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PALEOGEOGRAPHIC DEVELOPMENT OF THE LATERITIC CRUST PRODUCTS AND FURTHER PROSPECTING IN THE BILISHT-KASTORIA AREA (SOUTH ALBANIA-NORTHERN GREECE)

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ABSTRACT

Nickeliferous lateritic iron-ores are exposed as a discontinuous layer in the Bilisht-Kastoria area on both sides of the Albanian-Greek border. Two types of mineralization, representing two different levels of lateritic alteration, are observed in the area. The first was formed during the continental conditions which followed the orogenic process in the Middle Cretaceous and consists of nickel-silicate and iron-nickel ores. The second formed in the Late Paleocene-Early Eocene during the new paleogeographic situation which followed the Tertiary orogenic process, and caused an almost complete erosion of the Late Cretaceous sediments and the lateritic products of the first level. The second level includes the most important iron-nickel and nickel-silicate ore deposits in Albania which are found on the ophiolites and covered by molassic conglomerates of Middle Eocene age. During the Tertiary orogenic process a tectonic ophiolitic melange including blocks of Triassic-Jurassic limestone was formed as well. Redeposited lateritic products of the second level covered these Triassic-Jurassic blocks before the Middle Eocene transgression in the Molassic basin. Field observations on the sedimentary conditions of the molassic conglomerates as well as on the lateritic deposits indicate the most favourable areas for prospecting iron-nickel deposits in Greek territory.

INTRODUCTION

The iron-nickel and nickel-silicate mineral district of Bilisht-Kastoria straddles the Greek-Albanian border. Unlike all other lateritic ore deposits in Albania and Greece, here there is a full profile of the destruction crust with nickel-silicate and above it iron-nickel with a higher content of nickel of particular industrial importance.

In Albania large reserves of this mineral have been found and prepared for exploitation. On the Greek side of the border there are promising signs of the mineral at depth.

Knowing the importance of these minerals, the Polytechnic University of Tirana and Aristotle University of Thessaloniki have done some joint studies on both sides of the border. These studies aim at a new and more precise solution for the paleogeographic development of the lateritic crust and for the conditions of formation and development of mineralization. This in turn will help in finding new mineral reserves.

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THE STRUCTURAL GEOLOGY OF THE AREA

The Bilisht-Kastoria iron-nickel and nickel-silicate lateritic mineral field lies in the eastern part of the ophiolitic tectonic zone (Mirdita in Albania or Subpelagonian in Greece) in contact with the Triassic-Jurassic carbonates, in the Devolli-Thessalia molassic lowland (Mesohellenic trough) lying between mountainous regions dating from the Paleozoic to the Neogene (Fig. 1).

Geologically the district is made up of:

Triassic-Jurassic (T3-J1) carbonate deposits

These make up the extreme eastern part of the district from Mt Thate, Piramides, Kastraki to Kastoria. They are composed of massive limestone or thick layers of grey limestones; they are pellithomorphs at differing stages of recrystallization, at times with an intertwining of knotty and grainy limestones and radiolaritic silicates. Localy they are biomicrosparitic limestones. (Mountrakis 1982, 1984; Peza et al., 1987).

Often these limestones outcrop as blocks on ultrabasic rocks, tending to their western edges, such as at Bitincka, Tren, Kristallopigi, Koromilia etc. In the past they were treated especially by Albanian geologists (Pumo 1974), as belonging to the Cretaceous, but now they have been shown to contain fauna of the upper Triassic, such as Trochammina c. alpina, Textularidae, Nadosaridae, Ostrocoda, Ksinoide, Glomospirella friedli Kristan-Tollman, Ophthalmidium sp., etc, that date back to the upper Triassic (Molla & Jani 1986).

The Upper Jurassic (J3) volcanosedimentary series

This appears as a small outcrop not far from Lake Mikri Prespa and Golloborda, and is represented by radiolaritic silicates, clay-silicates, sands with a high manganese content and volcanic relicts (Grazhdani, Pavliqi 1970).

Upper Cretaceous (Cr2) carbonate deposits

These make a limited appearance at Zemblak on the ultrabasics and iron-nickel ore body. They date back to the Turonian-Cenomanian period and are represented by rudistic limestones of a grey, colour.

Paleogene-Neogene molassic deposits

These deposits extend all over the inner part of the Devolli-Thessalia (Mesohellenic) lowlands. These sediments do not form a whole sedimentary cycle, but range from Eocene to Pliocene, with stratigraphic interruption between them. The first between the Eocene and the Oligocene and the second between the Langian and the Pliocene-Quaternary, thus forming three sedimentary cycles (Jani 1985): First cycle: Eocene molassic sediments, (Pg231); Second cycle: Oligocene-Langhian molassic sediments, (Pg3-N11), Third cycle: Pliocene-Quaternary molassic sediments, (N2pl-Q).

The deposits of the first cycle of Eocene molasse (Pg231) lie in the eastern part of the lowlands. They start from Lake Mikri Prespa and, continuing south, acquire an ever larger surface. These deposits form the cover of the iron-nickel ores and are placed transgressively on the ultrabasics and limestones of the Upper Triassic. The age of these deposits in Greece (Plastiras 1980, Savorat, Monopfalin 1971) is still undefined, but they are considered Aquitanian. In the Bitincka-Kapshtica region these deposits are defined as a typical Eocene formation, not only because of the fauna found there but also because of the lithological composition of the series. The conglomerates with pebles of metamorphic composition, represented in the western part of the lowland, where the Aquitanian deposits are confirmed, are totally absent in this formation.

In this series, mainly in the limestones the following big foraminifers are found: Alevolina elongatat, A. violae, A. oblonga, Nummulites lucas, N.

