, *i.e.* Dognecea will not be accessible to our route. The two localities shared largely similar magmatic and contact metamorphism evolution, yet the most striking specific features will be noticed whenever necessary.

The basement of Dognecea-Ocna de Fier consists of Precambrian and Lower to Middle Paleozoic crystalline schists of the Bocşa Nappe *i.e.*, the Bocşiţa-Drimoxa Fm. The sedimentary formations show typical features for the ridge-type evolution; they are represented by a discontinuous and condenesed cover of mainly Cretaceous (Barremian-Aptian) iron-deficient carbonate rocks forming a narrow, N-S extended, syncline structure (Ezeriş-Cârnecea).

Banatites pertaining to the Bocşa$_3$ phase, occur within a large granodioritic body reaching a maximum width of 5 km. The main intrusion is accompanied by small bodies and enclaves of more basic rocks (monzodiorites, quartz - diorites) which apparently represent previous intrusive phases as compared to the granodiorites. Vein rocks subsequent to the main intrusion, *i.e.* andesites, lamprophyres, dacites and rhyolites (Russo-Săndulescu *et al.*, 1986) also occur.

Within the contact aureole of the main granodioritic body, various thermal metamorphic pyro- and hydrometasomatic assemblages are found. Non-carbonate rocks were partly replaced, forming silica-aluminous hornfels and locally, grossularite-bearing lenses. Carbonate rocks resulted in garnetiferous, wollastonitic and pyroxenic skarns. The apo-carbonate skarns are generally banded and parallel to the contact between the crystalline schists or igneous bodies and the calcic marbles. Subsequent retrograde hydrothermal alteration products of initial skarn assemblages together with iron oxide and sulphide mineralization are widely spread in the area.

About 130 minerals were described in the Dognecea-Ocna de Fier zone many of them quite rare or sole occurrences in Romania. Several features of the minerals described here together with some historical information of mineralogical interest, are given in Table 2.

Table 2. Mineral species so far identified at Ocna de Fier and Dognecea

Mineral species or varieties	Remarks
1. Actinolite	First mentioned by Radu-Mercus (1962); found in calcic hornfels.
2. Aikinite	Petrulian *et al.*, (1979).
3. Albite	Occurs in hornfels, banatites, crystalline schists and as metasomatic product in some pseudoskarns.
4. Allophane	Mentioned by Marka (1869). Supergene product, associated with relic garnets and iron hydroxides.
5. Andalusite	Found in association with cordierite, in silica-aluminous hornfels (Codarcea, 1931; Radu-Mercus, 1962; Vlad, 1974).
6. Andradite	The most abundant skarn mineral. Chemical analyses are given by Seebach (1906), Bergeat (1910), Zombory (1934) and Vlad (1974). Optical, X-ray and infrared data are also available (Kissling, 1967; Vlad, 1974).
7. Anglesite	Marka (1869). Large-sized crystals up to 13 cm long. Very rich in crystallographic forms, of which 16 were described by Krenner (1877).
8. Andesine	Rock forming mineral in banatites.
9. Ankerite	First mentioned by Cădere (1926). Also found by Vlad (1974).
10. Antigorite	Kissling (1967). Previously referred to as "schweizerite" or "serpentine".
Antimonite	See stibnite.

Table 2 — continued

11. Apatite	Kissling (1971). Unusually large crystals (2.5 cm long and 1.5 cm thick) occurring in skarns. Accesory mineral in banatites (Vlad, 1974).
12. Apophyllite	Mentioned by von Cotta (1864) among other supergene minerals. Not found afterwards
13. Aragonite	von Cotta (1864). Very rich in crystallographic forms: 45 were described by Zimany(1899) and Vendl (1926)..
Arakawaite	See veszelyite.
14. Arsenopyrite	First mentioned by Thémak (1906). Some later authors used the name "mispickel" (*e.g.* Kissling, 1967).
Asbestos	Named "Strahlstein" by von Cotta (1864). Probably tremolite.
Ascharite	See szaibelyite.
15. Augite	Rock forming mineral in banatites.
16. Aurichalcite	Supergene product. Forms overcoats on magnetite. A chemical analysis was carried out by Belar (1890).
17. Azurite	With malachite, filling cavities in magnetite+hematite bulk ores.
19. Barite	Old references only (*e.g.* von Zepharovich, 1859)
20. Biotite	Rock forming mineral in banatites.
21. Bismite	See Wismuthocker.
22. Bismuth	First mentioned by von Cotta (1864). Described by Koch (1948).
23. Bismuthinite	First mentioned by Zipser (1817). Analytical data were given by Krenner (1882) and Koch (1930, 1948).
24. Bismutite	Mentioned by Petrulian *et al.* (1979). Previously named "bismutosphaerite" (Koch, 1930, 1948).
Bismutosphaerite	See bismutite.
Bleiglanz	See galena
Bol	See halloysite, nacrite.
25. Bornite	Zipser (1817). Marka described compact masses, with chalcopyrite, sphalerite and quartz.
26. Brochantite	First mentioned by von Zepharovich (1893). Later described by Löw (1911).
27. Brucite	With serpentine, pseudomorphs after forsterite (Kissling, 1967)
28. Bytownite	Rock forming mineral in banatites (Kissling, 1967)
Calamine	See hemimorphite.
29. Calcite	Widespread. Very rich in crystallographic forms: 28 were described by Vendl (1927, 1930).
30. Cerussite	Marka (1869). Black crystalls up to 7 mm in size. Rich in crystallographic forms (Stanciu, 1925; Tokody, 1926).
31. Chalcanthite	Old refreneces only.
32. Chalcocite	Mentioned in the first mineral inventory of the area (von Born, 1774). Small amounts.
33. Chalcopyrite	First mentioned by von Born (1774). Common ore mineral
34. Chrysocolla	Old references only.
35. Chrysotile	First identified by van der Marel and Beutelspacher (1976), in samples from "Dognoeska". Later determined by Ilinca (1993, present Symposium)
36. Clinochlore	Common hydrotmetasomatic product. Usually refered to as "chlorite" (Kissling, 1967; Vlad, 1974).
37. Clinozoisite	In calcic hornfels
38. Copper	Early mentioned by von Born (1774).
39. Cordierite	Found in silica-aluminous hornfels (Codarcea, 1931; Kissling, 1967 *e.a.*)
40. Coronadite	

Table 2 — continued

41. Corundum	In gneisses (Codarcea, 1931) and in aluminous hornfels, with biotite and andalusite (Radu-Mercus, 1962).
42. Cosalite	Numerous analytical data in old papers (Lozka, 1925; Tokody and Vavrinecz, 1935; Koch, 1948). Later, optically investigated (Petrulian *et al.*, 1979).
43. Covellite	Common alteration product of chalcopyrite.
44. Cuprite	von Born (1774).
Cupro-asbolane	See wad.
Desmine	See stilbite.
45. Digenite	Mentioned by Petrulian *et al.*, (1979) in the Simon Iuda ore body.
46. Diopside	First mentioned by von Cotta (1864) as "Malakolith" and by von Zepharovich (1877) as "Fassaite". Very rich in crystallographic forms; about 24 were given by von Zepharovich (1877) and Weinshenk (1903). Later, commonly referred to as "salite" or "manganoan-salite".
47. DOGNACSKAITE (?)	Type locality. First described and chemically analysed by Krenner (1884). Other chemical data were given by Neugebauer (1905). Later not found. Mineral with incert status (Strunz, 1957).
48. Dolomite	Quite abundant. Saddle-shaped crystals or outstanding pseudomorphs after magnetite.
49. Emplectite	Petrulian *et al.* (1979).
50. Epidote	Collective term used by Kissling (1967) for minerals in the epidote group. Also epidote *s.s.* (Vlad, 1974).
51. Eulytite	The sole occurrence in Romania. Described and chemically analised by Koch (1930, 1948). Small yellowish crystalls, included in chalcocite.
Fassaite	See diopside.
Ferrosalite	See hedenbergite.
52. Fluorite	First described by Pavelescu and Kissling (1971).
53. Forsterite	In magnesian skarns (Codarcea *et al.*, 1957).
54. Franklinite	Koch (1960). Octahedral crystals coating ludwigite.
55. Galena	First mentioned by Castel (1869) at Petru and Pavel mine. Outstanding octahedral crystalls up to 5 cm were mentioned by Kissling (1967).
56. Galenobismutite	Petrulian *et al.* (1979).
57. Goethite	Main component of "limonite". Rarely, in millimetric crystals.
58. Gold	First mentioned by Marka (1869) in veinlets cutting the hydrothermally altered banatites. Also found by Petrulian *et al.* (1979).
59. Goslarite	Identified by Cădere (1925) in samples from Naturhistorisches Hofmusaeum, Vienna.
60. Greenockite	Tschermak and Schrauf (1873, *fide* Kissling, 1967).
61. Grossularite	Frequently mentioned but not always chemically analysed.
62. Guanajuatite	Sole occurrence of a Se mineral in Romania (Constantinescu and Ciobanu, 1993 present Symposium).
63. Gypsum	Quite rare. Sometimes in well-shaped crystals (Löw, 1911).
64. Halloysite	Doubtful occurrence in the so-called "Bol", mentioned by von Cotta (1864).

Table 2 — continued

65. Hedenbergite	Very abundant in skarns at Dognecea. Analytical data were given by Hidegh (1884 *fide* Kissling, 1967), Loczka (1885), Vlad (1974), Pavelescu and Pavelescu (1976); in fact, a managanoan or magnesian manganoan hedenbergite *sensu* Morimoto *et al.* (1988). Sometimes referred to as "manganoan ferrosalite" (Vlad and Vasiliu, 1969; Vlad, 1974).
66. Hematite	Widespread. Frequently found as pseudomorphs after magnetite (= "martite"). Rich in crystallographic forms described by Pelikan (1897), Kleinfeld (1907) and Krenner (1887). Outstanding specimens resembling the Elba occurrence. Beautiful "iron roses" aggregates.
67. Hemimorphite	First mentioned by Zipser (1817). Later, only sporradically found. Also named "calamine".
68. Hornblende	Collective term for rock forming amphiboles.
69. Ilmenite	Quite frequent accessory mineral in banatites.
70. Ilvaite	First mentioned at Dognecea, by Vlad (1968) as "manganoan ilvaite". Numerous analytical data in Vlad (1968, 1974), Vlad and Vasiliu (1969).
71. Jamesonite	Found in museum samples from Ramdohr's Collection of Heidelberg University (Udubaşa *et al.*, 1992).
72. Kaolinite	Vlad (1974). Hydrothermal alteration product of banatites.
Kipushite	See veszelyite.
73. Klaprothite	Petrulian *et al.* (1979). Proved to be a mixture of wittichenite and emplectite (Nuffield, 1947 *fide* Strunz, 1957).
74. Kotoite (?)	Doubtful identification (Koch, 1960).
75. Labradorite	Rock forming mineral in banatites (Kissling, 1967).
76. Lepidocrocite	Component of "limonite".
77. Liebethenite	Old references only.
"Limonite"	Early mentions referred to a mixture of hydrous iron oxides and clay minerals. See goethite, lepidocrocite.
78. Lizardite	Presumed in the so-called "isotropic serpentine" (="serpophite") described by Kissling (1967)
79. LUDWIGITE	The type locality is Ocna de Fier. First mentioned and analysed by Tschermak (1874). Numerous analytical data were given by Schaller (1911), Codarcea *et al.* (1957), Koch (1960), Kissling (1967) and recently, by Marincea (1993, present Symposium).
Magnesiaglimmer	Term used by Rumpf (1874) and Jacob (1938) to designate phlogopite.
80. Magnetite	Abundant. Early mentioned at Ocna de Fier by Leonhard (1805). Frequently found as pseudomorphs after hematite (="muschketovite") or andradite.
81. Malachite	Usually found in supergene alteration environments. Beautiful fan-like aggregates of acicular or fibrous crystals. Early mentioned by von Cotta (1864).
Malakolith	See diopside.
82. Manganite	Cădere (1925) found in association with other various manganese minerals.
Manganocalcite	Term used by von Zepharovich (1873) to designate managanoan calcite. Stalactitic aggregates with calcite and "asbestos"
Manganomelane	Kissling (1967). A mixture of hydrous and anhydrous manganese oxides.
83. Manjiroite	First mentioned by Ghergari *et al.* (1986). Forms coatings on calcite. Associated with todorokite.

