SOME CONSIDERATIONS ON TECTONIC RELATIONSHIP BETWEEN IONIAN AND SAZANI TECTONIC ZONES AND THEIR TECTONIC MODEL

Dhurata Ndreko
Polytechnic University of Tirana, Geology and Mining Faculty, Tirana; Albania
ndhurata@yahoo.it
Shaqir Nazaj
Polytechnic University of Tirana, Geology and Mining Faculty, Tirana; Albania
shnazaj@yahoo.com

Abstract: The study area is located in the southwestern part of the Outer Albanides. Three rock formations are easily distinguished and described from the geological studies, which are called as following: Evaporitic formation, carbonate formation and terrigenous (flysch and molasse) formation. The evaporitic formation is determined as the oldest one. The tectonic boundary between the Upper Liassic to Neogene deposits with the older ones (Triassic to Lower-Middle Liassic) is also drawn from the geological surveys. From the tectonic point of view, the study area is part of the Ionian and Sazani tectonic zones. The Ionian tectonic zone is extended from Peloponnese in the Greek territory to the south to Vlora-Elbasan-Diber transverse fault in Albania territory to the north. Ionian tectonic zone is bordered in the east with Kruja tectonic zone and in the west with Sazani tectonic zone. To the north and northeast direction, the boundary of Ionian Zone coincides with the orogen boundary, overlapping to a considerable scale over the Southern Adriatic zone. The Sazani tectonic zone is outcropped in Albanian territory in Sazani Island and Karaburun peninsula as well. This tectonic zone is covered by the Ionian Sea towards the south and is outcropped again in Greece territory further to the south on the Paxos Island. Towards the northwest, Sazani tectonic zone is dipping under the Adriatic Sea water and further to northwest, it appears in Apulia region in Southern Italy. This paper will provide some considerations on the relationships between these two tectonic zones based on the seismic data shooted in offshore area, field observations and published papers. Some consideration on the tectonic style of Sazani tectonic zone and how this zone continues in the northwest direction to connect with the Preapulian zone will also be given. The Ionian tectonic zone collides with the Sazan tectonic zone in the Vlora area (Albania) creating a triangular area of the most beautiful in the Outer Albanides. The Sazani tectonic zone is affected by orogenesis in the area of Karaburun peninsula and in the north of Sazani Island overlapping towards the west direction, while further to the northwest, it continuous in the Preapulian zone, where the part of Sazani tectonic zone is not affected by alpine orogenesis. In this region, Preapulian and has maintained the same form as a horst structure, the same as it was during the time of rifting phase. The studies made for Sazani tectonic zone have come to the conclusion that on the top of the rifted carbonate blocks are transgressively placed the Neogene deposits of Burdigallian to Pliocene in age.
Keywords: Tectonic fault, Ionian, Sazani.

1. INTRODUCTION

Albania is part of the Dinarido-Albanido-Helenic belt (Dinaride s.l.), part of the western segment of the eastern Mediterranean belt. Albanides are divided in two main groups: Internal Albanides and Outer Albanides. Outer Albanides are divided into: Kruja (Gavrovo), Ionian, Sazani (Apulia) and the Southern Adriatic Basin. We give some considerations for the tectonic model for the two tectonic zones in the southwestern part of the Outer Albanides (Ionian and Sazani tectonic zone).

2. GEOLOGICAL SETTING

Three main formations can be distinguished in the geological setting of the study area, evaporite, carbonate and terrigenous formations. The studies made to determine the age of evaporite deposits have concluded that these deposits have Upper Triassic age. (Mavrovi P., 2018). These formation are related to deep longitudinal and transverse faults that interrupt the geological structures.

Lithologically these deposits have different characteristics, in the Ionian zone where in the Kurveleshi subzone are concentrated the salts and in the eastern and western subzones (Berati and Cika) gypsum and anhydrite tend to be predominant. (Bega Z., 2017).