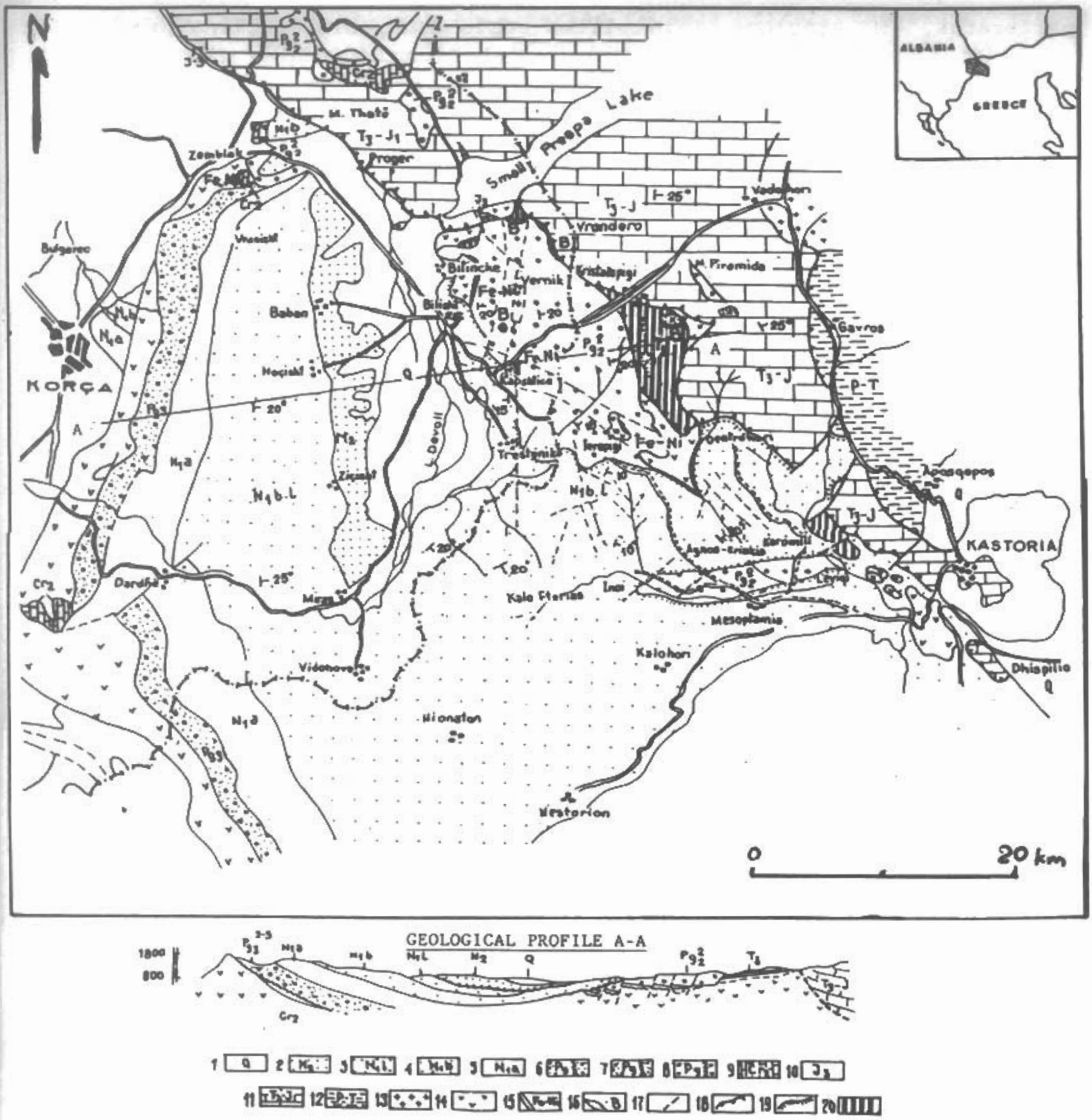


Fig. 1: Geological map of the Bilisri - Kastoria district of the iron - nickel lateritic deposits.
1. Quaternary. 2. Pliocen - Argilites, sandstones and coal stratums. 3. Langhian - Argilites, aleurite, sandstones, 4. Burdigaliane - Sandstones, marls. 5. Acuitaniane - Argilites, aleurites, sandstones and conglomerates. 6. Upper Oligocen - Flysch, marls, sandstones with limestones stratums, argilites and coal. 7. Middle Oligocen - Flysch, argilite, aleurite, sandstones, conglomerates, coralic limestones, marks and coal. 8. Middle Eocene - Limestones, marls and conlgomerates 9. Cretaceous - Rudistic limestones. 10. Upper Jurassi - Sedimentary -Volcanic serie. 11.Triassic - Jurassic - Limestones. 12. Permo - Triassic - Metamorphic schiste. 13. Granites. 14 Ultramafic. 15. Bauxite ore. 16. Iron - Nickel ore. 17. Tectonic line. 18. Thrust fault. 19. Transgressively contacty. 20. Tectonic blocks of the Triassic limestones.

perforatus, N. atacicus, Orbitolites coplanatus, Discocyclina pratti, D; nummulitica etc. The following molluses are also found: Certhium (Ptychocerithium johannae), Doastoma ef. castellatum, Vermetus(Tubylastrium) sorulecum, Ampulina gratum, Cordiopsis ef. increassatus, Miltha ef. escheri, M. Gipsula, and corals of the Dandracis gervilli species. This fauna argued for the Upper Lutetian-Priabonian (Pashko 1975, Peza, et al. 1987, Jani 1985). (Fig.2).

