

## **The Geological Setting of Durrës - Rodon Region in Albania**

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*Received March 04, 2020; Accepted April 21, 2020*

**Abstract:** The object of this paper are some considerations on the geologic features of the region north to Shkumbin river in Albania based on the latest data from the complex studies on the relations of Kruja and Ionian zones with the South Adriatic basin. The paper highlights the tectonic features of the prognosis deep structures, facies types etc. The folding phases for this region are of Chattian, Burdigalian and Tortonian when the structures of the eastern part of Kruja zone are folded at an earlier geologic time as compared to the structures foreseen to be encountered at the western part of region. The lower tectonic stage in the studied region, as compared to the know structures of Ionian zone to the south and of Kruja zone in the east, appear with less developed tectonics and less effected by the folding tectonic phases. The influence of these folding phases over Kruja and Ionian tectonic zones has been considerable causing a mighty folding of structures and at the same time their big overlapping to the west. These facts drive us to the conclusion that the Ionian zone structures and consequently the separate tectonic belts within this zone must not extent to the north.

**Key words:** *Kruja and Ionian zone, tectonic, structures.*

### **Introduction**

The study region represents a very complicated geological area, where three tectonic zones collides: 1- Kruja tectonic zone in the east; 2- Ionian tectonic zone in the south; 3- Southern extension of the Adriatic Basin, Fig.1. There have been various opinions about the interpretation of the tectonic style in this region, which have been the subject of discussion among geologists, such as the relationship between the orogeny and platform zones, the possibility of introducing the "Sazan" zone toward the east in the northern part of the Patos-Verbas structure. These problems still have not received a solution and their clarification in the future, requires the completion of additional works of wit some complex methods. This paper will provide some consideration on these problems. The solution of these problems has a great importance in the future for more accurate orientation of the research work on the limestone formation. The information from the previous works as well as the new geological data received from the geological study methods done in the area during the last years, have been used for the preparation of this paper.

### **The stratigraphy and the folding phases**

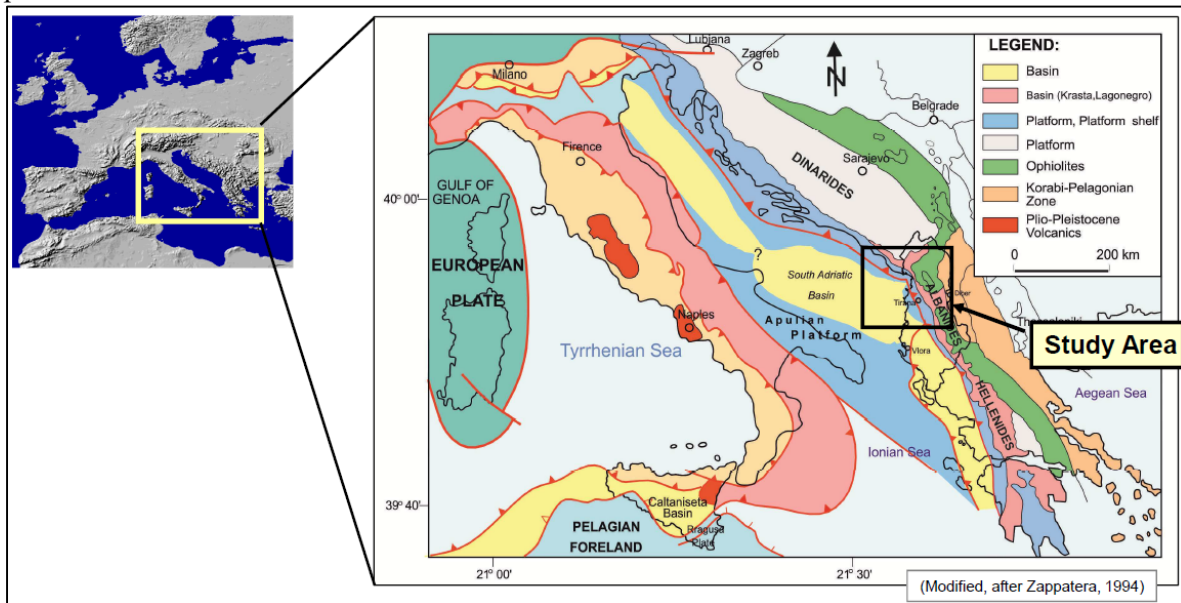
The oldest deposits of the Upper Cretaceous outcropped in the eastern part of the study area over Kruja, Ishëm, Tirana and Dajti structures. These deposits are represented by dolomitic limestone and organogenous - detritic limestone. These deposits are documented from the wells drilled in this region. The Paleocene-Eocene micritic limestone are placed with hiatus over the Upper Cretaceous deposits through a bauxite horizon (Velaj, 2012).