Table 2 — continued

84. Marcasite	Quite abundant. Sometimes pseudomorphs after pyrrhotite (von Zepharovich, 1859), pyrite or magnetite (Vlad, 1974).
Martite	See hematite.
85. Massicot	Mentioned by von Cotta (1864).
86. Matiidite	First described by Petrulian *et al.* (1979). Forms intergrowths with galenobismutite.
Meroxene	See phlogopite.
87. Microcline	Rock forming mineral in gneisses.
Mispickel	See arsenopyrite.
88. Molybdenite	Sporradically found (Kissling,1967).
89. Muschketovite	See magnetite.
90. Muscovite	In crystalline schists, hornfels and banatites.
91. Nacrite	Kleinfeld (1907). Main component of the so-called "Bol", with "limonite" and halloysite.
92. Nontronite	With "limonite" and hematite in pseudomorphs after calcic pyroxene (von Zepharovich, 1893).
Oligiste	Term used by Petrulian *et al.* (1979) as synonim for hematite.
93. Oligoclase	Rock forming mineral in banatites (Codarcea, 1931; Kissling, 1967).
94. Opal	von Cotta (1864). Secondary mineral in skarns or banatites.
95. Orthite	Codarcea (1931). Accessory mineral in banatites.
96. Orthose	Rock forming mineral in banatites (Codarcea, 1931; Kissling, 1967 *e.a.*).
97. Palygorskite	Ocna de Fier is the first occurence in Romania (Kissling, 1967). Masses of randomly oriented crystals, in cavities. Associated with calcite and quartz.
98. Phlogopite	First mentioned by Rumpf (1874). Also known as "Magnesiaglimmer" (Rumpf, 1874; Jacob, 1938) or "Meroxene" (Tschermak, 1879).
Pistacite	Term used as synonim for epidote (Vlad, 1974 *e.a.*).
Psilomelane	The term seems to designate massive, not specifically identified manganese oxides rather than romanechite.
99. Pyrite	Very abundant. Spectacular "limonite" pseudomorphs after pyrite crystals were found at Ocna Turcească mine, south of Ocna de Fier. Forms pseudomorphs after andradite, magnetite and pyrrhotite. Crystallographic studies were carried out by Zimányi (1910 - 1925).
100. Pyrolusite	First mentioned by von Cotta (1864). Supergene mineral, frequently associated with "limonite" and calcite.
101. Pyromorphite	Old references only (von Cotta, 1864; von Zepharovich, 1873). Supergene mineral. Millimetric crystals, with "limonite".
102. Pyrrhotite	Quite rare. First mentioned by Abt (1896). Associated with chalcopyrite, magnetite and ilmenite.
103. Quartz	Ubiquitous. Sometimes, outstanding 10 cm long, limpid crystals. Japanese twins were described by Koechlin (1904) and Ravász (1959). Co-axial twins of well-shaped crystals with no initial fastening point are world rarities.
104. Ramsdellite	Supergene product associated with other manganese minerals (Dordea *et al.*, 1992, unpublished data).
105. Rezbanyite	First mentioned and chemically analised by Koch (1930). Later, re-examined by Koch (1948) and Petrulian *et al.* (1979).
106. Rhodochrosite	Mentioned by Cădere (1928).

Table 2 — continued

107. Rhodonite	Old references only. Pseudomorph after grandites (?).
108. Romanechite	See psilomelane.
109. Rutile	Accessory mineral in banatites (Vlad, 1974).
Salite	See diopside.
110. Scapolite	Mentioned in endoskarns by Codarcea (1931). Mineral species not specified.
Schefferite	Mentioned by Hintze (1915) and later described by Kissling (1967). Most probably, a manganoan diopside.
Schweizerite	Term introduced by Krenner (1883) due to the resemblance between the serpentine minerals from Ocna de Fier and the ones known at the time from Zermatt, Switzerland. In fact, a mixture of chrysotile and Allizardite (Ilinca, 1993, present Symposium). Forms massive or radial aggregates of yellowish-green fibrous crystals, with resinous luster.
Serpentine	Collective term for unspecifically identified serpentine minerals. Usually, a synonim of "schweizerite".
Serpophite	See lizardite.
111. Siderite	First mentioned by Kleinfeld (1907). Associated with "limonite", pyrite and hematite.
112. Sillimanite	Codarcea (1931). In aluminous hornfels.
113. Smithsonite	Old references only. Compact masses, with "limonite".
114. Sphalerite	First mentioned by von Born (1774). Widespread. Iron-rich varieties with up to 11.8 wt% Fe (Kissling, 1967; Vlad, 1974).
115. Spinel	Codarcea (1931). In metagabbros.
Steatite	See talc.
116. Stibnite	Old references only (von Fichtel, 1791). Also called antimonite.
117. Stilbite	Rarely found. Low temperature alteration product, in banatites.
118. Stromeyerite	Found in museum specimens from Ramdohr's Collection of Heidelberg University (Udubaşa *et al.*, 1992).
119. Szaibelyite	First mentioned at Ocna de Fier by Löw (1911). Alteration product of ludwigite. Also called "ascharite" (Codarcea *et al.*, 1957).
120. Talc	von Cotta (1864). Found as pseudomorphs after tremolite or in compact masses called "steatite". Later mentioned by Vlad (1974), in hydrothermally altered calcic hornfels.
121. Tenorite	Old references only.
122. Tetradymite	First mentioned by von Zepharovich (1859). Later found by Constantinescu and Ciobanu (1993, present Symposium).
123. Tetrahedrite	von Cotta (1864). Quite rare. Later described by Petrulian *et al.* (1979).
124. Titanite	Accessory mineral in banatites.
125. Todorokite	With manjiroite, overcoats calcite. First identified by Ghergari *et al.* (1986).
126. Tourmaline	In aluminous hornfels (Radu-Mercus, 1962). Mineral species not specified. Probably dravite-ferridravite.
127. Tremolite	von Cotta (1864). Major component of the so-called "Strahlstein" (= asbestos). Fibrous aggregates sometimes of unusually-sized crystals (up to 30 cm along "c"). At Dognecea, available chemical data from various authors indicate rather a ferroactinolite-dominant member of the calcic amphiboles series than a tremolite *s.s.*
128. Vesuvianite	Old references only.

Table 2 — continued

129. VESZELYITE	The type locallity is Ocna de Fier. First described and analysed by Schrauff (1880). Later re-examined by Zsviny (1929,1932), Krenner (1930), Codarcea (1931) *e.a.* The synonymy with kipushite and arakawaite was established by Zsviny (1929).
130. Vivianite	Earthy masses. Mentioned by Cădere (1927).
Wad	Mentioned by von Cotta (1864). Collective term used to designate a mixture of hydrous and anhydrous manganese oxides.
131. WARTHAITE (?)	The type locality is Ocna de Fier. First described by Krenner (1925) and chemically analysed by Loczka (1925). Re-examined by Koch (1948). Later proved to be a mixture of cosalite and galena (Thomson, 1949 *fide* Strunz, 1957).
Wismuthocker	Mentioned in old papers as a supergene product of Bi sulphosalts. Probably a mixture of bismite with bismutite (Strunz, 1957).
132. Wittchenite	Petrulian *et al.* (1979). Myrmekitic intergrowths with bismuthinite and galenobismutite or centripetal replcement of the two minerals.
133. Wolframite	First mentioned by Kissling (1967) at Ursoanea waste dump. Black, acicular crystals up to 3 mm long, with quartz and pyrite.
134. Wollastonite	First mentioned and analysed by Vlad (1974). Monomineralic zones within the proximal, garnetiferous skarns.
135. Zircon	Accessory mineral in banatites.

The list is largely based on data from Rădulescu and Dimitrescu (1966), Kissling (1967) and Udubaşa *et al.* (1992).

Stop 1 - **Banatite outcrop near Bocşa** *(Doina Russo - Săndulescu)*

Following the road to Bocşa Montană and Bocşa Română, in a drive escarpment on the left bank of the Bârzava river, some relations between succesive intrusive stages of B stage can be observed.

The outcrop (Fig. 1) shows ocular gneisses of Tâlva Drenii Formation (1), crossed by a first generation of small dykes reaching up to 1 to 2 m width (2 and 2a) with a marked basic character. The dykes are followed by a second stage with granodiorites (3) which dislocates and includes parts of previously emplaced rocks. The dykes and enclaves consist of porphyric microdiorites with significantly zoned plagioclase phenocrysts within a microgranular groundmass of plagioclase and hornblende.

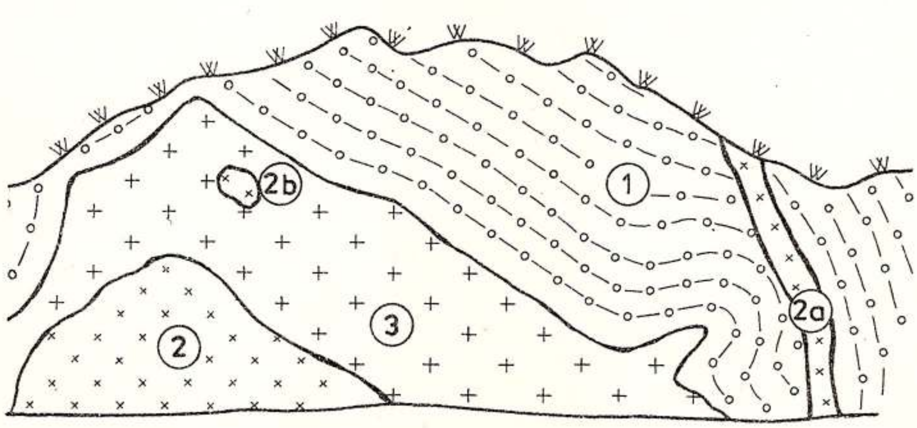


Fig. 1. Outcrop relationships between successive igneous phases of B banatitic stage (Maastrichtian - Paleocene), near Bocşa.

Some concentrations of actinolitic hornblende could represent pseudomorphs after pyroxenes. Quartz xenoliths with actinolite corronas may also be found. Certain autometamorphism phenomena are suggested by the alteration of the primary melanocrate mineral in an actinolite fibrous mass and by the argillization and saussuritization of the plagioclase phenocrysts.

The granodiorites (3) are typical for the Bocşa$_3$ phase. Here, they exhibit a marginal facies and a porphyric texture. They contain recurrently zoned plagioclase phenocrysts, biotite, hornblende and subordinately, corroded quartz within a groundmass of K-feldspar, plagioclase and quartz.

Stop 2 - **Gruescu mineralogical collection in Ocna de Fier** *(Şt. Marincea, Gh. Ilinca)*

The private mineralogical collection of Constantin Gruescu was intended to host the most representative mineral samples gathered from the banatite contact aureoles. Although initially it stressed upon the aesthetic features of the crystals and mineral aggregates, scientific value was implicitly contained, as many of the collected samples were the only remnants from no longer accessible or exhausted mining fields. It was as well intended to be a part of a larger project called " The Iron Museum" of Ocna de Fier, within which a comprehensive historical view of the mining activities in the area was to be completed.