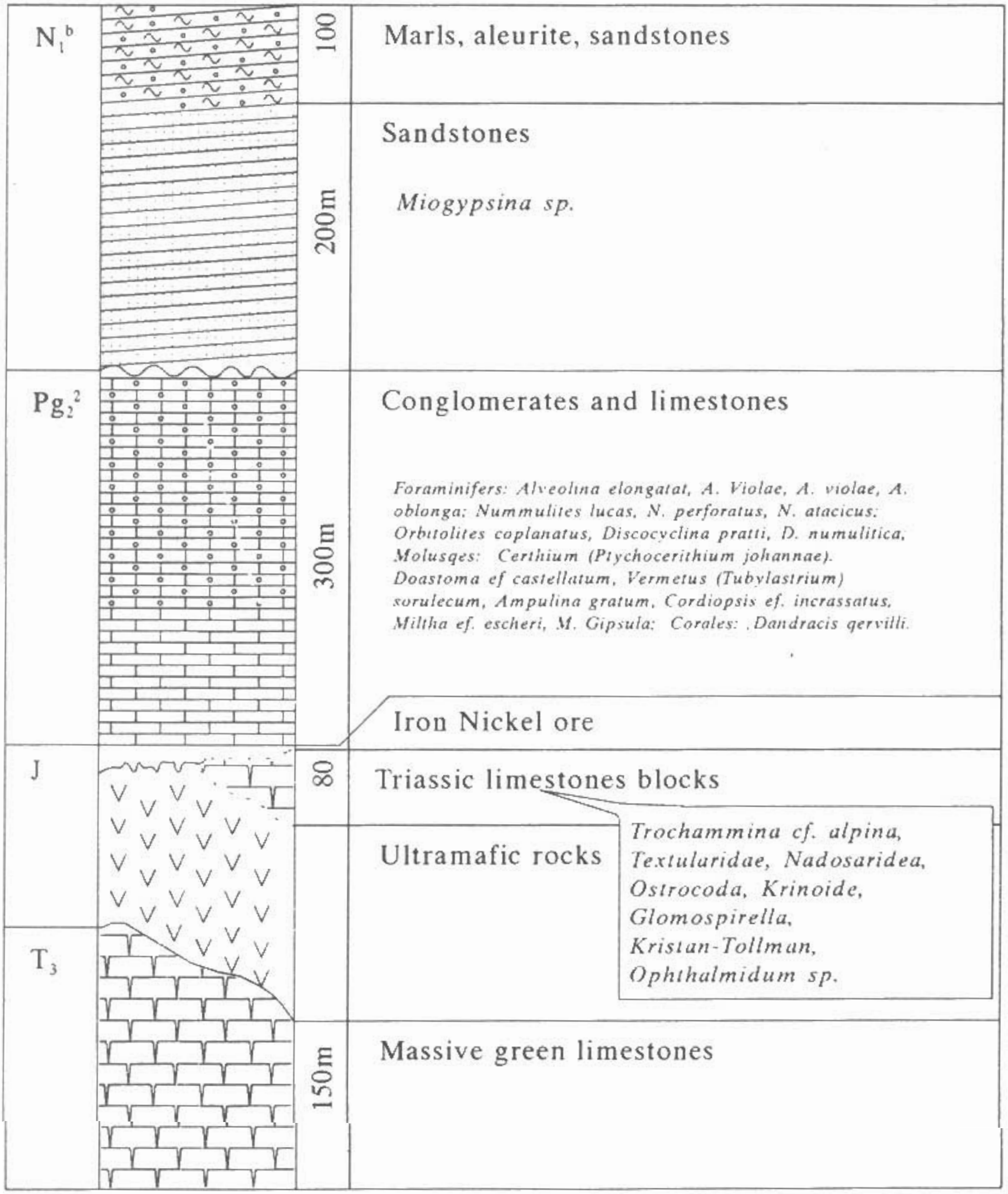


Fig. 2: Stratigraphic section of the deposit of the Iron - Nickel and Nickel - Silicats BILISHT - KASTORIA

A vertical section through this series reveals, first, the slabby limestones on the iron-nickel ores, some 150m thick, which are followed by conglomerates and conglomerate limestones some 350m thick. The composition of the conglomerate grains is mainly Triassic and Cretaceous limestone, with very few ultrabasic and basic pieces.

In the east these deposits are transgressively covered by Burdigalian, whereas in the central and western part of the lowlands, such deposits do not appear. The Eocene deposits are encountered as scattered relicts on the Triassic limestones on Mt Thate, Kristalopigi and Mt Triklarion-Piramida (Mountrakis 1982, 1984).

The deposits of the second cycle start with the Oligocene series that extends on the western side of the lowlands, transgressively lying on the ultrabasics of Mt Morava. These deposits start with conglomerates on which lie clay, marl and sandy layers, as well as coal layers in Mborje-Drenova. Over these lie Aquitanian conglomerates, composed of grains of metamorphic rocks (gneiss, quartzite), a smaller quantity of basic rocks and a still smaller proportion of limestones, which are characteristic of the Mesohellenic lowlands, of the "Meteora type", marls, sands and clays of Burdigalian and Langhian sands and aleorolites (Pashko 1977).

The third cycle of deposits is represented by clay and sand layers combined with coal layers and Pliocene clays of some 400m thickness, transgressively placed on the Burdigalian and Langhian deposits at the centre of Devolli lowland.

Ultrabasic magmatic rocks outcrop in the eastern part of the lowlands, not far from the Triassic limestones around Lake Mikri Prespa, in the village of Bitincka, Ieropigi and even in the vicinity of Kastoria. These are represented by Jurassic harzburgites, highly serpentinized and split on the surface as a result of lateritic processes. Another belt of ultrabasic rocks outcrops between Paleogene-Neocene mollasic deposits in the western part of the lowlands, on Mt Morava.

Extensive tectonics have influenced the formation of the Devolli-Thesalia (Mesohellenic) lowland, its structure and slopes in its central part. Normal faults trending NNW-SSE divide the ore field into several blocks, in the form of "steps" from west to east. Distances between tectonic lines range between 200 and 600m. More recent normal faults trending E-W have also split the ore field.

THE CHARACTERISTICS OF THE ORE BODIES

The lateritic mineralisation of iron-nickel and nickel-silicate in the district is represented by an ore body with an outer cover of layers lying on ultrabasic (serpentinized) rocks and covered by limestones.

There are two types of mineralization, corresponding to two different levels of lateritic alteration: The first is the Cenomanian level, represented by the Zemblak (Fig.3) and Spano (Fig.4) ore deposits. It lies on serpentinized harzburgites and is covered by Upper Cretaceous limestones. The ore body contains iron-nickel minerals and is composed of iron oxides and hydroxides containing 46% Fe, 0.9% Ni, 0.08% Co, 4.5% Cr_2O_3, 8.2% SiO_2 etc. The ore is dark brown and predominately of oolytic and pisolytic texture. The thickness of the iron-nickel ore varies from 2-7m, Fig.2 (Pumo 1974).

The second is the Upper Paleocene-Lower Eocene level, represented by the Bitincka-Kapshtica-Ieropigi ore deposits (Molla & Jani 1986; Albandakis 1981).

The ore bodies outcrop in the northern part of the district, in the Bitincka-Bilishti zone, in the tectonic outcroppings of Kapshtica, Ieropigi

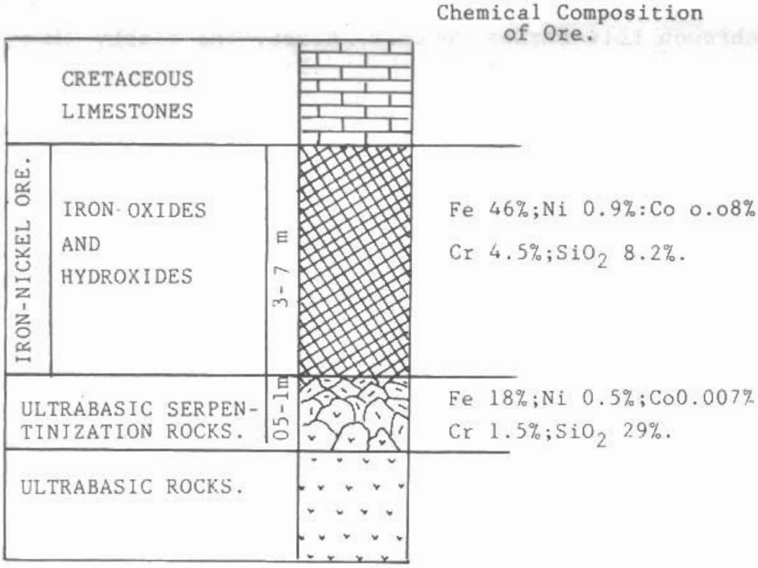


Fig. 3: Generalized section of the Iron - Nickel of the Cenomanian level of the Zemblaku ore deposit types.

etc. This level is the biggest iron-nickel and nickel-silicate ore deposit discovered in Albania. It lies on serpenti-nized harzburgites and is covered by limestones and conglomerates of Eocene age. (Fig.5, Fig.6).

On a vertical section, the ore layers are made up to two types of mineralisation. The lower part of the ore section presents a nickel-silicate type, that is a gradual continuance of the remaining cataclastic zones of the ultrabasic rocks. In the upper parts there is newly deposited iron-nickel ore, Fig.3. The contact between the two types of ore is clear-cut.

The iron-nickel ore is dark brown and predominately fine-grained. The upper part presents a round-shaped texture of an oolytic, pisolytic, and even true oolite outward in some cases. These textures are the best proofs of partial movements and the redeposition process included in the formation basin.