In all cases, evaporate deposits have tectonic relationships with surrounding rocks. The real thickness has not been determined, but it is visible about 6,000 m (well Dumrea 7) (Xhomo A., 2002). The carbonate formation can be divided into two main sequences, the sequence with neritic facies and sequence with pelagic facies. Both these

sequences are deposited in a passive margin. The passive margin for the Ionian zone existed until the beginning of the deposition of terrigenous formation in the Lower Oligocene, while for the Sazani zone it continued until the beginning of the Upper Oligocene (**Error! Reference source not found.**). The passive margin has migrated through space and time passing to active (compression) margin in different periods, for both tectonic zones. The Neritic facies are pre-rifting deposits from the Upper Triassic to the Lower and Middle Jurassic. The Upper Triassic deposits are represented by dolomites and dolomitic limestone. Over these deposits successively continue the Lower Liassic deposits and they have the same lithological characteristic for the two tectonic zones. The Pelagic facies are post-rifting deposits and they have different lithological characteristic in both tectonic zones (Roure F, Nazaj Sh, et al, 2004). This suggest that the passive margin after opening has been transformed in to a horst and graben structure,

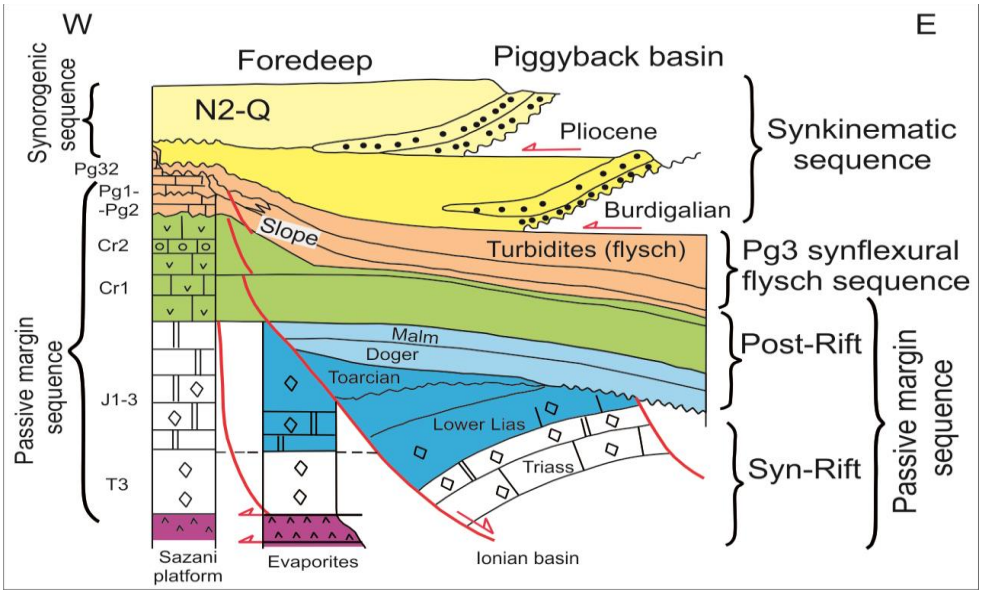

Figure 1 –*The tectonic model of Ionian tectonic zone in Albania (Modified from* (Roure F, Nazaj Sh, et al, 2004)

where Ionian zone has represented a graben, divided in several semi-rotated blocks, while the Sazani zone has represented a horst structure.