The collection started in 1945 with some samples which Mr Gruescu — a former mining foreman — inherited form his grandfather and great-grandfather who witnessed the periods of topmost extension of mines in Ocna de Fier. During the mining activity, he continued to collect and purchase minerals, and to preserve them carefuly so that in 1954, the collection expectedly became a local attraction point for tourists or other visitors. Though no financial returns have ever occurred to Mr. Gruescu, he managed to build a new exhibition room in response to an ever increasing interest shown in the country and abroad. The collection now hosts about 2300 samples of which 800 are permanently displayed. The collection was even larger, but many donations totalizing about 2000 samples were made to various museums and universities in Romania.

In their great majority, the specimens come from the surrounding Dognecea-Ocna de Fier area, yet beautiful samples from other renowned mineral occurrences in Romania and other countries are present, too. The collection hosts over 100 calcite crystallographic forms and twins, many of them of quite impressive dimensions. Attractive samples of hematite with rare crystallographic forms resembling the well-known Ginevro and Capo Calamita occurences in Elba, are specifically intergrown within "iron roses"-type aggregates. There are also spectacular magnetite pseudomorphs after garnet, concretionary magnetite aggregates in the form of "stalactitic curtains" and odd dolomite pseudomorphs after octahedral magnetite. Garnets are largely represented through a variety of morphological and chromatic aspects: melanite, demantoide and brown andradites. Diopside samples from the Simon Iuda ore body show large, perfectly shaped crystals which made the subject of numerous studies (see Table 2). Huge crystals of phlogopite and many other rare minerals such as guanajuatite, todorokite, manjiroite and palygorskite make the collection even more interesting. Special attention deserve also the ludwigite samples which were collected from their *locus tipicus* (Magnet quarry). The most impressive specimens however, are the extremely rare co-axial twins of columnar quartz which sometimes develop along three different directions and show no apparent supporting point.

Stop 3 - **Teresia quarry** *(Şt. Marincea, Gh. Ilinca)*

The quarry opens mainly calcic and magnesian skarns with superposed iron oxides (magnetite and hematite) and borate (ludwigite) mineralization. The host rock is represented by coarse-grained dolomite marbles. Old references mentioned by Codarcea (1931) and Kissling (1967) speak about native bismuth, bismuthinite, greenockite, sphalerite and stibnite.

The northeastern wall of the quarry exhibits a broad picture of metasomatic zoning arround a porphyric diorite apophysis: diopside - andradite+diopside - ludwigite - serpentines (chrysotile, lizardite) - dolomitic marble. The iron ores were mined as back as the nineteenth century; they are located within an andradite-dominant skarn area within which they form specific diffusion metasomatic intergrowths, described by Kissling (1967) as "orbicular" or "Liesegang textures". Such textures consist of magnetite (frequently pseudomorph after garnet or hematite), hematite and calcite or dolomite.

The main mineralogical interest of Teresia quarry is basically due to the skarn and magnesian or calc-magnesian pseudoskarn minerals such as diopside, phlogopite and palygorskite.

Diopside crystals provided many collection specimens. Their dimensions (up to 8 cm along "c") favoured numerous crystallographical studies (Weinschenk, 1903; Toborffy, 1911; Kissling, 1967, 1971). Frontal pinacoids {100}, lateral pinacoids {010} as well as prisms of III species: {110}, {210} or {120} prevail among the 16 described crystallographical forms. Wet chemical analyses reported by various authors (Table 3) show a relatively large isomorphism in the M1 sites where Mg^{2+}, Mn^{2+} and Fe^{2+} share different parti-

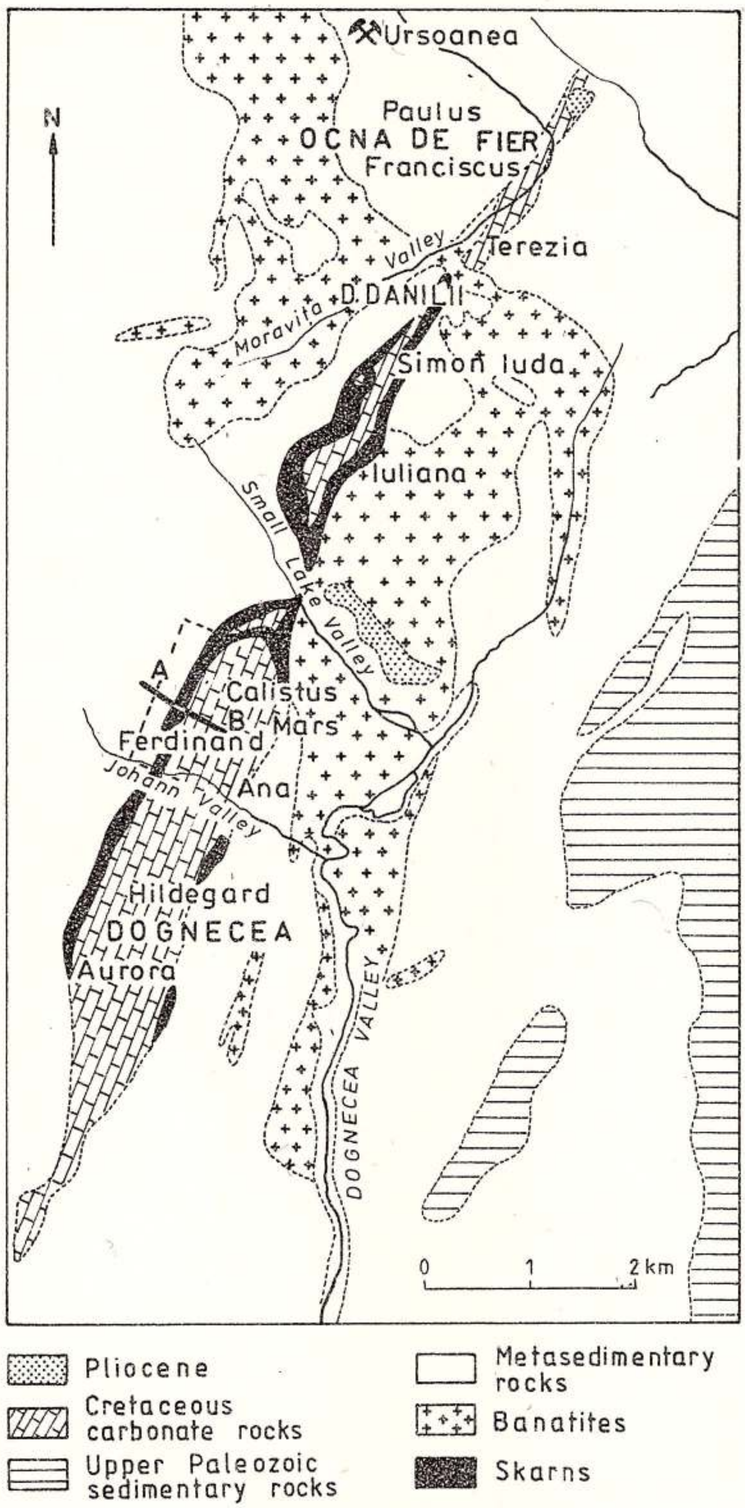


Fig. 2. Simplified geological sketch of Ocna de Fier - Dognecea area (after Halaváts 1888,1890 and Codarcea 1931, *fide* Vlad and Vasiliu, 1969).

cipations. They point to a diopside *s.s.* (sample 1) or ferrian diopside (sample 3), *sensu* Morimoto *et al.*, (1988), as well as to manganoan and ferroan diopsides (samples 2 and 4, respectively).

Table 3. Wet chemical analyses of diopside from Teresia quarry, Ocna de Fier (oxides, in wt.%).

Oxides	1	2	3	4
SiO_2	53.39	51.98	50.72	45.53
$Al2O_3$	—	—	1.74	0.95
Fe_2O_3	—	—	3.63	1.49
FeO	1.93	2.96	2.23	3.50
MnO	1.65	5.76	—	—
MgO	15.45	8.59	11.91	15.32
CaO	25.13	28.96	29.97	27.72
CO_2	2.83	—	—	6.32

1: Hidegh (1884,*fide* Kissling,1967); **2:** Weinschenk (1903); **3 - 4:** Kissling (1967);

Phlogopite from Teresia quarry was first described by Rumpf (1874) which he called *"Magnesiaglimmer"* and later studied by Tschermak (1879), Jacob (1938) and Kissling (1967). Platy crystals reaching up to 10 cm wide, frequently form monomineralic aggregates and bands which were interpreted by Kissling (1967) as representing Liesegang-type textures. Chemical data refinement of Teresia quarry phlogopites, carried out by Marincea (1993, unpublished data) revealed prevailing hydroxy-phlogopite with up to 11.92 mole percent fluorphlogopite and significant contents of annite-siderophyllite (up to 23.51 mole percent) together with minor amounts of manganophyllite (up to 1.71 mole percent). X - ray powder diffraction data suggest that the Teresia phlogopite is a $2M_1$ polytype.

Fibrous chrysotile is typically developed along the (001) cleavage planes in phlogopite and tends to form centripetal replacement zones resulting in the "chromatic zoning" described by Kissling (1967).

Palygorskite was first identified by Kissling (1967) within cavities located in the coarse-grained dolomite. It overcoats scalenohedral calcite suggesting deposition under low temperatures conditions. Palygorskite displays unusually large fibers up to 1 cm in length.

Stop 4 - **Iuliana quarry** *(Şt. Marincea)*

The quarry is located on the west limb of Ezeriş-Cârneccea synclinorium, south of Ocna de Fier. It is one of the largest mining works in the area.

Metasomatic zoning arround a porphyric grano-diorite dyke can be observed on the easthern wall: andradite - tremolite - coarse-grained dolomite.

Beautiful specimens of hematite, magnetite, garnets and tremolite as well as ludwigite can easily be collected from the quarry. There were described here, unusual pseudomorphs of dolomite after octahedral magnetite, and of magnetite after andradite. Most of the renowned "iron roses" of hematite originate in this place.

Andradite usually displays cubic-trapesohedral {112} and rhombic-dodecahedral {110} crystals. "Incised" faces, due to adventive {112} forms superposed on {110} are frequent.

Tremolite is quite abundant and unusually si[illegible]d (up to 30 cm along "c"). It forms radiating or fan-like aggregates, being commonly pseudomorph after diopside. A wet chemical analysis by von Zepharovich (1881, *fide* Kissling, 1967) gave: SiO_2 = 56.93 %, Al_2O_3 = 0.64 %, FeO = 3.87 %, MgO = 21.73 %, MnO = 0.37 %, CaO = 15.12 %, H_2O^+ = 1.25 %. It indicates a tremolite *s.s.* with only 9.1 mole percent ferroactinolite in solid solution.

Ludwigite occurs in a limited area on the eastern wall of the quarry close to the limit between skarns and dolomitic marble. The *locus tipicus* for this mineral is the Magnet quarry which is quite unaccessible now, but the Iuliana ludwigite shows remarkable similarities to the original material described by Tschermak (1874). Detailed analytical data on ludwigites from both loci are given by Marincea (1993, present Symposium).

Stop 5 - **Ursoanea waste dump** *(Şt. Marincea)*

The waste collects excavated material from a transport gallery which connects Dognecea and Ocna de Fier. The gallery practically crosses the entire skarn area so that its waste dump gathers a comprehensive suite of minerals and rocks of the two major mining fields. Among phlogopite, ludwigite and other minerals occuring only at Ocna de Fier, special attention deserve the hedenbergite and ilvaite samples which are characteristic to Dognecea zone.

