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TECTONIC WINDOWS OF THE EXTERNAL ZONES IN THE REGION OF PESHKOPI (EASTERN ALBANIA).

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Abstract:

Some tectonic windows of the external zones under the nappe sheets of the internal ones in the eastern Albania (region of Peshkopi) are observed.

The main tectonic windows are:

- Okshtuni tectonic window of NE extent is of Krasta zone. It is composed of Senonian limestones and Maestrichtian - Eocene flysch of Krasta zone, bounded on NW and SE by the normal faults which have caused the fracturation and the dipping of nappe sheets of Mirdita and Korabi zones.
- Mali i Bardhë, Banjat e Peshkopisë, Kërçishti and Dibra e Madhe tectonic windows of N extent are of Kruja zone.

Kërçishti tectonic window is composed of Lower Senonian neritic limestones and of Paleogene flysch of Kruja zone, which are overthrusted by Cretaceous flysch followed by Upper Cretaceous limestones and Maestrichtian - Eocene flysch of Krasta zone.

Banjat e Peshkopisë tectonic window is characterised by Permian-Lower Triassic evaporites and Paleogene slightly metamorphised flysch of Kruja zone. On southern sector this formation tectonically contacts Cretaceous flysch of Krasta zone, while on northern and northwestern sectors they are covered tectonically by Triassic deposits of Korabi zone.

Mali i Bardhë tectonic window is composed of Permian-Lower Triassic evaporites and Paleogene flysch of Kruja zone, which are overthrusted by Cretaceous flysch followed by Upper Cretaceous limestones of Krasta zone. Towards the west deposits of Krasta zone are overthrusted by the ophiolites of Mirdita zone which are transgressively covered by Upper Jurassic - Lower Cretaceous flysch and this one is overthrusted by Paleozoic and Mesozoic deposits of Korabi zone.

Dibra e Madhe tectonic window is composed of Permian-Lower Triassic evaporites and Paleogene flysch of Kruja zone and is of similar position with the Banjat e Peshkopisë tectonic window.

Tectonic windows, especially those of Kruja zone, are of cupola pattern due to the evaporite diapirism and the extensional tectonics which has acted during Pliocene-Quaternary in the eastern regions of Albania.

So in the eastern regions of Albania a pile of nappe sheets is evidenced (from top to bottom) as follows:

- Korabi nappe sheets,
- Mirdita nappe sheet,
- Krasta nappe sheet,
- Kruja nappe sheet.

Amplitude of the tectonic covering from Mali me Gropa up to Dibra e Madhe

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is over sixty kilometres.

Introduction

The presence of the nappe sheets in Albania is noted by many scientists, from Nowack (1929) and Nopcsa (1929) up to Peza (1959), Liko (1962), Aubouin and Ndojaj (1964), Melo (1966), Belostockij (1963, 1978), The Geological Map of Albania (1967) and at last Aliaj (1979, 1987, 1988, 1991), Melo et al (1985, 1991), Gjata and Kodra (1987), Frashëri et al (1991), Qirinxhi et al (1972, 1991), Turku and Shehu (1991), Xhomo et al (1991), Meço (1991), Çollaku and Cadet (1991), Molla (1985), The Geological Map of Albania (1983) etc.

Melo (1966, 1982) has noted Mali i Bardhë and Peshkopi tectonic windows of evaporite core, Kërçisht Eocene flysch windows, Okshtuni window, which the sames are represented on the Geological Map of Albania (1983) as well. Melo et al (1991) came to the conclusion that Okushtuni window belongs to Krasta zone and the ones beginning from Mali i Bardhë up to Dibra e Madhe belong to Kruja zone. Çollaku and Cadet (1991) beleive that the windows of gypsum core of Peshkopi region may be either of Ionnian or Kruja zone.

The author of this paper, following the opinion of Melo et al (1991), that the tectonic windows of evaporite core and Eocene-Oligocene flysch ring belong to Kruja zone, presents new data on the allochtonous placement of Mirdita ophiolites under the Korabi nappes as expressed before, too (Aliaj, 1991). All the evidence call attention to the fact that the pile of nappe sheets is cropped out in Peshkopi region (from bottom to top: Kruja, Krasta, Mirdita and Korabi nappe sheets).