The geological surface section for the Ionian zone, continues maily with carbonate deposits starting from "*Amonitico rosso*" formation of Toarian age and with cherts intercalated with limestone layers of Dogger - Malm age. The deposits for these geological age, in the Sazani zone are lithologicaly repsresented by limestone with alge or oolitic limestone. (Xhafa Z, Sadushi P, et al , 2000) The deposits of the Upper Liassic to Cretaceous (Aptian) in Tagjasi area are placed with unconformity over the olderer deposits or through the old paleofaults of rifting time. The terrigenous formation of the Paleocene-Eocene, in the Ionian zone is pelagic facies, whereas in the Sazan zone is neritic facies. The passage from carbonatic to terrigenous formation in the Ionian zone, begins in the Lower Oligocene. In this time in the Sazan zone, the carbonatic formation still continues the deposition until the Middle Oligocen (Pg_3^2) (Xhafa Z, Sadushi P, et al , 2000). These deposits are found in the western part of the Kanali Mountain (Mali i Kanalit), placed with unconformity over the limestones of Upper Cretaceous. For the Sazani tectonic zone, the passage from carbonatic to terrigenous formation begins in Upper Oligocene.

3. TECTONIC MODEL OF IONIAN ZONE

The Ionian tectonic zone begins in the Greek territory from Peloponnese and continues northwest in Albania territory until the Vlora-Elbasan-Diber tranverse fault. In the east, the Ionian tectonic zone is bordered with Kruja (Gavrova) tectonic zone, this boundary is visible for carbonate formation whereas for the terrigenous formation of Oligocene, the difference is almost non-existent. In the west part the Ionian zone is bordered with the Sazan tectonic zone, this border is visible for carbonate formation. The carbonate formation for the Sazan tectonic zone are neritic facies and continue untill the Middle Oligocene, while in the Ionian zone the carbonates formation are pelagic facies and continue untill Upper Eocene (Fig. 1) (Roure F, Nazaj Sh, et al, 2004). From the south to the north direction within the Albanian territory, this tectonic zone gradually reduces its width. This reduction is due to the combination of western tectonic fault with transverse tectonic faults of structural belts, and the very large scale of the overlapp

(over 50 km) towards the west (Fig. 2).The overlapps of the Ionian zone in the west has been influenced by two important factors: the presence of evaporite and the presence of old longitudinal and transverse tectonic fault. The evaporitic formation have served as "lubricant horizont" (Velaj T. et .al 1999) (Velaj T., 2015). One of the old transverse faults is observed in the north part of the Corfu Island (Otoni Island) (Milia A., 2017).This fault borders the Ionian zone in the south with to the Sazani zone (Apulia platform) in the north. (Fig. 2). The Ionian zone in the southwest part overlapps in the west direction, over the Sazan tectonic zone and completely hides some structural belts and the eastern edge of the Apulian platform. The border of the Ionian zone in the north and northeast direction, coincides with the orogenic edge, overlapped to a considerable scale over the structures Southern Adriatic zone (Konomi N., 2000). In the study area some structural units are observed.