Hedenbergite forms spectacular crystals and aggregates with typical "fish-bone" textures. Crystals are unusually large (up to 10 cm along "c") with prevailing {100}, {010}, {110}, {021}, {001}, {221} and {101} forms (Pavelescu and Pavelescu, 1986). Chemical compositions given by Hidegh (1884), Loczka (1886 *fide* Kissling, 1967), Vlad and Vasiliu (1969) and Vlad (1974) points to the presence of manganoan hedenbergite, magnesian manganoan hedenbergite, ferrian manganoan hedenbergite and ferrian magnesian manganoan hedenbergite, *sensu* Morimoto *et al.*, (1988).

Ilvaite was first described by Vlad (1969) and re-examined by the same author in 1974. Wet chemical analysis gave: SiO_2 = 28.89 %, TiO_2 = 0.04 %, Al_2O_3 = 2.31 %, Fe_2O_3 = 20.18 %, FeO = 24.32 %, MgO = 0.54 %, MnO = 8.30 %, CaO = 13.70 %, H_2O = 2.07 %. The unusually high MnO content pointed to a manganoan ilvaite. The large (up to 8 cm long, and 0.3 to 3 cm thick) and well shaped crystals exhibit mainly {110}, {010}, {111} and {101} forms (Vlad, 1969, 1974)

***Second day* — General remarks** *(Şt. Marincea, Gh. Ilinca)*

During the second day, the trip route includes several skarn exposures from Oraviţa-Ciclova area.

Crystalline schists of the Bocşa Nappe occur in the westernmost part of the region (Coşoviţa Hill). Micaceous gneisses and amphibolites of the Bocşiţa Drimoxa Fm. and greenschists, meta-granites and meta-rhyolites of the Caraş Group are unconformably overlain by a thin cover of limestones which is largely similar to the ridge-type sequence from Dognecea-Ocna de Fier. Grandite-dominant skarns and calc-silicate hornfels are banded parallel to the contact between the crystalline schists and the marbles. With the exception of several small tongues of fine-grained granodiorites, the pluton responsible for the thermal aureole do not crop out.

More significant contact metamorphism products occur east of Bocşa Nappe, where banatites penetrated a thick carbonatic rock sequence belonging to the sedimentary cover of the getic unit (*i.e.* the Reşiţa-Moldova Nouă synclinorium). As compared to the Ocna de Fier occurrence, the more diversified composition of the sedimentary paleosome (pure or cherty limestones, argillaceous limestones and marls), was the primary factor behind the skarn mineralogy which includes abundant Al- and Mg-rich calc-silicates. Several major banatitic bodies crop out in the area. They consist of early diorites, monzodiorites and gabbros (Oraviţa Valley and Ciclova), and subsequent porhyritic granodiorites (Maidan and Tâlva Mică, north of Oraviţa Valley). Members of an ending sequence with vein rocks (lamprophyres, andesites, syenites, alkali-granites, rhyolites and dacites) are randomly distributed within the main igneous bodies and their host rocks. The basic bodies from Oraviţa Valley and Ciclova correlate well with products of the $B_{3.1}$ phase, whereas the north granodiorite intrusions are geochemically similar to the rocks of $B_{3.2}$ phase (Russo-Săndulescu *et al.*, 1986). Extensive hydrothermal alteration and related copper-dominant mineralization were recognized to accompany the banatitic intrusions.

More than 110 minerals were described here, and as in the case of the previous occurence, they are summarized in Table 4.

Table 4. Mineral species so far identified at Oraviţa and Ciclova

Mineral species and varieties	Remarks
1. Aegirine	Rock-forming mineral of banatites.
2. Albite	*Idem.*
Alloclase	So-mentioned by Tschermak (1866 *fide* Palache *et al.*, 1961). Presumed to be a mixture of nickeloan skutterudite, cobaltoan arsenopyrite, bismuth and bismuthinite (Strunz, 1957), a bismuthian glaucodot or a precursor of the present alloclasite (Palache *et al.*, 1961). Chemically analysed by Krenner (1929).
3. Allophane	Old mentions only (*i.e.* von Zepharovich, 1859). Veinlets or overcoats on chalcopyrite.
4. Analcite	Mentioned in pseudoskarns by Superceanu (1956). Previous mentions reffered to "zeolite" (von Zepharovich, 1859).
5. Andradite	Wet-chemical analyses and other analytical data are given by Gheorghiţescu (1975a, 1975b), Cioflica *et al.* (1980) and Constantinescu *et al.* (1988b).
6. Antophyllite	Mentioned at Oraviţa by Gheorghiţescu (1975b). Optically and wet-chemically analysed.
7. Apophyllite	First mentioned by Marka (1869). It forms pseudomorphs after wollastonite.
8. Argentite	Found by Superceanu (1958) in skarns from Ciclova..
9. Arsenic	Old mentions only (*e.g.* de Born, 1790, *fide* Rădulescu and Dimitrescu, 1966).

Table 4 — continued

10. Arsenopyrite	First mentioned by Zipser (1817). Numerous analytical data. See also "alloclase".
11. Augite	Rock-forming mineral in some banatites.
12. Aurichalcite	Old mentions only.
13. Azurite	von Zepharovich (1859). Common alteration product of copper-rich ores.
14. Barite	Old mentions only (von Zepharovich, 1873).
15. Biotite	Rock-forming mineral in banatites and in hornfels or hydrothermal alteration product.
16. Bismite	First mentioned by Blum (1863, *fide* Rădulescu and Dimitrescu, 1966). Pseudomorph after native bismuth and bismuthinite.
17. Bismuth	First nentioned by Koch (1948). See also "alloclase"
18. Bismuthinite	First mentioned in some old papers quoted by von Zepharovich (1859). Most abundant bismuth mineral.
19. Bornite	First mentioned by von Zepharovich (1859).
20. Brochantite	Old mentions only (Marka, 1869).
21. Bustamite	Mentioned by Superceanu (1956, 1958) at Ciclova. Doubtful identification.
22. Calcite	Widespread in hornfels, skarns and pseudoskarns.
23. Chalcocite	First mentioned by Zipser (1817). Widespread supergene alteration product.
24. Chalcopyrite	Most common ore mineral. Early mentioned by Zipser (1817).
25. Chondrodite	In calcic-magnesian skarns from Ciclova (Gheorghițescu, 1975a). Later described by Constantinescu *et al.* (1988b)
26. Chrysocolla	Zipser (1817). Associated with "limonite" in the so-called "Kupferpecherz".
27. Chrysotile	Pseudomorph after chondrodite.
28. Clinoclore	Usually found in pseudoskarns and in calcic hornfels (Gheorghițescu, 1975a)
29. Clinozoisite	Widespread in hornfels; also found in some pseudoskarns.
30. Clintonite	Sole occurrence in Romania. In calci-magnesian skarns at Oravița (Popescu and Constantinescu, 1977). Green, platy crystals up to 1 cm wide.
31. Cobaltite	First mentioned by von Zepharovich (1873). Commonly associated with pyrrhotite, pyrite and arsenopyrite.
32. Copper	von Zepharovich (1859). With cuprite, azurite, malachite. Also described by Superceanu (1958).
33. Cordierite	In silica-aluminous hornfels with biotite, andalusite, corundum (Constantinescu *et al.*, 1988b).
34. Corundum	In aluminous hornfels (Constantinescu *et al.*, 1988b).
35. Cosalite	First mentioned by Ilinca (1992). It usually pseudomorphs galenobismutite and contains tiny bladed inclusions of pavonite, bismuthinite and bismuth.
36. Covellite	Mentioned by Superceanu (1956). Quite common alteration product of chalcopyrite.
37. CSIKLOVAITE	Type locality. First identified (but unnamed) by Sztrokay (1941 *fide* Koch, 1948). Reliable chemical and crystalographic data are given by Koch (1948), who also named the mineral after Ciclova.
38. Cubanite	First mentioned by Superceanu (1958). Later described by various authors (Popescu and Constantinescu, 1977; Cioflica and Vlad, 1981; Ilinca, 1992). Lamellae within chalcopyrite pseudomorphs after pyrite.
39. Cuprite	Early mentioned (von Zepharovich, 1859). Also found by Superceanu (1956, 1958).

Table 4 — continued

Desmine	See stilbite.
Dellesite	Mentioned by Gheorghiţescu (1975a) in calcic hornfels. Probably clinochlore.
40. Digenite	Mentioned by Gheorghiţescu (1975a) in the Rochus mining field from Coşoviţa zone (Oraviţa).
41. Diopside	Abundant in skarns. Also mentioned as "fassaite" (von Zepharovich 1873, 1893) or as "salite" (Gheorghiţescu, 1975b). Chemical analyses given by Liffa (1924) and Gheorghiţescu (1975b) indicate diopside and ferrian ferroan diopside *sensu* Morimoto *et al.* (1988).
42. Emplectite	Ilinca (1992). Usually found as a reaction product between chalcopyrite and other Bi minerals.
43. Enargite	Popescu and Constantinescu (1977).
44. Epidote	Main component in some pseudoskarns (called "epidotites" by Gheorghiţescu, 1975a) and in some calcic hornfels (with actinolite). Common retrograde hydrothermal alteration product of grandite. Frequently pseudomorphs after garnet.
45. Erythrite	First mentioned by Zipser (1817). Later found and described by Superceanu (1956). Quite rare. Forms earthy masses and crusts.
Fassaite	See diopside.
46. Fluorite	Mentioned by Superceanu (1956). Minor hydrothermal phase.
47. Forsterite	Mentioned in some magnesian skarns at Oraviţa by Pieptea (1964).
48. Galena	First mentioned by von Zepharovich (1859). Also described by Superceanu (1956, 1958), Gheorghiţescu (1975a, 1975b) *e.a.* More frequent at Ciclova.
49. Galenobismutite	Ilinca (1992). Commonly substituted by cosalite and lillianite + bismuthinite.
50. Gehlenite	Mentioned by von Zepharovich (1899), but only in recent alluvia south of Oraviţa. Also referred to as "melilite" (von Zepharovich, 1893; Superceanu, 1958; Constantinescu *et al.*, 1988b) or "samoite" (von Zepharovich, 1893). Later found *in situ* by Constantinescu *et al.* (1988b) in the Lacul Mare-Ogaşul Crişenilor zone (Oraviţa).
51. Glaucodot	First mentioned by von Zepharovich (1859) and more recently by Superceanu (1956, 1958) and Cioflica and Vlad (1981). Needle-like crystals embedded in calcite. See also "alloclase".
52. Goethite	Main component of "limonite" and of "Kupferpecherz".
53. Gold	Mentioned by von Zepharovich (1873, 1893) at Oraviţa (Elisabeth mine). Found by Superceanu (1956, 1958) as grains embedded in pyrite, chalcopyrite or tetrahedrite.
54. Grossularite	In fact, Al-rich grandites. Most abundant skarn minerals. Wet-chemical analyses, given by Loczka (1885), Gheorghiţescu (1975 a), Popescu, Constantinescu (1977), Cioflica *et al.* (1980) and Constantinescu *et al.* (1988b) indicate 54.8 to 84.6 mole percent grossularite in the solid solution.
55. Hammarite	Ilinca (1992). Reaction product of Pb-Bi sulphosalts and chalcopyrite.
56. Hematite	Widespread. Early mentioned by von Zepharovich (1859). Also known as "oligiste", "specularite" or "martite".
57. Hemimorphite	Found as earthy masses of milky-white or yellowish-green colour (von Zepharovich, 1859).