Kruja zone is discovered in tectonic windows from Mali i Bardhë up to Dibra e Madhe

The tectonic windows of gypsum and anhydrite core are apparent in Peshkopi region, Mali i Bardhë, Banjat e Peshkopisë and Dibra e Madhe (Figure 1). The Kërçishti tectonic window, under Krasta nappe sheet, situated between Banjat e Peshkopisë and Dibra e Madhe windows, is the most representative demonstrating the presence of Kruja zone.

Kerçishti window - Neritic limestones of Upper Cretaceous (Senonian) are cropping out in Kerçisht, under Paleogene flysch (Kici et al, 1988) (Figure 1). Neritic limestones (the lower strata of which are with rudists) are noticed southwards, too, out of the border of our country, from Banjishte to Hame, northwards of Dibra e Madhe (Çipan e Nesterovski, 1979).

In Kerçisht the oldest part of the section is composed by limestones with rudists, which have undergone a dolomitization process, and with sulphur nests in the upper part. These limestones contain Accordiella conica Farinaçi, Aeolisacus Kotorri, etc. of Santonian-Campanian such as in Kruja zone. Clay flysch of sandstone and marly limestone strata follows the limestones in the upper part. The Nummulites noticed in this flysch (N. laevigatus, N. Perforatus) give evidence to the age of the Middle Eocene, while the planktonic foraminifers, which are met at marly limestones (Globigerina linaperta, G. cf. triloculinoides, G. cf. Yeguansis, etc.) are spread in Eocene and Oligocene deposits.

The neritic limestones of Senonian with Eocene-Oligocene flysch upon are tectonically covered by the marly flysch of Cretaceous (Albian-Cenomanian), which is normally followed by Upper Cretaceous limestones with Globotruncana and by Maestrichtian flysch, which belong to Krasta zone and compose Kerçinë and Velivari mountains (Figure 1, 2). Such a placement of Krasta nappe on Eocene-Oligocene flysch, which lays upon the neritic limestones of Upper Cretaceous, give evidence to the fact that the later ones belong to Kruja zone.