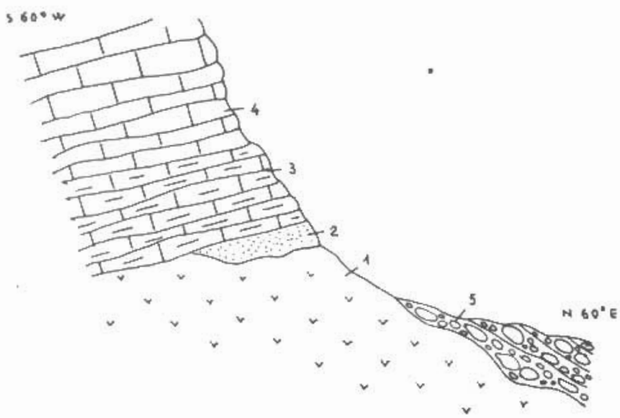


Fig. 4: Section of Cretaceous Iron - Nickel deposit "Spanos" (After Plastiras 1980).
1. Ophiolite, 2. Fe/Ni, 3. Red cretaceous limestones, 4. Gray cretaceous limestones, 5. Stampian molasse

The ore body of iron-nickel mineralization is composed of iron oxides and hydroxides, containing 44% Fe, 1.12%Ni, 0.09% Co, 3% Cr_2O_3, 9.12% SiO_2, 3% MgO, 2.5% CaO. The thickness of the iron-nickel ore varies from 2-10-20m.

The nickel-silicate ore is composed of serpentine, nontronit with vein quartz, calcite, ancerite, magnezite and serpofite. It contains 16% Fe, 1-3% Ni, 0.05% Co, 1.1% Cr_2O_3, 34% SiO2, 20% MgO, 7% CaO. This zone varies from 2-10-30m. (Fig.5).

Bauxite mineralisation. In this district there are two levels of bauxite mineralisation (Fig.1), the first between the karst of the Triassic limestones and Eocene deposits (Prespa, Vrondero, Vernik, Kristalopigi areas), and the second over the karst of the Eocene limestones and conglomerates (Bilisht). These two levels are connected with the two transgression series. The existence of the trace elements Cr, Ni, Co, Cu, Pb, Zn, Sr, Ga, Nb, As, Ba, La, (Vgenopoulos & Kanellos 1978 and Plastiras 1980) agrees with the view of the formation of bauxites to a great extent from the mafic-ultramafic rocks and the acid-neutral rocks of the Florina-Prespa granite cluster and Hercynian basement of the Pelagonian zone.

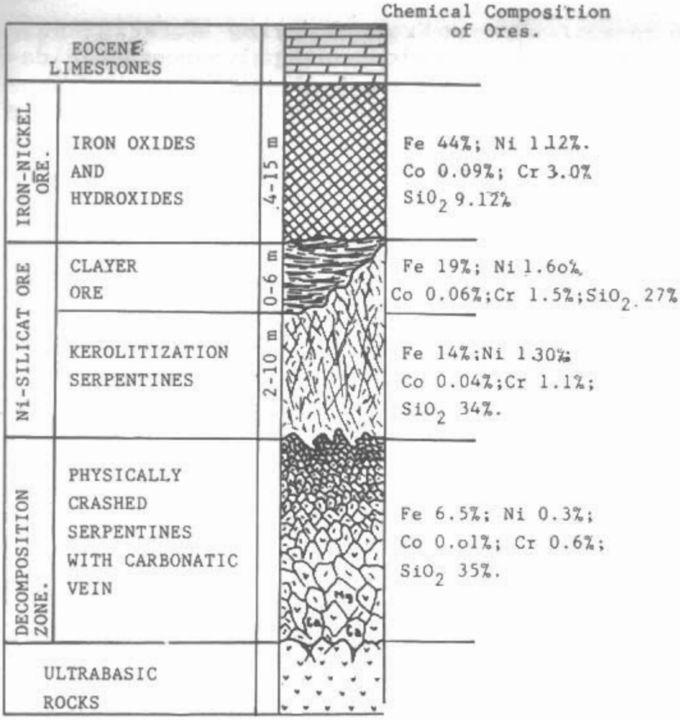


Fig. 5: Generalized section of the Iron - Nickel and Nickel - Silicat of the Eoceneof the Bitincka ore deposit types.

PALEOGEOGRAPHIC DEVELOPMENT OF THE LATERITIC CRUST AND FURTHER PERSPECTIVES OF PROSPECTING FOR Fe-Ni DEPOSITS

Many studies have been done on the paleogeographic development of the region and of the lateritic crust in Albania and Greece (Pumo 1974; Mountrakis 1982, 1984; Peza, et al 1988). But the new dating of the limestone blocks inside the mineralization level to the Triassic rather than the Cretaceous (Molla & Jani 1986) put the development of the lateritic crust in a new light.

When the limestone blocks were believed Cretaceous (Pumo 1974), all the laterite products in the Mirdita zone were seen as developing one zone but covered at different times by the deposition. With the verification of their Triassic age this idea has changed.

The formation of the laterite crust was a long and complicated process that took place under special geological and morphological conditions and was accompanied by secondary processes like wash-out, redeposition, diagenesis etc.

All iron and nickel laterite deposits are joined to the eastern ophiolite branch. By studying their geological conditions of formation in central-southern Albania and north-western Greece, we have defined two periods for the laterite extension.

It is well known that the ultrabasic rocks belong to the Middle-Upper Jurassic and the limit of volcanic activity is Tithonian-Beriasian. Radiolaritic-siliceous sediments and pelagic flysch covered the ultrabasic rocks. In the Librazhd-Pogradeci district and the Zemblaku-Spano region, the iron-nickel laterite mineralizations are found between ultrabasic rocks and limestones with Upper Cretaceous rudiste. This level presents the first laterite cycle (Fig.3).

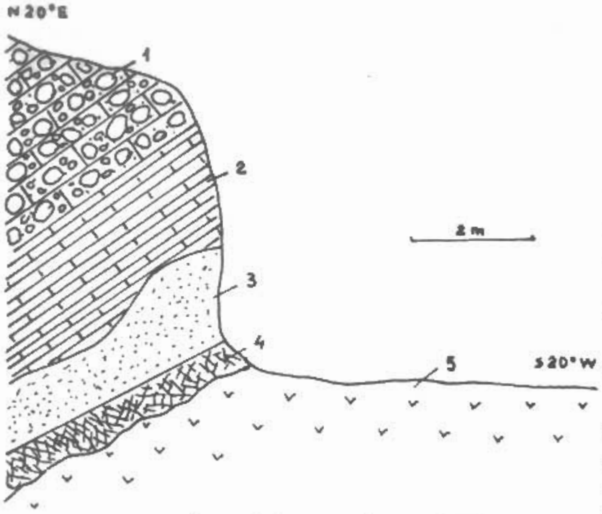


Fig. 6: Stratigraphic section of the Agios Athanasios (Ieropigi) ore deposit. (After Albandakis 1981).
1. Conglomerates of molasse, 2. Limestones, 3. Nickel - iron ore, 4. Flints of the base of the ore, 5. Serpentinites

From studying stratigraphic sections and paleogeographic development during the orogenic processes in Cenomanian and Turonian, we conclude that this region is characterized by continental conditions probably inherited from the Late Kimmerian orogenic phase, after the obduction of the ophiolitic rocks Cr1/Cr2 in Fig.7, 8).