Table 4 — continued

58. Heulandite	Tóth (1882) . Doubtful identification.
59. Hornblende	A collective term for common rock-forming amphiboles in banatites.
60. HÖRNESITE	Type locality. First mentioned at Ciclova by Kenngot (1860) who gave a chemical analysis and many physical data. Found in small cavities within a sample from Naturhistorisches Hofmusaeum (Vienna).
61. Hydrotungstite	Recently found by Ilinca and Marincea (1993, present Symposium). Alteration product of scheelite.
62. Ilmenite	Quite frequent accesory mineral in banatites and crystalline schists.
63. Kobellite	First mentioned by Constantinescu *et al.* (1988a). A doubtful phase with a PbS:Bi2S3 ratio of about 54:36 mole percent, matching the composition of kobellite — but with no Sb — was also found by Ilinca (1992)
64. Krupkaite	Ilinca (1992). Largely similar to hammarite.
Kupferpecherz	See chrysocolla, "limonite".
65. Labradorite	Rock-forming mineral in some banatites.
66. Laumontite	Mentioned by Gheorghiţescu (1975a) at Oraviţa in some pseudoskarns. Common in low-temperature hydro-thermal environments.
67. Lepidocrocite	Component of "limonite".
68. Lillianite	Ilinca (1992).
Limonite	Mixture of hydrous iron oxides. It forms pseudomorphs after calcite (von Zepharovich, 1859) and siderite. Main component of the so-called "Kupferpecherz". See goethite, lepidocrocite.
69. Löllingite	Mentioned by Tóth (1882) at Ciclova. Also found by Superceanu (1956, 1958).
70. Mackinawite	Found by Ramdohr in a sample from his personal collection (Heidelberg University). Precise location of this specimen (from Oraviţa) is not known (Udubaşa *et al.* 1992). Usually, as minute inclusions within exsolved chalcopyrite blebs in sphalerite.
71. Magnetite	Early mentioned (von Zepharovich, 1859). Frequently found as pseudomorphs after hematite (= muschketovite).
72. Malachite	Mentioned by von Zepharovich (1859) and Marka (1869). Associated with azurite and "limonite" in the so-called "Kupferpecherz".
73. Marcasite	Gheorghiţescu (1975a). Sometimes, in quite spectacular spheroidal aggregates.
Martite	See hematite.
74. Meionite	Constantinescu *et al.* (1988b). More frequent in Ogaşul Rândunicii, Oraviţa. Commonly referred to as "scapolite".
Melaconite	See tenorite.
Melilite	See gehlenite.
75. Molybdenite	Early mentioned (von Zepharovich, 1859; Marka, 1869). Found in banatites at Oraviţa-Maidan, as well as in some calcic skarns (Superceanu, 1956; Gheorghiţescu, 1975a; Popescu and Constantinescu, 1977; Cioflica and Vlad, 1981; Constantinescu *et al.*, 1988a)
Muschketovite	See magnetite.
76. Nickeline	Old mentions (*i.e.* von Zepharovich, 1859). Associated with gold and "smaltite" .
Oligiste	See hematite.
77. Oligoclase	Rock-forming mineral in banatites
78. Opal	Quite rare.

Table 4 — continued

79. Orpiment	Only old mentions.
80. Orthoclase	Rock-forming mineral in banatites (Gheorghițescu, 1975a, *e.a.*). Also found in hydrothermal alteration assemblages as euhedral, limpid crystals. Usually quoted as "adularia".
81. Parawollastonite	See wollastonite.
82. Pavonite	Ilinca (1992). Minute inclusions in cosalite.
83. Phlogopite	Mentioned at Oravița by Pieptea (1964) and at Ciclova by Cioflica *et al.* (1980). Found in some calcic-magnesian skarns.
Pleonaste	See spinel.
84. Pyrite	Widespread. Impregnations in banatites, hornfels *etc.* Major component of mineralized zones.
85. Pyromorphite	Old mentions only (*i.e.* von Zepharovich, 1859).
86. Pyrrhotite	Widespread. Early mentioned (von Zepharovich, 1873). Various data are given by Nyredi (1896, *fide* Rădulescu and Dimitrescu, 1966).
87. Quartz	Ubiquitous. Rock-forming mineral in banatites, hornfels, pseudoskarns *etc.* Sometimes, well developed crystals.
88. Rutile	Accessory mineral in banatites.
Salite	See diopside.
Samoite	See gehlenite.
Scapolite	See meionite.
89. Scheelite	First mentioned at Ciclova by Koch (1924) and later found at Oravița (Superceanu, 1956). Koch (1924) described crystals up to 0.5 cm along the "c" axis, with usual forms {001}, {101} and {111}. Cioflica and Vlad (1980) described two generations of scheelite.
90. Scorodite	First mentioned by Constantinescu *et al.* (1988a). Quite abundant alteration-product of arsenopyrite.
91. Siderite	Old mentions only (*i.e.* von Zepharovich, 1859).
92. Silver	Mentioned by von Zepharovich (1873) and later by Vendl (1938) and Superceanu (1956). Skeletal aggregates on some barite crystals (von Zepharovich, 1873). Associated with copper and cuprite.
93. Skutterudite	Mentioned as "smaltite" by von Zepharovich (1859, 1873). Prismatic crystals embedded in calcite or compact masses with pyrite, chalcopyrite and nickeline.
Smaltite	See skutterudite.
Specularite	See hematite.
94. Sphalerite	Early mentioned (von Zepharovich, 1859). Usually contains exsolved chalcopyrite and mackinawite.
95. Spinel	Mentioned as "pleonaste" by Tóth (1882). Also found by Gheorghițescu (1975a) in some magnesian skarns at Oravița.
Steatite	See talc.
96. Stibnite	First mentioned by Zipser (1817). Also found by Superceanu (1958).
97. Stilbite	Early mentioned (von Zepharovich, 1859). Described as "desmine". Chemical and physical data are given by Hidegh (1881). The most abundant zeolite mineral.
98. Sulphur	Old mentions only (Cădere, 1925).
99. Talc	Mentioned by von Zepharovich (1859). Compact masses called "steatite".
100. Tellurium	Mentioned by von Zepharovich (1873) and Tóth (1882). Also found by Superceanu (1956, 1958).
101. Tellurobismutite	Popescu and Constantinescu (1977).

Table 4 — continued

102. Tenorite	Mentioned as "melaconite" by von Zepharovich (1859) and Tóth (1882). Also present in the so-called "Kupferpecherz" and "Kupferschwarze"
103. Tetradymite	Mentioned at Ciclova by Tóth (1882). Also found at Oraviţa (Gheorghiţescu, 1975a). Chemical analyses are given by Loczka (1890), and also by Antal (1928) and Clauder (1931), *fide* Palache *et al.* (1961).
104. Tetrahedrite	First mentioned by Tóth (1882) at Ciclova. Chemical analysis is given by Pákozdy (1949).
105. Thomsonite	Mentioned in pseudoskarns from Oraviţa by Gheorghiţescu (1975a).
106. Titanite	Accesory mineral in some banatites.
107. Tourmaline	Popescu and Constantinescu (1977). In banatites at Oraviţa. Quite abundant. Mineral species not specified. Probably schörlite.
108. Tremolite	First mentioned by von Zepharovich (1859). Extensive analytical data were given by Gheorghiţescu (1975a).
109. Vesuvianite	Widespread. First mentioned by von Zepharovich (1859). Beautiful, unusually sized crystals were found at Ciclova (Ţiganilor Valley). Very rich in crystallographic forms: 14 were mentioned by Klein (1894 *fide* Rădulescu and Dimitrescu, 1966), Koch (1924) and Constantinescu *et al.* (1988b). Chemical analyses were given by Weibull (1896 *fide* Rădulescu and Dimitrescu, 1966) and Constantinescu *et al.* (1988b).
110. Vivianite	Rare. Earthy masses. Mentioned by Tóth (1882). Later not found.
Wad	Old mentions only (von Zepharovich, 1859). Probably a mixture of manganese oxides, not specifically identified.
111. Wittichenite	Ilinca (1992). Quite common.
112. Wolframite	Old mentions only (Marka, 1869).
113. Wollastonite	Abundant. Optical data are given by Zimányi (1894), Constantinescu *et al.* (1988b), *e.a.* Unusually sized crystals (up to 6 cm long) at Ciclova. The type-material for the X-ray powder pattern of parawollastonite, given by Heller and Taylor (1956) *fide* J.C.P.D.S. (1974) is from Ciclova: J.C.P.D.S. card 10-489
114. Zircon	Accessory mineral in banatites.

The list is largely based on data from Palache *et al.*, (1961), Rădulescu and Dimitrescu (1966) and Udubaşa *et al.*, (1992).

Stop 1 - **The skarns in Ţiganilor Valley, Ciclova** *(Gh. Ilinca)*

In the northern part of Ciclova, calc-magnesian skarns comprised of wollastonite, diopside, chondrodite, grandite, vesuvianite and minor phlogopite, are largely exposed in relation with a monzodiorite-diorite banatitic body and with Lower to Middle Cretaceous argillaceous-carbonate rocks. Skarns assemblages show strong disequillibria with scarce or no paragenetical intergrown phases.

Wollastonite (*i.e.*, parawollastonite — see Table 4) forms large, prysmatic or needle-shaped crystals sometimes in monomineralic concentrations. It is commonly associated with diopside, chondrodite and garnet, and subordinately with vesuvianite. Extensive replacements of wollastonite by calcite are usual.

Calcic pyroxenes belong to the diopside-hedenbergite series, but magnesian members are by far dominant. Macroscopical diopside is not very striking, but in thin sections it is quite abbundant and well developed. It usually replaces wollastonite, being in its turn, substituted by garnet and vesuvianite. Retrogade hydrothermal metamorphism of diopside resulted in calcite and quartz.

Two generations of garnet with significant chemical contrast occur in Ţiganilor Valley: one with Al-rich composition, forming euhedral, anomalous anisotropic crystals, and another represented by isotropic andradite which frequently cuts and replace the grossularite-dominant members. Locally, some odd myrmekitic inter