Banjat e Peshkopisë window - Paleogene flysch interrupted by the evapor-

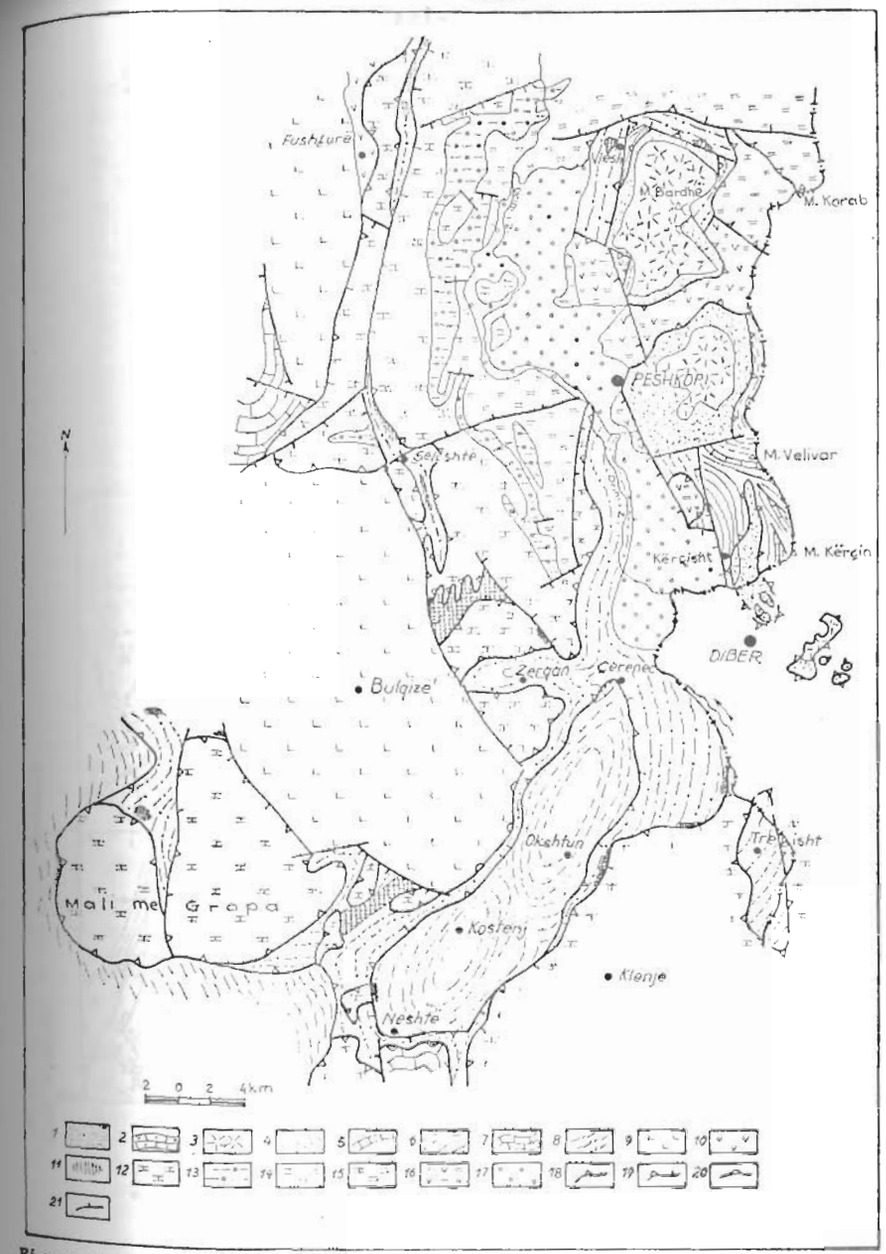


Figure 1: Geological Map of Peshkopi Region
1 to 3: Kruja zone, 1: Upper Eocene-Oligocene flysch, 2: Upper Cretaceous limestones, 3: Permian-Lower Triassic evaporites; 4 to 6: Krasta zone, 4: Maestrichtian-Lower Eocene flysch, 5: Upper Cretaceous limestones, 6: Lower Cretaceous flysch; 7 to 11: Mirdita zone, 7: Cretaceous basal conglomerates and limestones, 8: Upper Tithonian-Valanginian flysch, 9: ultrabasic massifs of Lura and Bulqiza, 10: mostly effusive rocks, 11: ultrabasic rocks (mostly serpentinites) outcropping under Upper Tithonian-Valanginian flysch and along normal faults; 12 to 16: Korabi zone, 12: Middle Triassic-Jurassic limestones, 13: Permian-Lower Triassic terrigenous formation, 14: Paleozoic terrigenous formation, 15: Paleozoic carbonate-terrigenous formation of Korabi mountain, 16: volcano-sedimentary formation of Grama nappe; 17: Pliocene-Quaternary deposits of Dibra depression, 18: nappe boundries, 19: nappe boundries complicated by normal faults, 20: reverse faults, 21: normal faults.