The terrigenous deposits (flysch-flyschoidal formation) of Lower Oligocene to Burdigalian are normally placed over the carbonate deposits through the marls transitional package. Upper Oligocene sediments are transgressively placed over the deposits of lower tectonic stage (carbonate and flysch formation), as it is clearly seen in the Valeshi structure. (Valbona & Sadiku, 1984). We emphasize two important things about the character of carbonate and terrigenous deposits of the Kruja tectonic zone. Firstly: The thickness of the pelagic deposits of the Lower and Middle Oligocene is big and decreases westward direction becoming much thinner in the Ionian tectonic zone. The lower Oligocene deposits thickness is 600-1500 m, while the Middle Oligocene is 1250 m thick (Velaj, 2012). These data clearly indicate that during this geological time and later, Kruja tectonic zone was deep basin environments. Secondly: The outcropped carbonates, and the carbonate meet by the wells drilled in the study region, in general belongs to a shallow platformic facies. This continued until the beginning of the Eocene

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series. We note that the presence or not of flysch formation is not an argument for the presence of the platform conditions.



**Figure 1.** The location of the study region (Zappatera, 1994)

The paleogeography conditions of the carbonate formation must be taken into consideration. Based on the sedimentation conditions, we believe that the Kruja tectonic zone existed as a platform until the beginning of the Paleocene-Eocene sedimentation, which later as a consequence of the dip, changed to a very deep basin. The Tortonian deposits (representing the Molasses Formation) along the eastern side of the Durrës basin (Peri-Adriatic Depression). (Dalipi & Kokobobo, 1989). This deposit is placed transgressively over the older deposits of Kruja tectonic zone and over the eroded deposits of Upper Cretaceous. The thickness of the Tortonian deposits increases greatly from east to west (Valbona & Shaqir Nazaj, 1989) while the unconformity moves upward within the younger sediments in the same direction. This indicates that the most eastern structures of the Kruja tectonic zone were highly differentiated compared to the western ones expected to exist under the Durrës basin to the west of Kruja tectonic zone. Based on the lithological changes of the formations and the unconformity between them, it can be interpreted that the most powerful folding phases that transformed the area are those of Chattian, Burdigalian and Tortonian ages, which migrate in time from east to west. It means that the most eastern structures, which belongs to Kruja tectonic zone, have been affected by the earliest tectonic phases, while the most western structures, which belongs to the Ionian tectonic zone (clearly identified further to the south of the study area) are affected by the later folding phases. (Sadiku, *et al.*, 1989) All the existing structures outcropped or proved by the drilled wells got the main features during the Burdigalian tectonic phase but their tectonic elements started since the Chattian time. It is believed that the tectonic contours of some big anticlinal folds, which existed since the Chattian time, correspond more or less with the tectonic boundaries of the existing outcropped anticlinal belts within the Ionian tectonic zone (Berati, Kurvelesh, and Çika anticlinal belts). Even the geological data show that the structures of the Kruja tectonic zone like Valesh-Letan, Makaresh, Tirana-Fushë Kruja, Petrela, Kozan and Ishëm (Sazhsanaku & Thomal, 1989) structures, were created before the Chattian time.