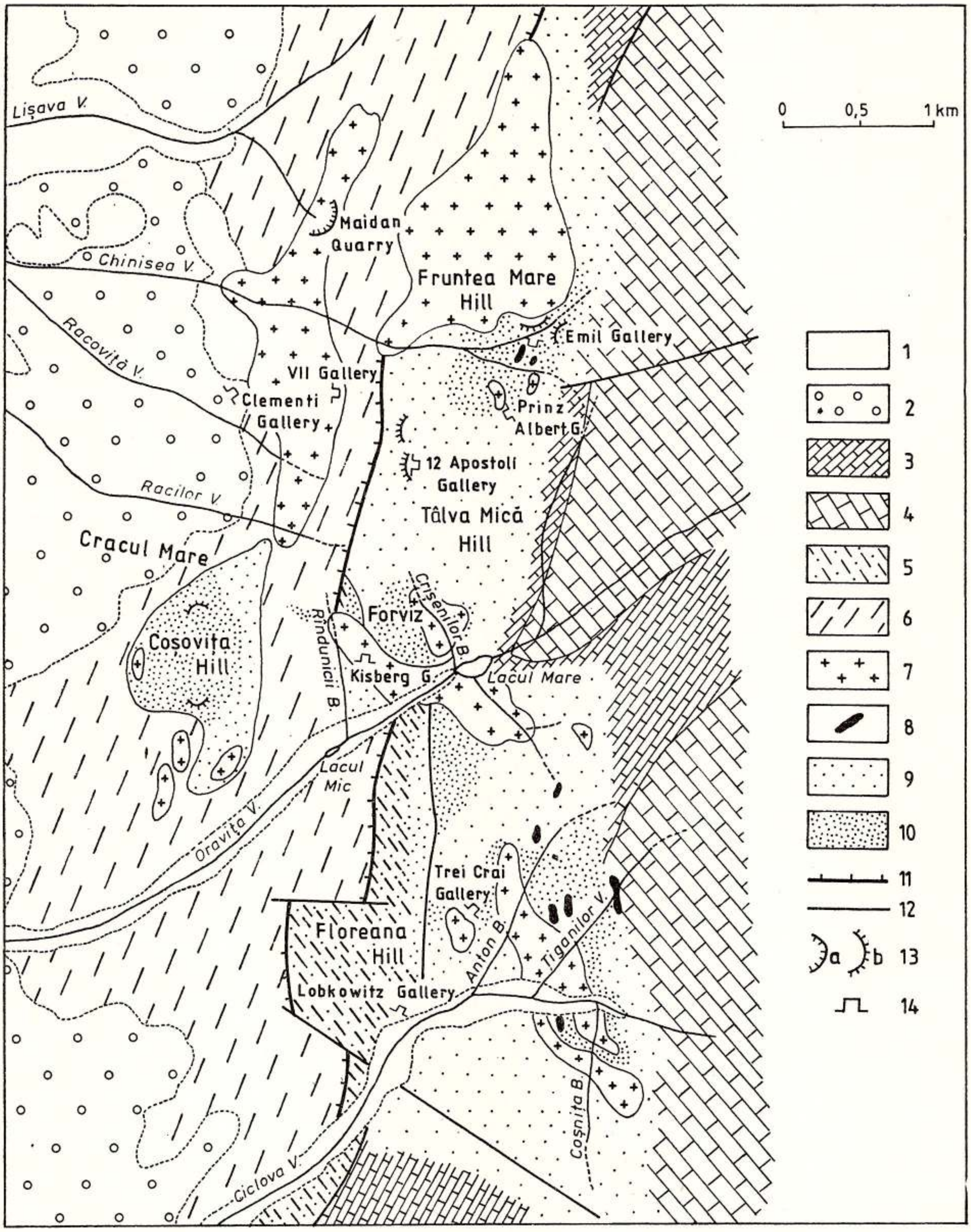


Fig. 3. Simplified geological sketch of Oraviţa-Ciclova zone.
1. Pleistocene (gravel, sands, clays) 2. Miocene (conglomerates, sandstones) 3. Cretaceous (marls, calcareous clays, cherty limestones, reef limestones) 4. Jurassic (cherty limestones, litographic limestones) 5. Permian (lithic sandstones, clay shales) 6. Precambrian (Bocşiţa Drimoxa Fm. and Caraş Group: micaceous gneisses, chlorite-muscovite schists, amphibolites, muscovite-bearing quartzites, metagabbros, *etc.*) 7. Banatites (Late Cretaceous-Paleogene: granodiorites, diorites, monzodiorites) 8. Banatitic vein rocks (andesites, lamprophyres, syenites, alkali-granites, rhyolites, dacites) 9. Hornfels, marbles 10. skarns 11. Bocşa Nappe thrust plane (the Oraviţa Line) 12. Faults 13a. Quarries 13b. Dump wastes 14. Galleries.

growths between andradite and K-feldspar are accessible to microscopical observation.

Vesuvianite is the most abundant skarn mineral. The Ţiganilor Valley is in fact, the most spectacular occurrence of this mineral in Romania. It appears as minute, yellowish-green prysmatic crystals or compact, brownish masses. The most striking, yet not so frequent, are the huge, pegmatite-like crystals with tetragonal-bipyramidal habit, reaching up to 10 cm along horizontal axes. This habit was found to be characteristic to the Oraviţa-Ciclova zone, as the other known occurennces (*e.g.* Sasca Montană, Constantinescu, 1980) display mainly tetragonal prisms. Chemical composition (after Constantinescu *et al.*, 1988b) reveals average contents of main oxides: SiO_2 = 37.64%; TiO_2 = 0.12%; Al_2O_3 = 20.38%; Fe_2O_3 = 5.15 %; MnO = 0.08 %; MgO = 2.72 %; CaO 33.19 %; Na_2O = 0.03 %; H_2O^+ = 0.30 %; H_2O^- = 0.19%. As compared to other occurrences, the vesuvianite from Ciclova shows no FeO values or extremelly small amounts: 0.58 or 0.25 % (Cioflica *et al.*, 1980). Vesuvianite is the latest phase in the skarn mineral sequence and most probably it makes the transition to the cooler, hydrothermal stage. It is commonly replaced by phlogopite, epidote, quartz and calcite.

Isolated specimens from the aureoles of several vein bodies of syenites, exhibit unusual fibrous-radial aggregates of vesuvianite, apparently pseudomorph after a fibre-shaped mineral. X-ray powder diagrams of such samples pointed to major vesuvianite and traces of serpentine and szaibelyite (Constantinescu *et al.*, 1988b).

Stop 2 - **Clintonite occurrence from Lacul Mare-Ogaşul Crişenilor, Oraviţa** *(Gh. Ilinca)*

The Lacul Mare-Ogaşul Crişenilor area represents the "hottest" thermal metamorphic and metasomatic point in Banat. Gehlenite-diopside skarns, previously known only in some recent alluvia, south of Oraviţa originate in this area (Constantinescu *et al.*, 1988b). They are related to a mixed, diorite-gabbro banatitic body which is the north extension of the monzodiorites from Ciclova. With the exception of gehlenite the skarn mineralogy is very similar to the one described in Ţiganilor Valley. Gehlenite may incidentally be found as millimetric grains of a dark green colour, within a groundmass of diopside and clay minerals. Garnets and vesuvianite are also abundant.

The late hydrothermal stages produced significant amounts of epidote, clintonite, calcite, quartz, K-feldspar and zeolites (stilbite, thomsonite).

Clintonite was first described here by Popescu and Constantinescu (1977). Previous authors may not have failed to notice this occurrence, but most probably the mineral was considered phlogopite. Minor amounts are also known from some old waste dumps, north of Oraviţa (*e.g.* the Clementi gallery).

Macroscopically, clintonite occurs as green, platy crystals of up to 1 cm wide. It usually underwent supergene decolouring which gave the crystals a muscovite-like appearance.

Stop 3 - **Scapolites from Ogaşul Rândunicii, Oraviţa** *(Gh. Ilinca)*

In the northwestern margin of the diorite-gabbro body from Oraviţa Valley (previous stop) affects the crystalline schists of the Bocşa Nappe (*i.e.* the Bocşiţa-Drimoxa Fm.). Andalusite + cordierite-bearing hornfels prevail, but some small veins or lens-shaped skarn bodies occur, too. The skarns contain mainly skeletal-garnet which is heavily replaced by scapolite, epidote, calcite, quartz and zeolites.

Scapolite form centimetrically developed radial-aggregates of prysmatic crystals. Microscopically they emphasise limpid, euhedral forms with marked pseudo-absorption. Basal section zoning shows evolution of the crystals from initial {100} tetragonal prisms to {110} forms. Optical features point to a composition close to meionite end member.

2. EXCURSION B.

First day

Stop 1 - **Alkali-basaltic volcanites from Lucareţ - Şanoviţa** *(I.Seghedi)*

This volcanic area (about 40 km^2), located *c.a.* 35 km east of Timişoara on the southern bank of the Bega Channel, is accessible to observation in quarries of exploitation for road constructing raw materials dated as back as 1779.

Volcanic activity developed in three main episodes (Adda, 1897, Mateescu, 1937). It started with explosive eruptions forming bedded pyroclastic tuffs exposed only in the northern part at Lucareţ. They overlie sands and argillaceous sands considered of Pontian age (Adda, 1897) or Pliocene (Mateescu, 1937).

The paroxismal phase corresponds to massive outpouring of lavas. The thickness of lava flows is variable — 12-16 m in the central area and 2-3 m at the periphery. A complete section of lava flow sequence is well illustrated in the Lucareţ quarry where one can observe platty jointing at the bottom and columnar jointing in the middle and *aa* lava in the top. A complex pattern of irregular and spheroidal jointing is visible in the biggest quarry in Şanoviţa.

During the third phase a scoria cone of strombolian type at Piatra Roşie Hill has been built up (Adda, 1897). Its remnants consists of scoria and volcanic bomb fragments and scoriaceous lapilli. Piatra Roşie hill was considered later as the main eruptive center for the volcanic material of the whole area where a large monogenetic shield volcano is developed (Mateescu, 1937).

The basaltic rocks display vesicular or porous structure in pyroclastic fragments or at the base and/or top of lava flows. Granular or "Sonnebrenner" or "cucuruz" (local name) type structures are encountered, as well. Secondary silica or calcite locally occur in the vacuoles.

The rocks occasionally contain rare mantle and crustal xenoliths (*e.g.* Şanoviţa big quarry). Their mineralogical features are typical for alkali-basalts including phenocryst assemblages dominated by olivine, subordinate clinopyroxene, mycrophenocrysts of ore minerals (Ti-magnetite, ilmenite) set in a fine to medium grained groundmass of olivine, clinopyroxene, plagioclase, oxides, apatite and glass (Mateescu, 1937, Savul and Nichita, 1944, Savu *et al.*, in press). The olivine phenocrysts are abundant and slightly skeletal (Fo_{80}-Fo_{77}), some of which are presenting iddingsitic rims. Forsteritic olivine crystals (Fo_{89}) found in these rocks may reflect a xenocrystic origin (Downes *et al.*, in press). The clinopyroxenes ($En_{40}Wo_{49}Fs_{11}$) coexist with plagioclase of An_{55-51} (Downes *et al.*, in press).

The earliest geochemical data concerning Lucareţ basalts have been published by Savul and Nichita (1944) (Table 5). Recent data were furnished by Savu *et al.* (in press) and Downes *et al.* (in press). In a SiO_2-K_2O+Na_2O diagram (Fig. 6) almost all the samples plot inside the trachybasaltic field (Le Bas *et al.*, 1986).

Table 5. Major chemical analyses.

Oxides	Lucareţ*	Sanoviţa*	g(8)**	d(11)**
SiO_2	48.330	48.900	47.91	47.71
TiO_2	2.252	2.186	3.99	3.44
Al_2O_3	14.880	14.680	13.62	15.83
Fe_2O_3	10.640	10.690	4.92	1.76
FeO	—	—	6.37	8.14
MnO	0.153	0.154	0.28	0.36
MgO	8.020	8.430	8.05	8.14
CaO	8.230	8.520	8.04	6.54
K_2O	1.992	1.633	1.08	1.08
Na_2O	4.340	3.390	4.06	4.41
P_2O_5	0.700	0.598	0.39	0.45
LOI	0.000	0.290	—	—
H_2O^+	—	—	0.36	0.28
H_2O^-	—	—	0.84	0.51

* Downes *et al.*, (in press); ** Savul and Nichita (1944)

Information concerning trace element distribution in Lucareţ-Şanoviţa basalts was recently obtained by Savu *et al.* (in press) and Downes *et al.* (in press) (Table 6). Trace element and REE data (Downes *et al.*, in press) and the $^{87}Sr/^{86}Sr$ and $^{143}Nd/^{144}Nd$ ratios determined at the University of London (Downes *et al.*, in press) are displayed in Table 6.

Table 6. Trace elements (a), REE (b) and isotopic data (c).

a.