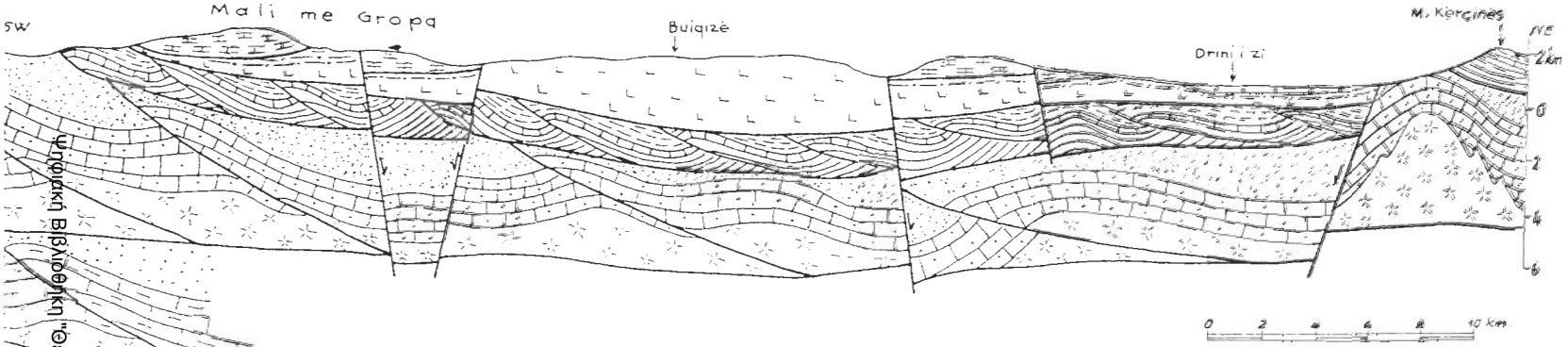
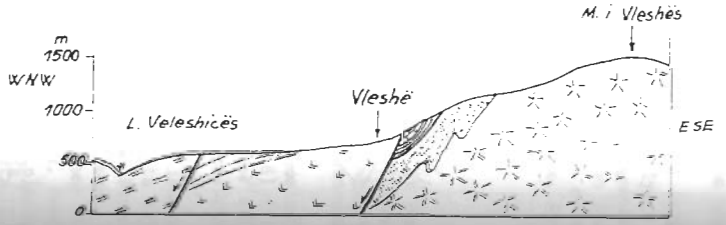
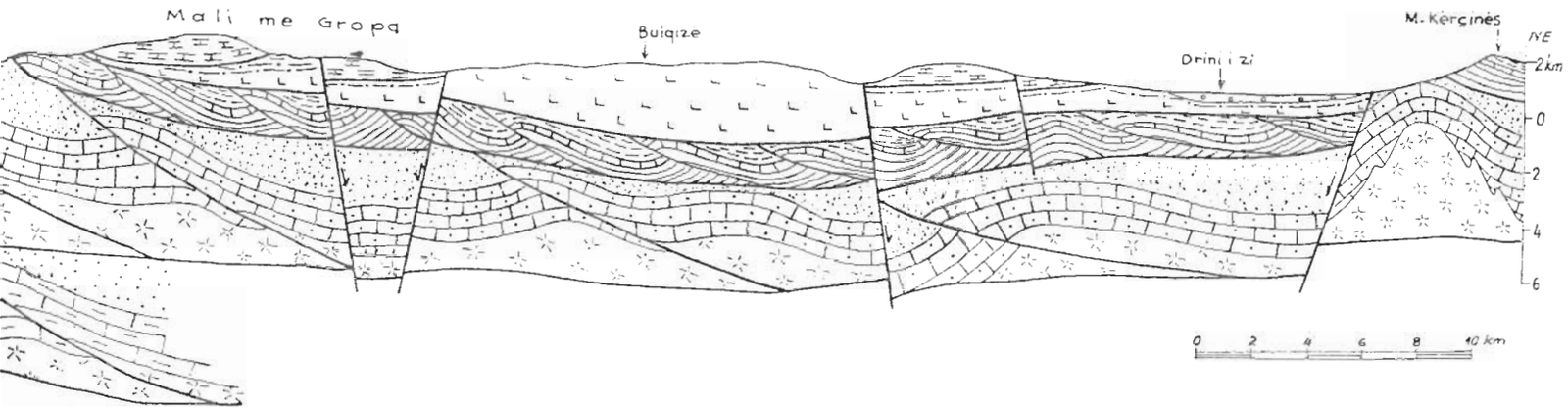


Figure 2: Geological cross-section from the front of Mali me Gropa up to Kërçin mountain, showing the pile of nappe sheets (from bottom to top: Ionian, Kruja, Krasta, Mirdita and Korabi nappe sheets).