Tortonian deposits in the eastern part are transgressively placed on the Upper Cretaceous limestone, while to the west these deposits are placed on the younger deposits. The relationships between Kruja zone in the east and the Adriatic Basin in the west can be seen easily identified in F Figure 2.

### **The geological-tectonic model.**

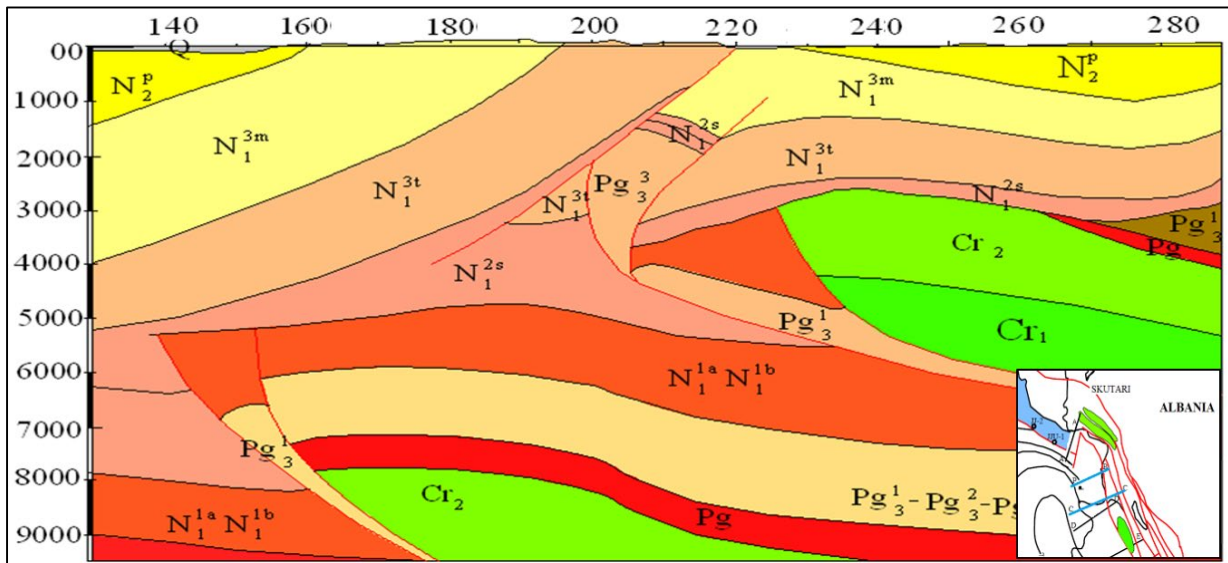
The eastern part of the study area is part of the Kruja tectonic zone, while the western part belongs to the Durrës basin (Adriatic Basin). The geological data from the wells show that the eastern part of this basin have two tectonic stage (Molasses formation transgressive placed over the flysch and carbonate formation). The data show also that the scale of structuring (folding) of the deposits under the

unconformity is more intensive comparing with the deposits above it (Xhomo,*et al.*, 2002). From east to west direction the anticlinal structures are as following:

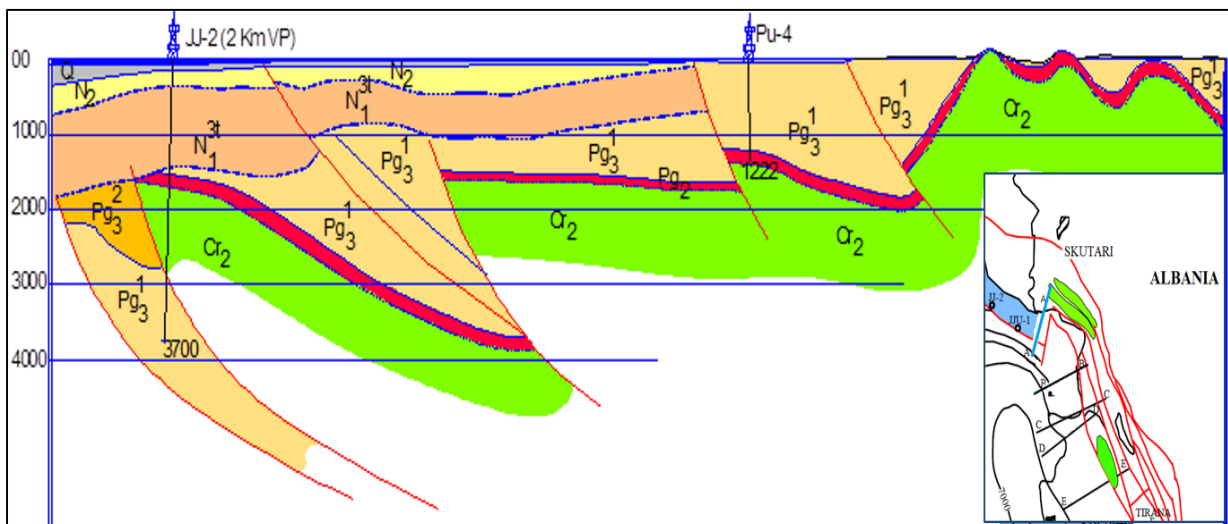
- Valesh-Letan-Dajt-Kakariq anticlinal structures
- Makaresh-Renc anticlinal structures
- Kozan-Petrela-Fushe Kruja-Tirana anticlinal structures
- Ishëm anticlinal structures

The eastern carbonate structures are very deformed, especially those found in the northern part of the study area. The eastern arms of carbonate structures can be seen in the surface, while their western arms are missing. This indicates the high coefficient of structuring compared to their low rate of folding.

The westernmost structure has the same characteristics as Ishmi structure, which is faulted along its western arms with a high amplitude and dips to the west. This fault is the main longitudinal fault with the highest amplitude in the region, which is related to the main western fault of the Dalmatia tectonic zone, meet by wells JJ-2 and JJ-1, further to the north in Montenegro (Bega, 2015).



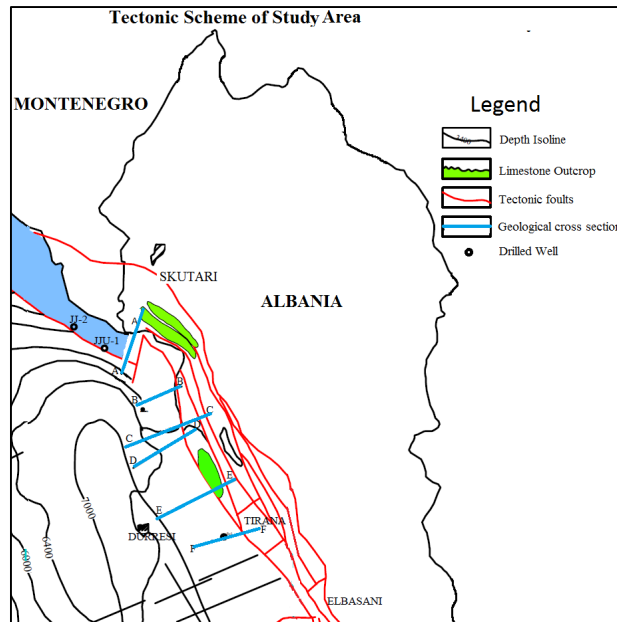
**Figure 2.** Seismic-geological cross section C-C & D-D.



**Figure 3.** Seismic-geological section A-A

The seismic data show that the western fault of Kruja, which is linked to the north with the western fault of Dalmatia zone meet by the JJ-2 well in Montenegro (Figure 3).