During the period, of Cenomanian-Turonian the relief flattened and the ultrabasic rocks were faulted and hence the nickel-silicate and iron-nickel mineralization took place (Pumo 1974; Katsikatsos 1980).

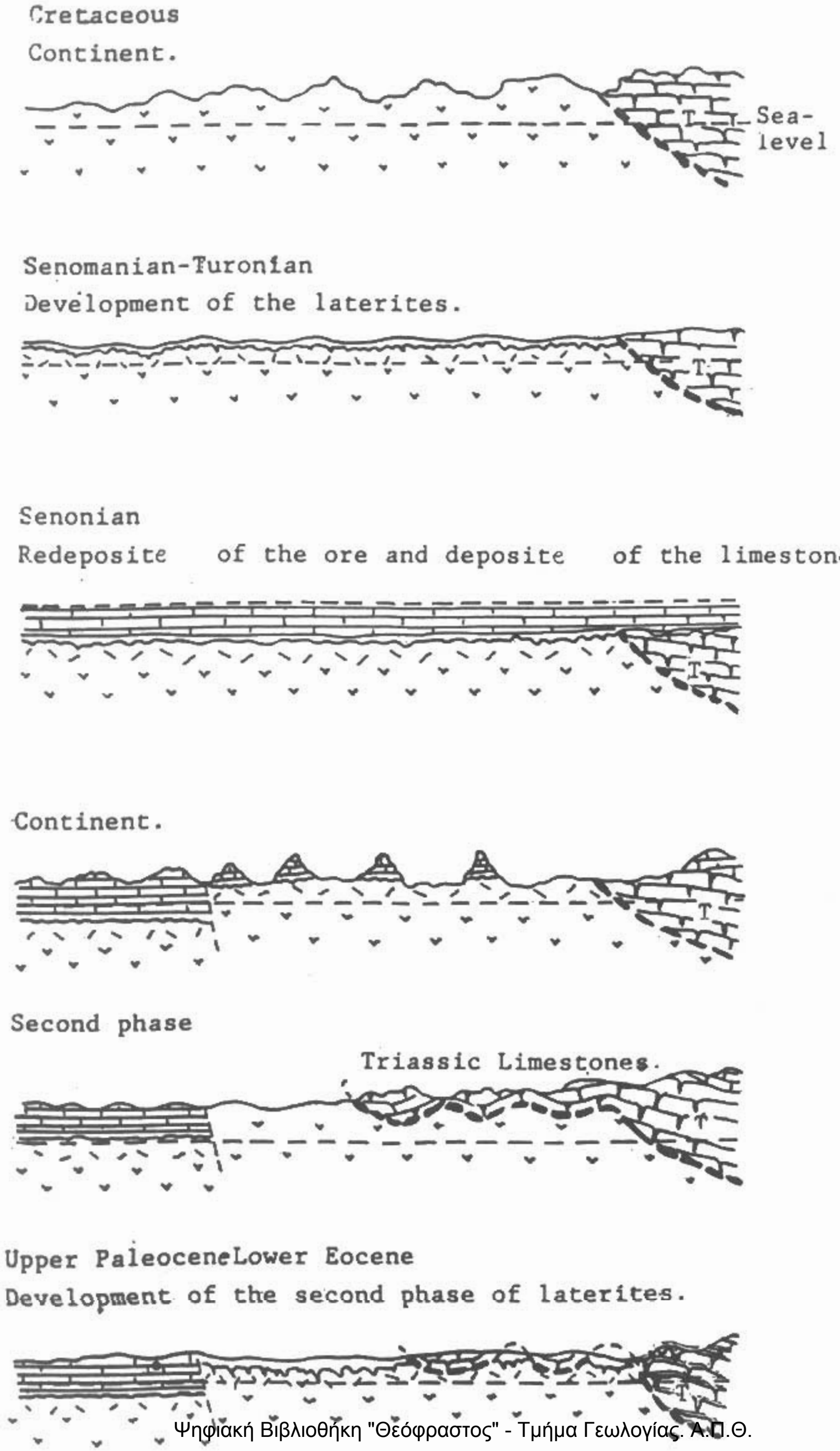
During the Cenomanian this region was subjected to the transgression of the Upper Cretaceous. Descending movements had probably started in the Turonian, that in the first phase makes their appearance by shifts and depositions of the cataclastic laterite products. This is shown by the non-preservation of the full iron-nickel and silicate-nickel laterite profile, but by their emergence and by the characteristic oolytic and pisolytic redeposition textures that are mineralizing at the moment. This transgression, which characterizes the whole district, is documented by the limestone relicts on the laterite products in Zemblak area and by the relicts of these same limestones on the Triassic deposits of Mt Thate.

A new paleogeographic situation had been created by the end of the Upper Cretaceous (Maastrichtian?-Lower Paleocene). As a result of the orogenic Laramic phase (Cr2/Pg1), the relief moves up and breaks. By this time the Upper Cretaceous deposits and the laterite products of the first cycle have been fully eroded, thus bringing to the surface the ophiolitic basement. In the western part of the district there must have existed, since then, a normal faulting which lowered the western block and preserved the carbonate deposits of the Upper Cretaceous as well as the laterite products in Zemblak and their continuation to the south, to Spano (Mt Gramos), which today are covered by the Paleogene deposits. This continuation is related to the uncovering of isolated blocks of the Cretaceous limestones in the south near the Greek border.

By the end of the Laramic orogene, Triassic limestone slabs had tectonically accumulated in the sectors of the lowest relief of ultrabasic rocks (Mountrakis 1982). Remains of these slabs are found today in Zagradec, Tren, Bitincka, Kristalopigi, Koromilia (Fig.1). These slabs are exclusively encountered on crashed, silicated and carbonated ultrabasic rocks, which proves them to be the lowest parts remaining from the Cretaceous laterite profile. Nowhere else in this limestone zone are any industrial lateritic mineralizations encountered. This has been proved by the tracing works on certain Triassic limestone slabs, as in Bitincka, Kapshtica etc. (Fig.9).

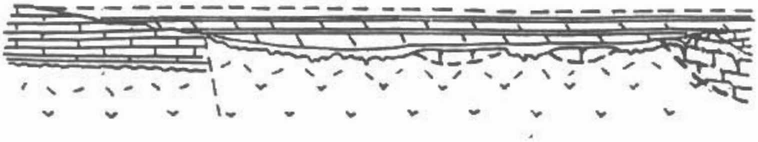
Triassic blocks are overthrust onto ophiolites all along this contact. A

Fig. 7: Phases of Paleogeographic development of lateritic mineralizations in the Bilisht - Kastoria district.