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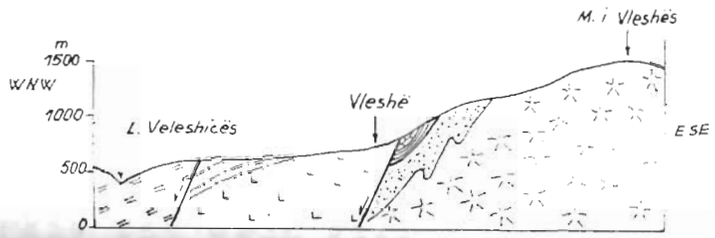

Figure 3: Geological cross-section through Vlesh

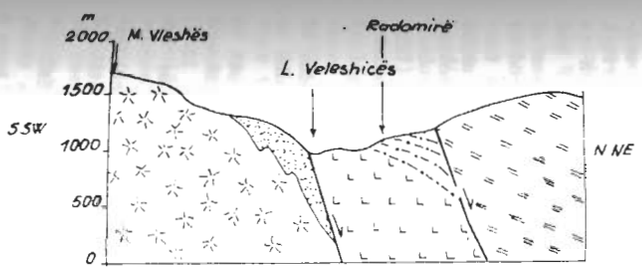

Figure 4: Geological cross-section through Radomirë (north of Mali i Bardhë)

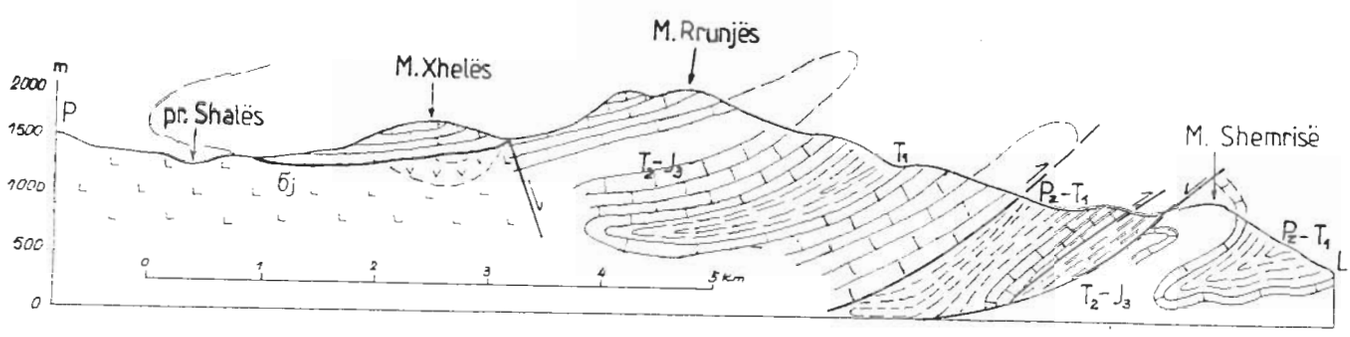

Figure 5: Geological cross-section north of Selishtë

ite (gypsum and anhydrite) diapir, which has created cupola structure, crops out in the stream of Banjat e Peshkopisë, and in the surrounding area in a tectonic window of 9x6 km (Figure 1). This flysch is metamorphised and of wild flysch type where lens of black limestones with Nummulites between shists and sandstones are clearly noticed. Nummulites testify for the age of Middle Eocene, while the planktonic foraminifers testify for the ages between Upper Eocene and Lower Miocene (Çollaku and Cadet, 1991).

Southward Paleogene flysch of this window tectonically contacts Cretaceous flysch of Krasta zone, meanwile, northwards, it contacts Grama nappe. The normal faults border the Banjat e Peshkopisë window in the south and west side. Thermal springs get out along a normal fault of nearly northern extent in Përroi i Banjave.

Mali i Bardhë window - The evaporites, which interrupt the Paleogene flysch, form a brachyanticline up to a cupola one of 11x6 km in Mali i Bardhë (Figure 1). Southwards, this one crops out such a window from below Grama nappe, and, northwards it crops out from below J_3-Cr_1 marly flysch. Paleogene flysch is the same with the one of the window of Banjat e Peshkopisë.

The window of Mali i Bardhë borders normal faults north and westwards which have caused the fracturation and the dipping of nappe sheets on its sides.

Dibra e Madhe window - There are some small tectonic windows cropping out for about 8 km along the valley of Radika river, Dibra e Madhe surroundings (Figure 1). These windows, represented by evaporites, which interrupt Middle-Upper Eocene flysch (Çipan and Nesterovski, 1979). This flysch is analogous to the one of Banjat e Peshkopisë: clay shists, sandstones and conglomerates with limestone strata and lens. The evaporites are represented by gypsum, anhydrite and alabaster. Eocene flysch is tectonically covered by the Cretaceous flysch deposits of Krasta zone. In addition to the nappe tectonics, there are normal faults, which have fracturated the pile of nappe sheets during Pliocene-Quaternary. Thermal springs get out along these normal faults.