Based on the seismic and well data the top carbonates are interpreted about 7000m deep and are covered by the overlap the structures of Kruja tectonic zone. (Velaj, 2012)



**Figure 4.** Tectonic scheme of study area

Another important discussion is the existence of Ionian tectonic zone further to the north and cover by the Peri Adriatic zone. Previous interpretations show different opinions. Based on geological data from the new seismic lines and wells we will give same consideration.

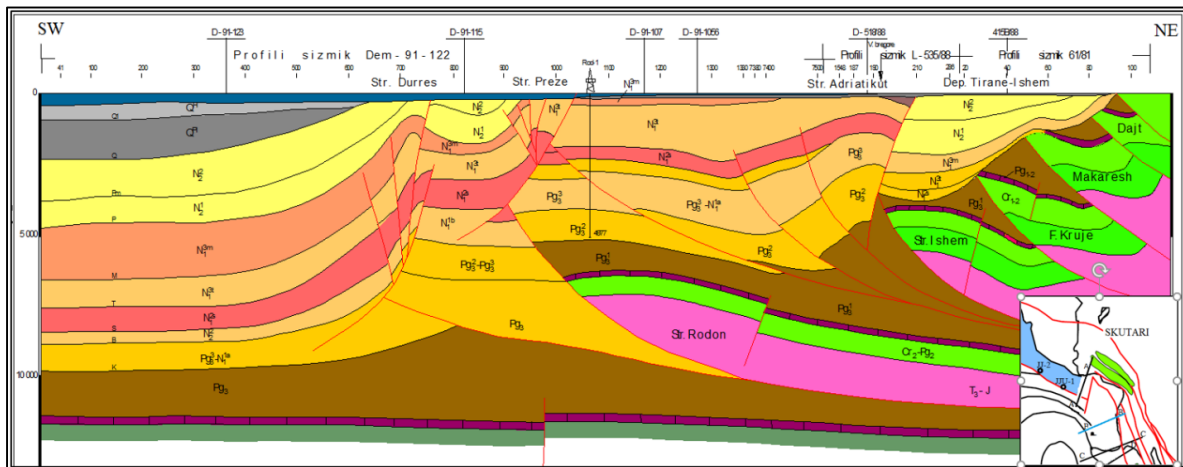
**First** - The gravimetric data indicate the presence of a large negative anomaly following from the - south (west of the Cika structure) to the north (west of the Kurveleshi structure) (Mëhillka,*et al.*,1986-1987 ) (Velaj,2015) which turns eastward near the Shkumbin river indicating that the tectonic belts do not extend towards the north of this river. **Second**- The data from the very depth Well-18 (Bega, 2010) proved the existence of this gravimetric anomaly. **Third**- The seismic data and the correlation from the south to the north of the top of carbonate of the anticlinal structure of Patos-Verbas has shown that this structure does not continued further to the north of Vlora-Elbasan-Peshkopi fault. (Sadiku ,*et al.*,1989). Regarding to the continuation of this transverse fault to the east it is more possible that passes in the west of Paper and Rove anticlinal structures. In the depth this fault is join with the main west thrust of Kruja tectonic zone. This interpretation includes Paper and Rova structures (referring to the top carbonates) to the northern continuation of Ionian tectonic zone. (Thomai, 1987 )

The seismic data registered down to 8 seconds (sections D-D, E-E, F-F; Figure 4) can be interpreted that the folding intensity of the carbonate structures in this region is less than the intensity of the known carbonate structures for the same tectonic stage for Ionian and Kruja tectonic zones.