Lutetian (Pg_2^2)

Deposite of the limestones and conglomerates.



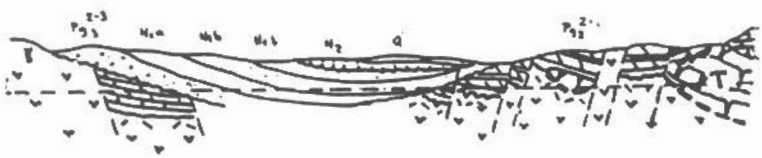
Continent.

Deposite of the molassic formation.

Tortonian-Mesinian

Continent.

Present stage.



little further to the north of our region in the Katjel-Skroska ore deposit, Triassic blocks are placed on Upper Cretaceous limestones. This indicates the age of post-Cretaceous overthrust. (Fig.10). After the overthrust of limestones in the Upper Paleocene and lower Eocene all over the region the flattening started and conditions were created for the second phase of

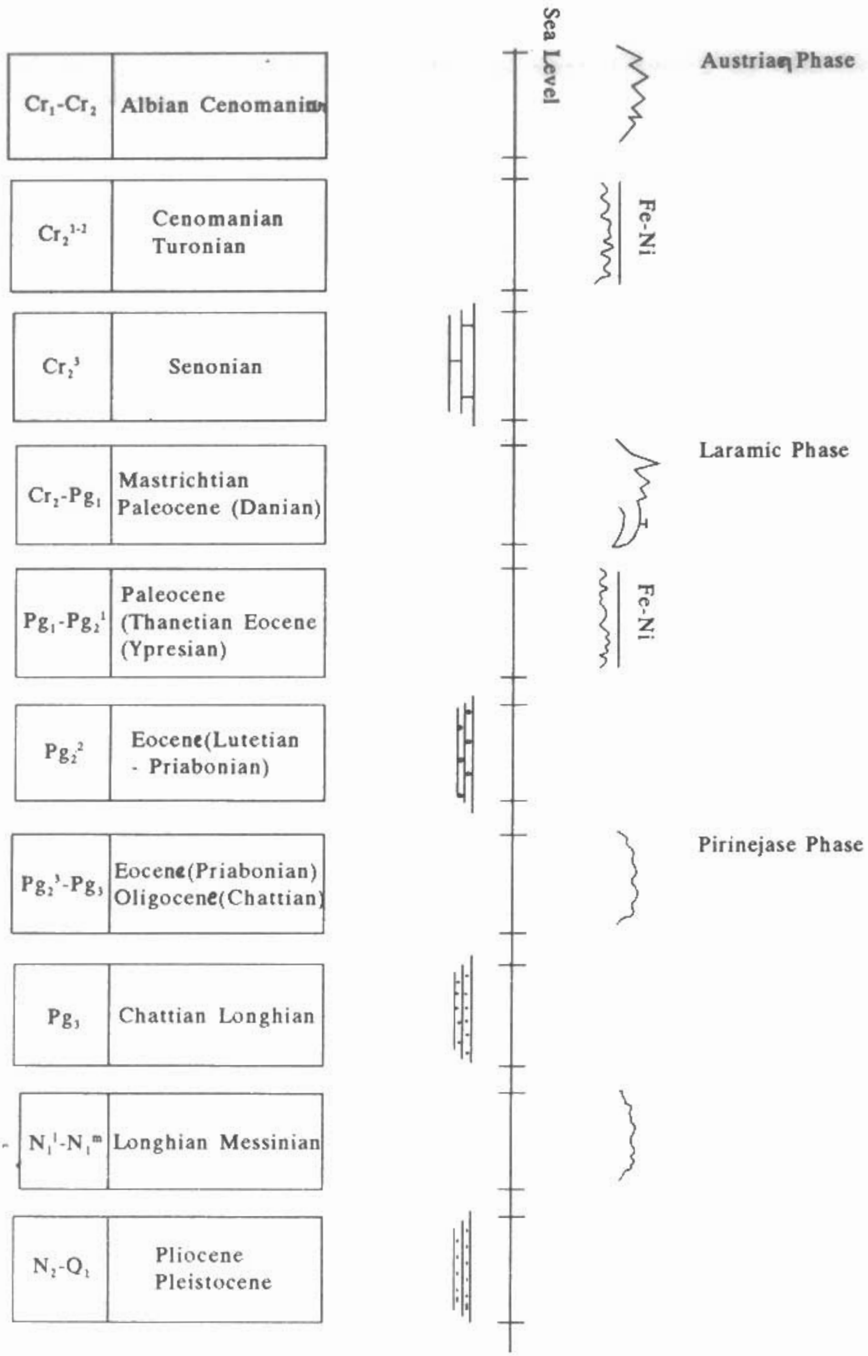


Fig. 8: Generalized paleographic development of the lateric crust in the Bilisht - Kastoria district.

lateritic crashing and the formation of silicate nickel and iron-nickel deposits. During this phase lateritic crashing influenced only the bare parts of ultrabasic rocks, whereas those parts covered by Triassic uneroded calcareous relicts were not affected and no laterite ore ever existed under them.

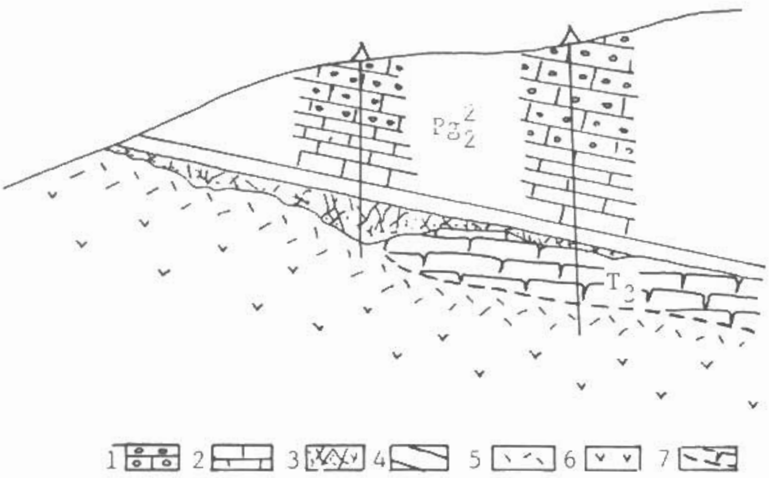


Fig. 9: The contact of the lateritic alteration production of the Eocene with the fronts of the Triassic tectonic blocks.
1. Conglomerates of the Middle Eocene; 2. Limestones and marls of the Middle Eocene; 3. The nickel - silicate ores; 4. The iron - nickel ores; 5. Serpentintes; 6. Ultabasic rocks; 7. The tectonic setting of the Upper Triassic limestones.

Until now these mineralisations were thought to be of the same phase as the previous one, the Upper Cretaceous. (Pumo 1974; Plastiras 1980).