Krasta zone is cropping out in Okshtuni window and around Kruja zone windows from Mali i Bardhë up to Dibra e Madhe

In the region of Peshkopi, Krasta zone is cropping out in the window of Okshtuni and around the windows of Kruja zone beginning from Mali i Bardhë up to Dibra e Madhe (Figure 1).

Okshtuni window - The flysch of Maestrichtian-Lower Eocene crops out in a window from Neshta to Çerenec, and a small outcrop of Upper Cretaceous (Senonian) limestones with Globotruncana is noted in Çerenec (Kici, 1989) (Figure 1). These deposits belong to Krasta zone, and are surrounded by the marly flysch of Upper Tithonian-Valanginian through normal faults.

From the structural point of view the flysch deposits of Maestrichtian-Lower Eocene form en échélon brachyanticline folds of Kostenjë and Okshtun of NNE extent.

Around the windows of Kruja zone from Mali i Bardhë up to Dibra e Madhe - Deposits of Krasta zone are cropping out around the windows of Kruja zone, too, from Mali i Bardhë up to Dibra e Madhe (Figure 1). These deposits have a large extent southwards the window of Banjat e Peshkopisë up to the southern surroundings of Dibra e Madhe. They are represented by Cretaceous marly shist flysch there, which is normally followed by Upper Cretaceous limestones with Globotruncana, and by Maestrichtian-Lower Eocene flysch in their top (Melo, 1982; Çipan and Nesterovski, 1979). These deposits are placed as an allochtonous sheet on the Eocene-Oligocene flysch of Kruja zone.

The Cretaceous marly shist flysch and Upper Cretaceous limestones with Globotruncana upon are also noticed in the NW side of the window of the Mali i Bardhë, near Vleshë and Kallë, and form a nappe sheet on the Eocene-Oligocene flysch of Kruja zone (Figure 1, 3).

The Ophiolites of Mirdita zone are outcropping over 25 km eastwards the ultrabasic massifs of Lura and Bulqiza

In the considered region, the most important outcrops of the ophiolites of Mirdita zone constitute the ultrabasic massifs of Lura and Bulqiza with small development of basic effusive rocks in their eastern part (Figure 1). Small outcrops of Mirdita ophiolites are also noticed over 25 km eastwards these massifs up to Mali i Korabit and in the surroundings of Dibra e Madhe.

So, outcrops of ultrabasic rocks transgressively covered by the marly flysch of J_3-Cr_1 are met in the western and northern surroundings of Mali i Bardhë window, in Radomirë, from Silova to Dipjakë, in Vrenjt, etc. (Melo, 1966; Aliaj, 1987, 1991; Qirinxhi et al, 1991). Mirdita ophiolites, covered by J_3-Cr_1 flysch in the western and northern part of the window of Mali i Bardhë, are bordering with the later through normal faults (Figure 3, 4). Through these faults they are also borderd with Pz-T_1 terigenous deposits of Korabi zone. These normal faults have caused the fracturation and dipping of nappe sheets northwards and westwards, not allowing to discover the base of Mirdita ophiolites and Korabi nappes, besides some tectonic outlier of T_2-J_1 limestones of Korabi zone in Venisht and Dipjakë.

In the NE side of Mali i Bardhë, the evaporite diapir contacts J_3-Cr_1 flysch with ultrabasic rock lens in the pass of Biçaja (Gjata et al, 1984), which, as it seems, outcrops along the zone of normal fault. The deposits of the Miocene molasse along this fault bear evidence to that fact.

Similar outcrops of ultrabasic rocks are also noticed in the NE part of the window of Banjat e Peshkopisë, in Skërtec (Melo, 1966).