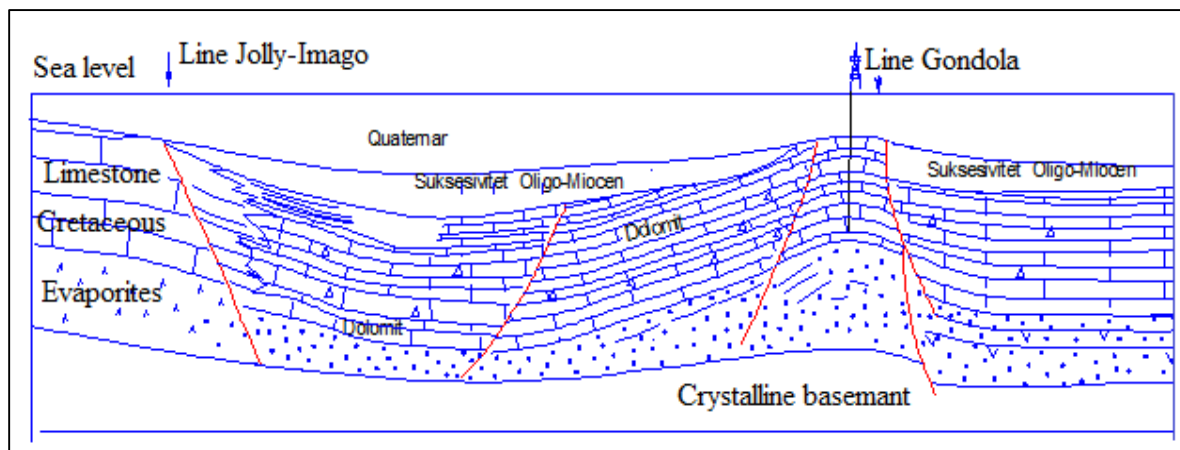
Otherwise, the folding intensity looks to be the same for the Neogene structures from south to the north along the Kreshpan, Ardënica, Divjaka - Durrës (southern part) and Lushnja – Mlik - Shkoza (northern part). The axis orientation of these Neogene folds does not coincide with the orientation of the known carbonate structures. This means that the Neogene folds are the consequence of new tectonic phases, mainly after Tortonian time, which tells for the presence of the same sedimentation conditions for both the Ionian tectonic zone and Durrës. Basin during this time. The impact of tectonic phases was different over the different areas of the Ionian tectonic zone and Durrës basin as well. It is understandable that the thrusting amplitude of the possible interpreted structures is decreasing from east to west towards the Sazani tectonic zone. This is also supported by studies conducted for the areas in surrounding countries (Franket *et al.*, 1983.) Which interpret the Adriatic platform is composed of some tectonic blocks divided by a series of normal tectonic faults. These tectonic blocks are found deeper moving from west to east passing gradually from the platform to the southern Adriatic basin. (Figure 6.) (Gartner *et al.*, 2002). The seismic data registered down to 8 seconds (Figure 7), seismic section E-E distinguish two seismic facies: one seismic facies containing strong intense seismic reflections from 0 to 2.8 seconds and the other with rare seismic reflections belonging to the deeper section. These seismic models of reflections show for different degrees of deformation during the folding phases. Unconformity between



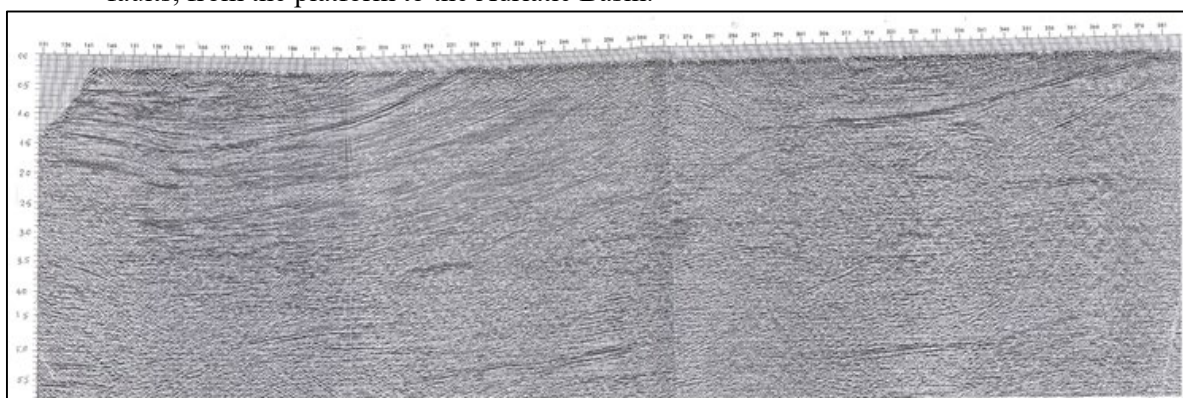
Neogene and Mesozoic folds and the lower stage of folding of structures to the west of Kruja zone (Figure 5).