The lateritic extension on ultrabasic rocks has developed over a flattening relief, insignificantly influenced. Its interior is characterized by cuts resembling holes of differing dimensions and lifted edges. Near the lower parts the thickness approached 10-30m whereas near the lifted edges it is less, 1-3m, because of smaller movement of water.

During the Middle Eocene, ultrabasic rocks protruding from the water were influenced by a new transgression. During the first phase of this transgression a processing and transformation of lateritic products took place, which influenced only their highest part, not touching all the silicate nickel levels. This processing is seen in the formation of oolytic, pisolytic etc., textures of the iron-nickel ore, and in the covering of the Triassic calcareous blocks by iron-nickel products. At the same time, Fig.7 reveals that the side

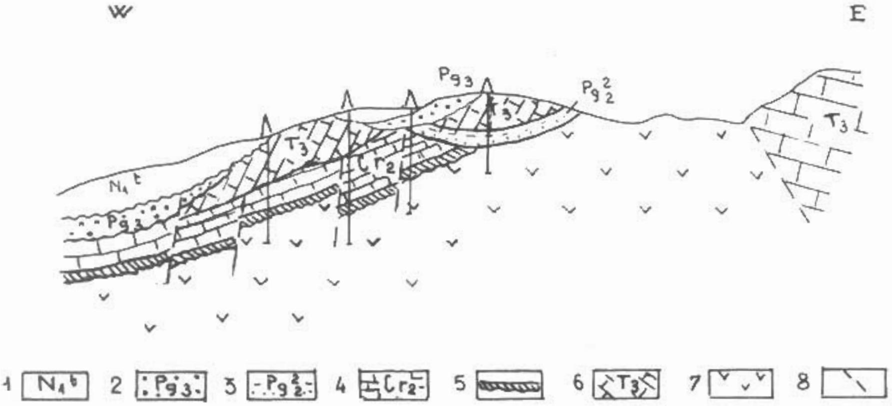


Fig. 10: Cross section of the Skroska deposit.
1. Tortonian - Sandstone, argilites and conglomerates, 2. Oligocen - conglomerates, 3. Middle Eocen - sandstone, marls, conglomerates, 4. Cretaceous Rudistic Limestones, 5. Iron - Nickel ore, 6. Triassic - Limestones, 7. Ultramafics, 8. Tectonic line.

slopes of the Triassic calcareous blocks were covered by the deposited silicate-nickel cataclastic products. This cover took place during the formation of the lateritic crust, under continental conditions that once more shows their original position before the lateritic products started to form.

The laterite products were later covered by Middle Eocene conglomerate limestones several hundred metres thick. The Eocene deposits and their basin developed in a north-south direction with the result that in Greece there are more developed deposits, whereas northwards, in the Devolli lowland, the process is noticed especially in the eastern part but not in the western part on the Morava (Korca) unltrabasics. The Eocene basin includes not only lowlands but the Triassic limestones as well, which we meet as relicts in Mt Thate, Kristalopigi, Mt Triklario-Piramida.

The Eocene transgression with carbonatic deposition begins with a quiet basin, retaining lateritic products and helping the chemical sedimentation of limestones. In successive phases the Eocene basin develops due to vertical movements and a deeper erosion starts, which deposits the conglomerates. But the composition of the conglomerate grains, which is mainly Triassic and Cretaceous limestones and very few ultrabasic and basic pieces, shows that the source area for those sediments was in a near zone.

During the more recent Oligocene cycle up to the Helvecian, the basin developed more in the western part. Only in the Burdigalian did it begin to develop towards the east, as shown by the transgression setting of these deposits on the Eocene of Bilisht, Kapshtica, Ieropigi and Kastoria. The bauxite developed in this transgression on the Eocene deposits of Bilisht.

In the deposition of this basin the rising zone is widened further in comparison with the Eocene. This widening is in the direction of the Pelagonian zone and is shown by the predominant grains of gneiss, quartzite schists in the Aquitanian conglomerate rocks.

During the third, Pliocene-Quaternary cycle the lowland was better developed in the central part down to the present. During the second cycle, and even more during the third, the splitting tectonics developed, especially of a lengthwise type which created the lowland. These tectonics have created separate blocks and in some cases, such as in Vernik, Kapshtica and Ieropigi, have brought to the surface the ultrabasic basement between the Eocene deposits.

The perspectives of development of laterite mineralized areas in the Bilisht-Kastoria district are good and there are large deposits in the south covered by Eocene sediments in Greece.

Prospecting has been carried out in the northern part of this sector, in the vicinities of Lake Mikri Prespa between the villages of Bitincka, Vernik, Kapshtica. Rich silicate-nickel and iron-nickel deposits have been discovered and it has been proved that mineralization has been permanent and with the same characteristics from north to south, with no variation in quality or thickness. But these works have shown that in the eastern part of the district, close to the contact with the Triassic limestones, the laterite section is one metre thick or less, which is normally useless for industry. This is the case in the vicinities of Vernik and Ieropigi villages (Fig.1, Fig.6). This is explained by the fact that during the Eocene transgression, the most easterly part near the carbonate Triassic framework was raised slightly more and the laterite products were driven back towards the central and westerly parts of the district. This is prove by the fact that the most easterly parts round Lake Mikri Prespa are characterized by laterite deposits containing a rela-