Ophiolite outcrops are noticed along the zones of normal faults which have caused the fracturation of Korabi zone deposits and J_3-Cr_1 flysch of Mirdita zone, which is largely developing southwards Peshkopi up to Okshtuni window (Figure 1). Of these outcrops are noticed in Resk and DrajReç (Aliaj, 1987), in Presh and Rrafshi i Korabit (Gjata et al, 1984), in Tuçep and in its southwestern part, where, besides the serpentinites, outcrop gabbros, too (The Geological Map of Albania, 1983), up to the surroundings of Dibra e Madhe, where, besides the sepentinites, effusive rocks are noticed, too (Petkovski, 1979).

These data show that outcrops of Mirdita ophiolites are noticed up to more than 25 km eastwards of the big ultrabasic massifs of Lura and Bulqiza. It seems that in many places the ophiolites are transgressively covered by J_3-Cr_1 marly flysch over which Korabi nappes have moved.

There is a similar geological situation westwards of Bulqiza ultrabasic massif, in Mali me Gropa, where under the allochtonous sheet of T_2-J limestones of Korabi zone, J_3-Cr_1 flysch covers the ophiolites (ultrabasic and basic effusive rocks) (Aliaj, 1987; Liko, 1962) (Figure 1, 2). Mirdita ophiolites are placed such as a nappe sheet on Krasta zone, which is well noticed at the front of carbonate nappe sheet of Mali me Gropa, where the serpentinites of tens meters thick overthrust Maestrichtian-Eocene flysch of Krasta zone.

From all above we come to the conclusion that part of Mirdita zone eastwards of ultrabasic massifs of Lura and from Mali me Gropa eastwards, and around the window of Okshtuni has been developed as flysch trough after its tectonization at the end of late Jurassic.

Korabi zone is placed such as nappe sheet on Mirdita ophiolites

A few years ago typical nappe structures = west plunged folds are no-

ticed at the front of Korabi zone, at the sector from Resku up to Selishtë (Aliaj, 1987, 1991). These folds are composed of an overturned stratigraphic sequence of Pz-J deposits, in a belt large 8-10 km, just eastwards of ultrabasic massifs (Figure 5). The frontal folds are placed over Mirdita ophiolites (ultrabasic and rarely basic effusive rocks). So, at Selishta stream, T_2-J limestones of overturned section overthrust the serpentinites, and westwards, more than 8 km, there are mainly ultrabasic and rarely effusive rocks noticed always under T_2-J carbonates and Pz-T_1 terrigeneous deposits (Figure 1).

These plunged folds in Pz-J deposits of Korabi zone are developed as retrocharriage (surly after Cretaceous, perhaps later) over Mirdita ophiolites transgressively covered by J_3-Cr_1 flysch. Their advancement towards west is obstructed by the strong barrier of Cretaceous basal conglomerates and neritic limestones, transgressivelly lying on the ophiolites.

The allochtonous placement of T_2-J_1 limestones over this flysch is clearly seen southwards Selishta and Peshkopi, where the J_3-Cr_1 flysch deposits are largely distributed. So, the T_2-J_1 limestones are overthrusting J_3-Cr_1 flysch in the halfwindow of Zerqani, and more northwards up to Kovashicë and further northwards (Figure 1). Even here, more than 8 km westwards, the nappe sheet of T_2-J_1 limestones is overthrusted on J_3-Cr_1 flysch eastwards, and on the east extremity of the ultrabasic massif of Bulqiza, through a thin shist packet, westards. The serpentinites outcrop here along the normal faults, which have caused the fracturation of allochtonous limestones on J_3-Cr_1 flysch.

The T_2J_1 limestones are allochtonous on J_3-Cr_1 flysch in the window of Trebisht, too (Figure 1). As in Tuçep and southwestwards the serpentinites and gabbros, some place, outcrop here along the normal faults cutting the nappe structures.

All above give evidence to the opinion that Korabi zone is allochtonously placed on Mirdita ophiolites.