**Figure 5.** Seismic-geological section B-B



**Figure 6.** Geological profile according to line D-438. Gradual transition, through normal tectonic faults, from the platform to the Adriatic Basin.



**Figure 7.** Seismic-geological section E-E.

Two seismic facies can be distinguished: One with plenty of reflections tractable up to 2.8 sec time and the other facies with rare reflections and preserved up to 5 seconds time. In the time 4.5-5 seconds we distinguish a steady reflection which rises to the west. This reflection belongs to the top of Mesozoic section. (Figure 7). The paleogeography changes that ha the Ionian zone from the south to the north and the decreasing of tectonic belts along this direction indicate the different tectonic style of the structures toward the north. Based on these facts we conclude that the study region represents a transitional zone,

where the structures of the lower tectonic stage (carbonate and flysch formations) are less folded and less fragmented. The top carbonate is shallower from east to west direction passing gradually in to the South Adriatic platform. It is also possible that during the Paleocene-Eocene time the South Adriatic basin and in the Ionian basin have been unified. The data mentioned above for the study area as wells as the data from the surrounding regions (Italy, Montenegro) suggest that for the Jurassic and possibly Cretaceous carbonates a platformic facies is expected. The tectonic style during this time was represented by a horst and graben model, which passes into the basin conditions in the later geologic time and was not affected or less affected by the tectonic phases. As a consequence, we think that the structures of the tectonic belts within the Ionian tectonic zone to the south do not extend along the study area towards the north with the same features. This fact is to be taken into consideration during the geological interpretations, structure prognosis and their depth.

## **Conclusion**

The study region is not very folded and should belong to the Southern Adriatic zone. The structure of this are different from those we know today in the Ionian and Kruja tectonic zone. Expected structures in the region are thought to be large in size less tectonically complicated and with much lower folded structures.

Paleogeographically the carbonate deposits of the Kruja zone in the Upper Cretaceous are platform facies whereas the Paleocene - Eocene and newer deposits are pelagic facies. Because during the Paleocene-Eocene age must have occurred the unification of the Ionian zone with the Kruja tectonic zone, at this time a single basin is created. Regarding to the type of the deposits in Southern Adriatic zone based on the geological phenomena observed in the surrounding units and regions the Eocene and Paleocene age are pelagic facie. At this time must have occurred the unification of the Southern Adriatic zone with Ionian zone.

Relations between the Kruja zone and the surrounding structural units are of a tectonic contact. The fault is thought to have a very large displacement amplitude in both vertically and horizontally direction. This fault is also confirmed by the work made outside the Albania borders. The carbonate structures of the Kruja tectonic zone appear tectonically complicated and eroded up to the level of Upper Cretaceous carbonate deposits. They have large size, with wide roofs, smooth eastern arms and no western arm with northwest-southeast extension.

Relationships between the Ionian Zone and the units in the west have tectonic character, where the fault is thought to have a much greater overlap amplitude and must pass in the west of the Patos-Verbas structure, arching further to the north, where in the vicinity of the Shkumbini river interrupts the continuation of this structure and further to the north.

The most powerful folding phases affecting the study area are those of the Hatian (Kugleri zone) Burdigalian and Tortonian.

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