Elem.	Lucareţ	Sanoviţa
Sc	19	18
Ba	581	539
V	192	192
La	35	37
Ce	92	66
Nd	42	30
Cr	210	247
Ni	147	170
Cu	55	56
Zn	107	110
Pb	4.8	5.1
Th	6.7	5.1
Rb	50.7	37.2
Sr	731	658
Y	26.6	24.0
Zr	262	220
Nb	70	56.4
Ta	4.8	4.06
Hf	5.5	4.9
Co	48	49

b.

Elem.	Lucareţ	Sanoviţa
La	42.6	35.2
Ce	78.7	65.5
Nd	37.0	32.0
Sm	7.52	6.66
Eu	2.33	2.13
Gd	6.64	6.23
Dy	5.56	5.14
Er	2.53	2.45
Yb	2.02	18.3
Lu	0.29	0.27
Eu/Eu*	1.01	1.01

c.

	Lucareţ	Sanoviţa
$^{87}Sr/^{86}Sr$	0.70347 ± 1	0.70371 ± 1
$^{87}Sr/^{86}Sri$	0.70346	0.70370
εSri	-14.6	-11.2
$^{143}Nd/^{144}Nd$	0.512890 ± 06	0.512860 ± 20
εNdi	4.5	4.3

Adda (1897) emphasized a late Lower Pliocene age for the basalts overlying Pontian sedimentary deposits. Later, Mateescu (1937) considered the age of these sedimentary rocks as Pliocene and defined the lower limit of the eruptions not older than the Uppermost Pliocene (Levantine) and their upper limit not younger than Lower Quaternary. On the Geological map of Romania, scale 1:200 000, sheet Timişoara, the Lucareţ-Sanoviţa basalts are assigned to Quaternary (Drăgulescu *et al.*, 1968).

Recently obtained radiogenic datings resulted in K/Ar ages of 2.64 m.y. for the Sanoviţa quarry basalts and 2.52 m.y. for those from the Lucareţ quarry which indicate Upper Pliocene age of the volcanic activity (Downes *et al.*, in press).

Savu *et al.* (in press) underlined the similarities between the Lucareţ basalts and other known continental intraplate basalts. Downes *et al.* (in press) show that the alkaline basalts resulted from primitive undersaturated trachybasaltic magmas (8.02-8.43 wt % MgO, 147-170 ppm Ni, 210-247 ppm Cr). Mantle normalised trace element diagrams reveal their similarity to continental intraplate alkali-basalts but their similarity to average OIB is obvious, too (Fig. 7,8).

In terms of $^{87}Sr/^{86}Sr$ and $^{143}Nd/^{144}Nd$ isotope ratios, the Lucareţ-Sanoviţa basalts are indistinguishable from those occuring in the western Pannonian basin (Embey-Isztin *et al.*, in press) indicating a similar mantle source for both locations (Fig. 9).

Stop 2 - **Colţan flag station. Bocşiţa-Drimoxa Formation in the basement of the Bocşa Nappe and the sedimentary cover** *(Viorica Iancu)*

The outcrops exhibit Precambrian plagiogneisses of the Bocşiţa-Drimoxa Fm. belonging to the basement of Bocşa Nappe; they are overlained by a thin sedimentary cover: Upper Carboniferous conglomerates and breccias and a discordant carbonate cover (Middle Jurassic-Upper Cretaceous). Thin Mesozoic cover (from the ridge area) is preserved discontinuously into a narrow synclinal and affected by post-nappe (post-Middle Cretaceous) folding and high angle thrusting (a reverse fault with eastern vergency).

Pre-Alpine basement is represented by rocks of the Bocşiţa-Drimoxa Formation: micaceous plagiogneisses with relics of almandine, biotite, plagioclase (oligoclase-andesine), formed during M1 dynamo-thermal event under amphybolite facies conditions, and secondary (M2 – green schist facies reactivation) dynamo-thermal phases: chlorite, muscovite, albite, Fe oxides, quartz. The outcrops reveal intra-folial transposition F2 folds and S2 foliations as well as quartz seggregations.

Stop 3 - **Moniom-Valea Satului volcano-sedimentary Formation; Cârşie metaconglomerates (Upper Devonian-Lower Carboniferous) structural relations between Alpine Moniom and Reşiţa Nappes. Internal, pre-Alpine structures** *(Viorica Iancu)*

The Moniom Alpine (Middle Cretaceous) Nappe outcroping area (west to the Moniom Valley) exhibit: a) a sequence of the Valea Satului Formation (Upper Devonian-Lower Carboniferous) represented by basic metatufs, metaconglomerates, metapelitic and metapsamitic rocks, with subordinate carbonaceous rocks and associated metarhyolites, metagranodiorites and, metagabbros; b) a sequence of the Cârşie Fm. (Lower Carboniferous): metapsamitic-metapsefitic rocks with subordinate metapelites. These two lithologic entities are separated by a pre-Alpine shear zone, in which greenschist facies blastomylonitic rocks appear in a progressive (apparently transitional) deformation zone, superposed on the two mentioned types of lithologies. Dynamo-thermal effects of a Variscan event (Sudetic Phase) are: S1 cleavages and foliations, F1 folds or mullion-type structures, deformed pebbles as well as anchizone to greenschist facies blastesis. An important feature of the two mentioned formations is a good preservation of inherited minerals and structures, in the sedimentary rocks (S0 bedding, pebbles, etc.) and in the magmatic ones.

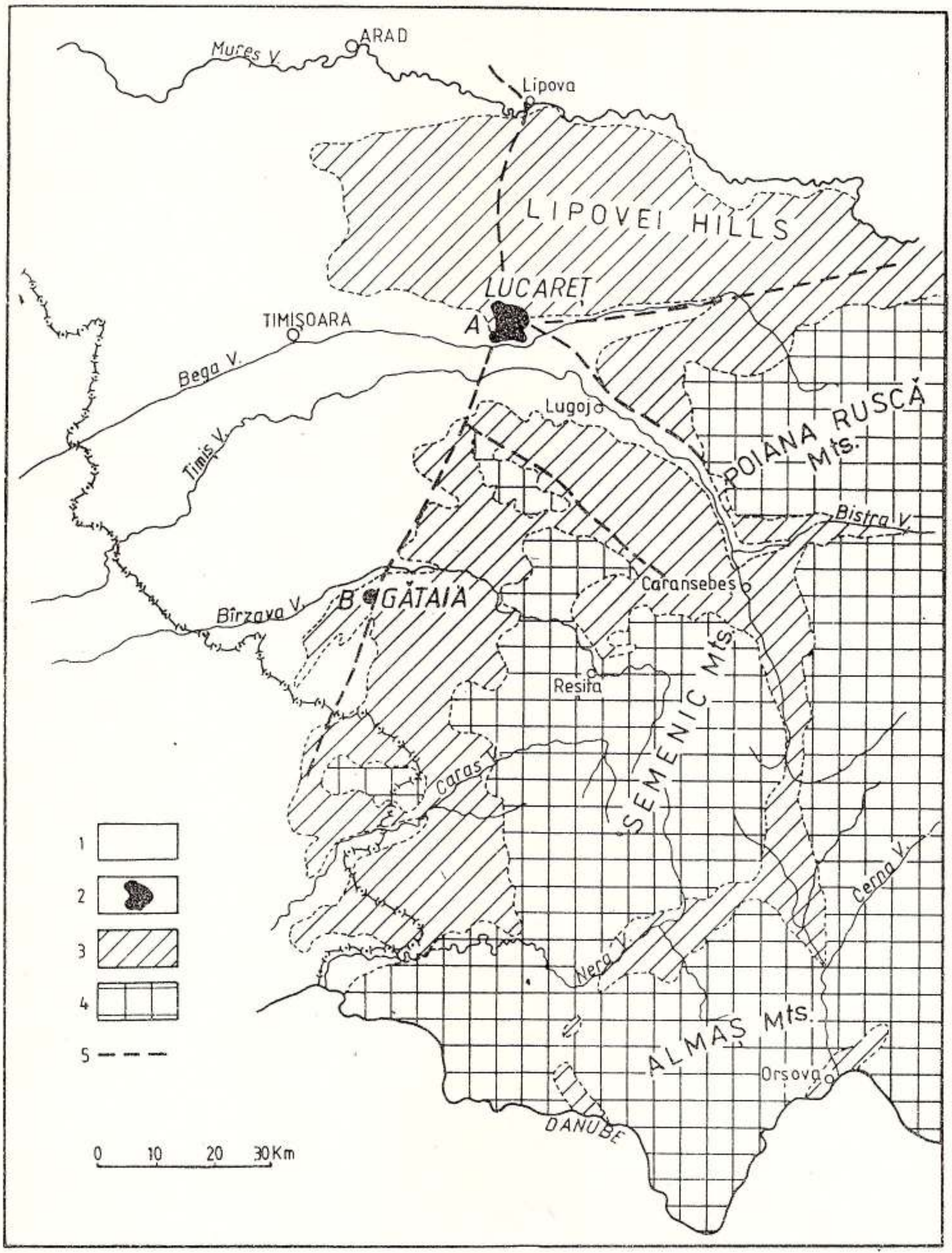


Fig. 4. Geological sketch of Banat with alkali-basaltic occurrences (after Mateescu, 1937; slightly modified). 1. Recent alluvia (Holocene) 2. Alkali basalts (A. Lucareţ-Sanoviţa, B. Gătaia) 3. Neogene and Pleistocene deposits 4. Metamorphic rocks and Paleozoic and Mesozoic deposits 5. Fractures.