Discussions and Conclusions

1. In eastern Albania (Peshkopi region) some tectonic windows of external zones are noticed under the nappe sheets of internal zones of Mirdita and Korabi. Among them the mainly ones are:

- The tectonic windows of Kruja zone of brachyanticline structure nearly to cupola one of almost northern extent from Malï i Bardhë up to Dibra e Madhe, are composed of Permian-Lower Triassic evaporites, Upper Cretaceous neritic limestones and Upper Eocene-Oligocene flysch. The allochtonous placement of Krasta zone formations on the ones of Kruja zone is clearly seen in the window of Kërçishti and in the one of Malï i Bardhë. A horst structure is developing eastwards of Dibra graben depression, from Kërçinë and Velivar mountains, southwards, up to Malï i Bardhë, northwards. This development is also due to the diapiric uplift of the evaporites, where, because of the erosion, Kruja zone is outcropping in some windows. Evaporite diapirism has deformed the nappe sheets of saddle shape beside the windows. Thermal sulphurous springs get out along the normal faults as in Peshkopi and Dibër.

- The window of Krasta zone in Okshtun, of NNE extent, is composed of Upper Cretaceous limestones with Globotruncana and Maestrichtian-Lower Eocene flysch, which form two en échélon brachyanticline structures. Okshtuni window outcrops as a horst surrounded by Upper Tithonian - Valanginian marly flysch. The sulphurous thermal springs getting out along the normal faults, from Kosienja to Çerenec, in some places of methane gas, which contains heavy fractions as in Çerenec and Sopot (Naço et al, 1987), suggest us that the formations of Kruja zone should be met under the Krasta nappe sheet.

2. The windows of Kruja zone and Krasta one, eastern Albania, are formed due to the extensional tectonics, which took place during Pliocene-Quaternary, and diapir uplift of the evaporites, creating horsts, favouring the erosion of the upper nappe sheets, which are seen only at the margins of these windows.

3. The window of Trebisht and Zerqan halfwindow of Upper Tithonian-Valanginian marly flysch, under T_2-J_1 allochtonous limestones of Korabi zone, belong to Mirdita one. The outcrops of ultrabasic rocks under this flysch, from Vlesh to Dipjakë up to Radomirë, in Linosi valley (Mali me Gropa), and the outcrops of serpentinites, rarely of gabbro and effusive rocks along the normal faults fracturating this flysch as in Tuçep and southwestwards, in Guri i Muzhaqit, northwards of halfwindow of Zerqani and up to the pass of Biçaja etc., indicate that Upper Tithonian-Valanginian marly flysch, which transgressively covers the ophiolites, belong to Mirdita zone. The ophiolites transgressivly covered by Upper Tithonian-Valanginian marly flysch, under T_2-J_1 allochtonous limestones of Korabi zone, are allochtonously placed on Maestrichtian-Eocene flysch of Krasta zone in Mali me Gropa. These data show that Mirdita zone, eastwards of big ultrabasic massifs and around the Okshtuni window up to Korabi mountains, and in the surroundings of Dibra e Madhe, has been developed as a flysch trough after its tectonization at the end of late Jurassic. Just the presence of this flysch has favoured the movement of Korabi nappes towards west up to the ophiolites transgressively covered by Cretaceous conglomerates and neritic limestones.

4. The data presented indicate that in eastern Albania (Peshkopi region) the pile of nappe sheets is as follows (from bottom to top):

- Kruja zone, as it seems, allochtonous on the Ionian one,
- Krasta nappe sheet,
- Mirdita nappe sheet, and
- Korabi nappe sheets.

5. These data and interpretations oppose the point of view that Mirdita ophiolites are brought from Vardari moving over Korabi zone as Nowack expressed (1929), and Çollaku and Cadet (1991) think, and the opinion that Mirdita ophiolites (obducted over the both continental margins) are not developing any more eastwards the big ultrabasic massifs, and the outcrops of ophiolites under the limestones, eastwards of these ophiolite massifs, present a preophiolitic synrift magmatism, developed along the sinsedimentary normal faults, which changed to reverse faults during the compressive tectonics as Kodra and Bushati (1991), Kodra et al (1991), Godroli et al (1991) and Vergely et al (1991) believe. As made known some years ago (Aliaj, 1987, 1988), during the neotectonic stage the considered region is subdued to the extensional tectonics, which has fracturated by normal faults the pile of nappe sheets. These normal faults are incorrectly considered of continental rifting stage.

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