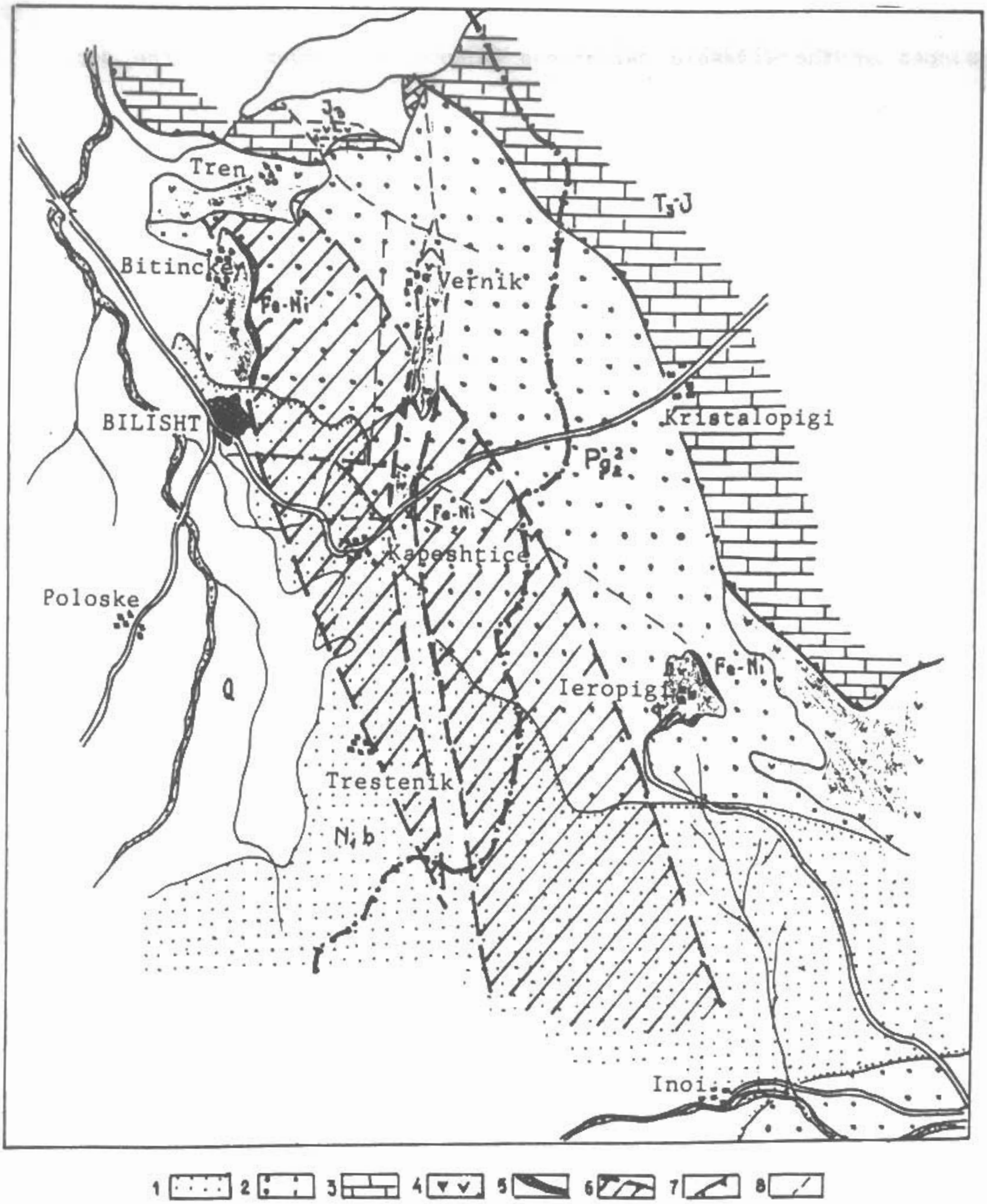


Fig. 11: Schematic development of the direction of the mineralization field. 1. Burdigalian. - Sandstones and marls, 2. Middle Eocene. - Limestones marls and conglomerates. 3. Upper Triassic - Jurassic. - Limestones. 4. Ultramafic rocks. 5. Iron - Nickel and Nickel - Silicat Ore. 6. Mineralization field. 7. Thrust boundary. 8. Fault.

tively higher percentage of aluminium, because of the western drive of the cataclastic products of the Triassic limestones "terra rossa".

Studying on this basis, the procedure of mineralization towards south, in

Kastoria sector, similar conditions of the structural geology and the lateritic processes development are observed. Over the remnants of the Triassic carbonate cover of Kristalopigi under the Eocene there are small amounts of bauxite and iron-nickel. Besides this, in this zone round Ieropigi (Mountrakis 1982) in contact with the serpentinized ultrabasics a low mineralization of iron-nickel is developing. The most productive parts should be traceable further to the west. Taking into consideration the northern part of the district, the NNW-SSE regional axis of the mineralization process passes through Bitincka to Kapshtica and should continue southwards to the village of Inoi (Fig. 11). Following this direction there is no difference either in composition or in thickness of the laterite products. This suggests that it continues southwards to Inoi, because composition and structural geology are the same. The thickness of the Eocene cover might vary from tens of metres to 300-500m. Clarifying this situation would demand an even more detailed geological study, of the whole area.

CONCLUSIONS

1. The age of the calcareous-conglomerate series that covers the iron-nickel and nickel-silicate ores in the Bilisht-Kastoria ore field is Middle Eocene.

2. There are two levels of laterite crust in the Bilisht-Kastoria ore field: a) The first level, of Cenomanian-Turonian age, is represented by the Zemblak and Spanos mineralisations with iron-nickel ores. b) The second level, of Upper Paleocene-Lower Eocene age, is represented by the Bitincka, Kapshtica and Ieropigi mineralisations with iron-nickel and nickel-silicate ores.

3. The prospects of development of the ore field need more research in detail from Kapshtica to Inoi.

REFERENCES

ALBANDAKIS, N. (1981). The nickel-bearing iron-ores in Greece. Project Nr.169, 194-215, UNESCO.

BURI, S. (1988). Sections of lateritic iron-nickel and nickel-silicate ores in Albania. Bul. Shk. Gjeol.Nr.2, 75-86. (in Albanian).

GRAZHDANI, A., and PAVLIQI, P. (1970). Some ore occurrences in the Zagradec-Proger area. Bul. Shk. Nat. Nr.4 p.37-45. (in Albanian)

JANI P. (1985): Geological mapping of the Bitincka-Kapshtice area on scale 1:10.000. Fond. Gjeol. Tirana (in Albanian)

KATSIKATSOS, G., et al.(1980). Contribution to the genesis of lateritic deposits of the Upper Cretaceous transgression in Attica and Central Euboea (Greece). UNESCO Project Nr.169.

MOUNTRAKIS, D. (1982). Etude geologique de terrains metamorphiques de Macedoine occidentale (Grece). Bul. Soc. geol. France, 24, 697-704.

MOUNTRAKIS, D. (1984). Structural evolution of the Pelagonian Zone in Northwestern Macedonia, Greece. In: The Geological Evolution of the Eastern Mediterranean (edited by Dixon J.E. & Robertson A.H.E.) Spec. Publ. Geol. Soc. Lond. 17, 581-591.

MOLLA, I., JANI, P. (1986). Tectonic fragments of Upper Triassic limestones in the Bilisht district and their relation to lateritic mineralization. Bul. Shk. Gheol. Nr.2, 3-7, Tirana (in Albanian)

PASHKO, P. (1975). Eocene depositions of the Mirdita Zone. Permbl. Stud. Nr.2, Tirana. (in Albanian)

PASHKO, P. (1977). Classification of the Oligocene depositions of Morava. Permbl. Stud. Nr.3, Tirana. (in Albanian).
PEZA, L., VRANAJ, A., and SHALLO, M. (1987). Geology of Albania. (edited by U.T. Tirana, 250 p. (in Albanian).
PLASTIRAS V. (1980): Contribution to the knowledge of lateritic type formations of NW Macedonia. UNESCO An international Symposium on Metallogeny. Athens, Project N 169, 355-370
PUMO, E. (1974). Products of the old lateritic crust of the Mirdita Zone. Permbl. Stud. Nr.4, p. 106-131, Tirana. (in Albanian)
SAVOYAT, E., and MONOPOLIS, D. (1971). Geological Map of the Kastoria District, 1:50000 IGME, Athens.
VGENOPOULOS, A., and KANELLOS, G.K. (1978). Preliminary study of bauxite occurrences at Vronderon in Northern Greece. 4th Int. Con. at ICSOBA, Vol. 2, Athens.