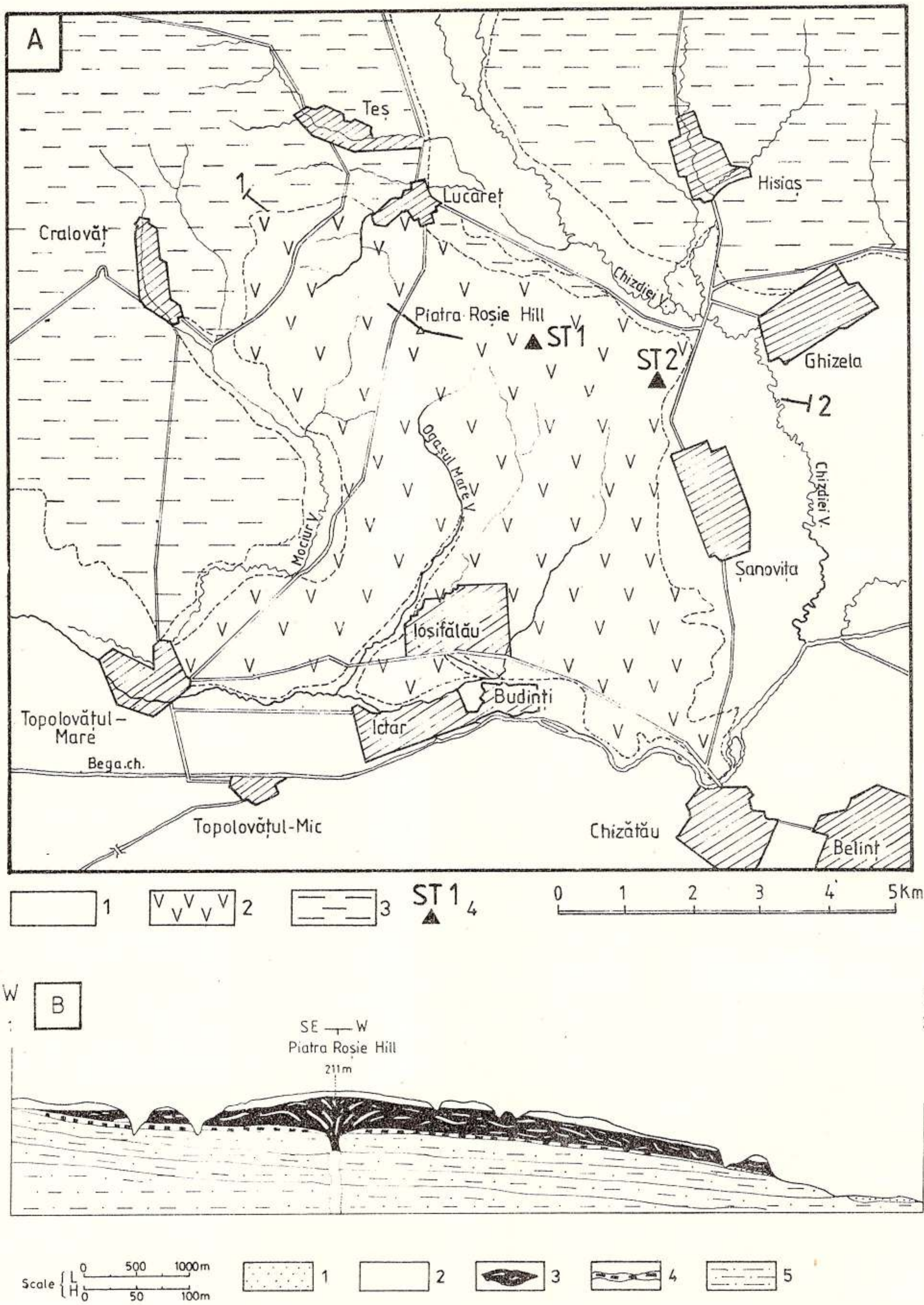


Fig. 5. The Lucareț-Șanovița alkali basaltic occurrence (after Mateescu, 1937). A.Geological sketch: 1. Quaternary deposits 2.Alkali-basalts 3. Pliocene deposits 4. Stops: St-1 — Lucareț quarry St-2 — Șanovița quarry. B. Geological section: 1. Alluvial terrace 2. Quaternary deposits 3. Basaltic lava 4. Pyroclastics 5. Pliocene deposits (clays and sands).

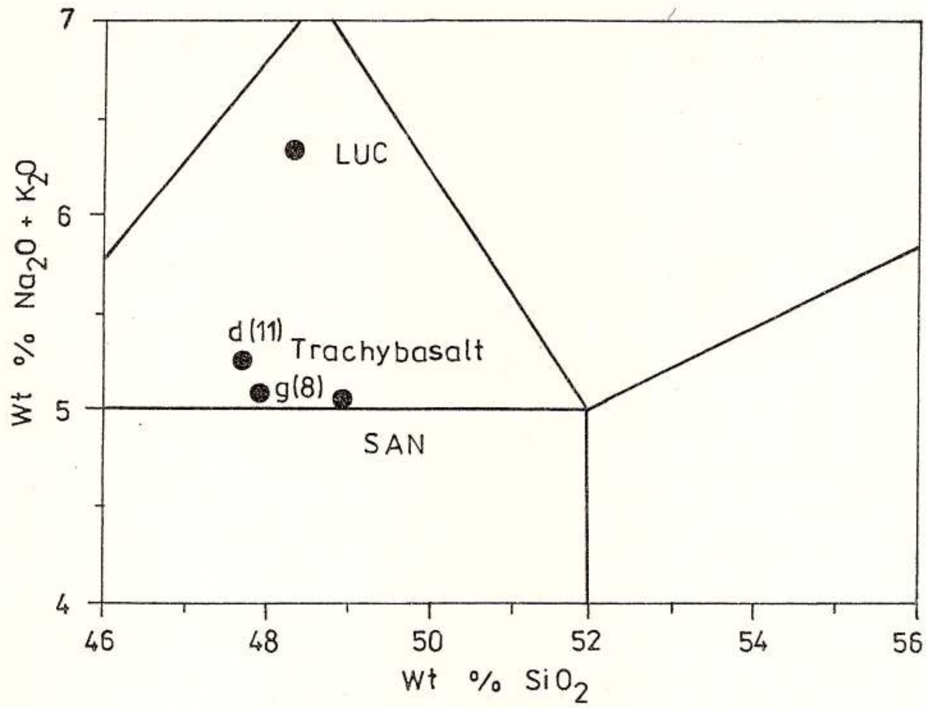


Fig. 6. $K_2O + Na_2O$ *vs.* SiO_2 diagram for Banat basalts.

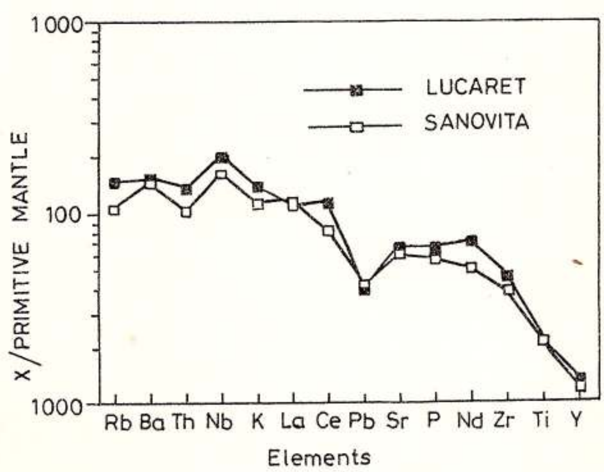


Fig. 7. Primitive mantle normalized trace element variation diagram for Banat basalts.

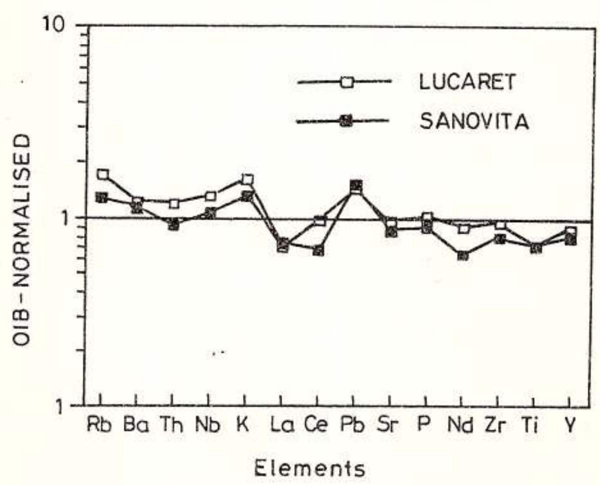


Fig. 8. OIB normalized trace element variation diagram for Banat basalts.

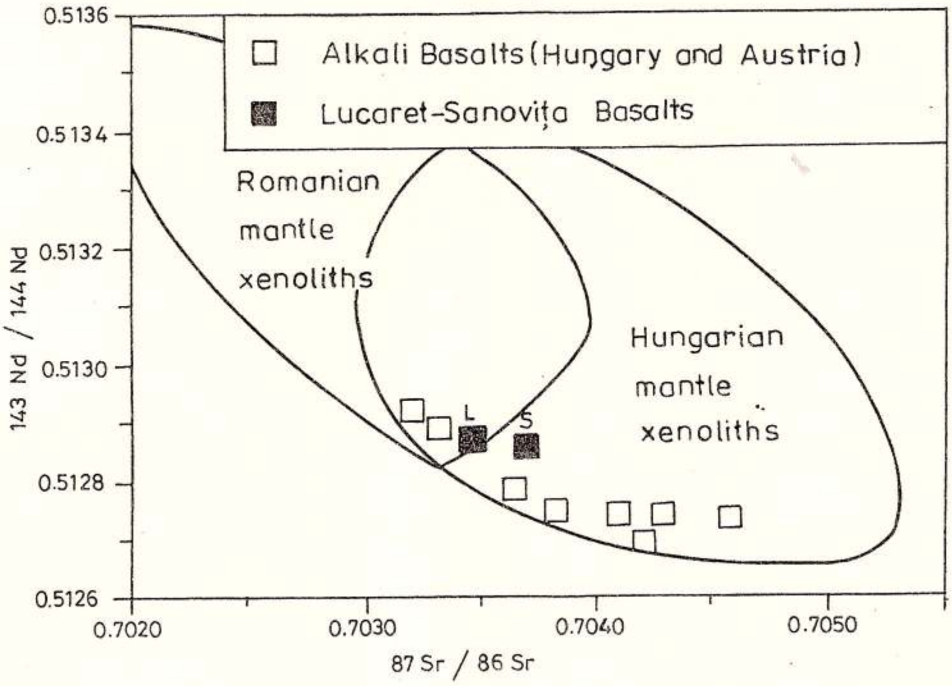


Fig. 9. ^{143}Nd / ^{144}Nd *vs.* ^{87}Sr / ^{88}Sr diagram for Banat basalts

Second day

Stop 1 - **Nera Valley between Sasca Montană and Bogodinţi**
Stop 2 - **Stilpnomelane-bearing metarhyolites on the road Oraviţa-Moldova Nouă** *(Viorica Iancu)*

A geologic profile on sequences from the Caraş Group (Lower Paleozoic) and their tectonic contact with ante-Paleozoic basement (Bocşiţa-Drimoxa Fm.) may be seen along Nera valley, downward of Sasca Montană (approximately 6 km). The tectonic contact between these two litho-tectonic entities is a pre-Alpine blastomylonitic zone preserved in the Bocşa Alpine Nappe. In the field, a transitional zone of aproximately 1 km wide, reflect a shear zone in which, low angle, simple shearing was connected to blastesis under greenschist facies level and abundant seggregations of metamorphic quartz. This contact is embodied by a set of common S2 foliations.

There is a strong lithologic and petrographic contrast between Căraş and Bocşiţa-Drimoxa rock sequences, concerning the type of their succesive metamorphic and deformational regional evolution regimes.

In this profile, the Bocşiţa-Drimoxa (Precambrian) Fm. is represented by retrogressed plagiogneises, quartzo-feldspatic gneisses and micaceous and garnetiferous plagiogneises. Relic garnet, biotite and plagioclase are preserved in association with greenschist mineral facies.

The Caraş Group from Locva massif consists of two formations: Naidaş volcano-sedimentary Fm. and Zlatiţa terrigenuous Fm. Based on the palynoprotisologic content of the two entities, the estimated ages are: Lower Paleozoic (Cambrian to Silurian) in the case of Naidaş Fm. and Upper Devonian-Lower Carboniferous for the Zlatiţa Fm. (Maier, Visarion, 1976; Visarion, Iancu, 1986; Iancu, 1984).

In the eastern part of the Locva massif, in the profile to be visited there are exposures of the Naidaş Fm. represented by: quartz-micaceous schists, quartzites and green rocks (chlorite-epidote / clinozoisite + actionte ± albite porphyroblasts) and scarce bodies of doleritic and gabbroic rocks. A special characteristic of metamagmatic basic rocks in this formation is the presence of acid magmatites (metarhyolites) in a bimodal magmatic association. In some occurrences, metarhyolitic rocks exhibit stilpnomelane or muscovite as metamorphic phases, coexisting with magmatic phases: K-feldspar, bi-pyramidal quartz; in this case, mixed structures (inherited and tectonitic) are typical

The first dynamo-thermal event (M1) does not exceed the greenschists facies level (chlorite- stilpnomelane, biotite, and locally garnet zones) and is associasted with regional F1 folds. A superposed F2 folding and partial isofacial re-organization (M2) may be synchroneous with simple shearing and overthrusting on the older basement.

Similar rocks and structural elements, as well as nice occurrences of stilpnomelane-bearing metarhyolites may be observed on the road Oraviţa-Moldova Nouă, on the southern slope of the Locva massif .

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