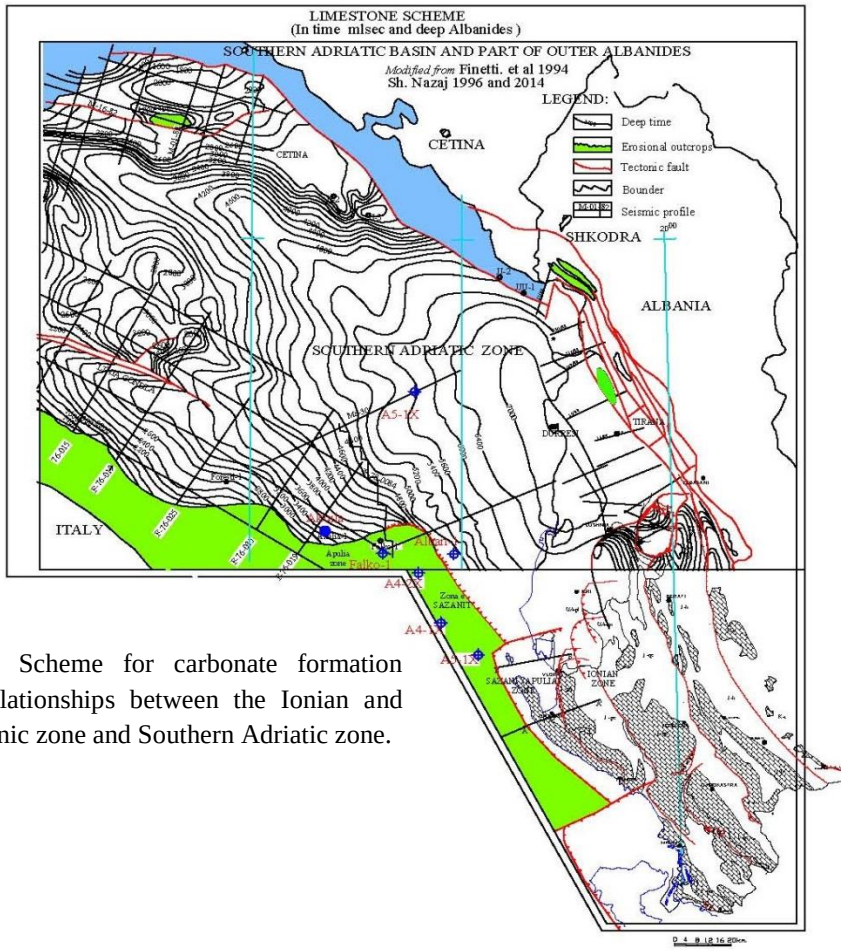

Figure 2 - Scheme for carbonate formation showing, relationships between the Ionian and Sazani tectonic zone and Southern Adriatic zone.

3.1 Anticlinal structure of Cike-Tragjasi

The anticlinal structure of the Cike – Tragjasi has northwest-southeast direction, but in Tragjasi area this structure changes direction to the east, and becames almost northeast to south direction. This change is related to the old paleofaults of the rifting time. At the core, this anticlinal structure is built by dolomitic deposits of the Upper Triassic, while the eastern flank is built by carbonate and terrigenous formation from Jurassic to Oligocene age. In the west part this anticlinal structure is complicated by some tectonic faults. The main tectonic fault is found in Dukati stream (Melo V., Hyseni A., 1999). This fault contacts the Langhian deposits that build the Dukati synclinal with the carbonate deposits (Cretaceous) that build the western flank of the Tragjasi anticlinal (Fig.3). The carbonate deposits have very small thickness and also are tectonically affected and give the impression of a tectonic zone (Fig. 3). These deposits in the east part contact tectonically with the Upper Triassic deposits that build the core of Tragjasi anticlinal structure.

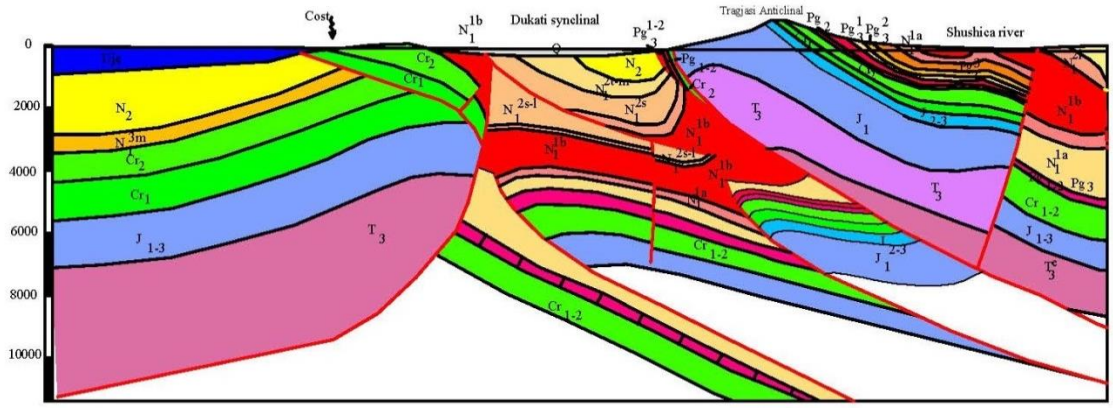

Figure 3 - Geological profile AA' showing the relationship between the Ionian zone (east) and the Sazani zone (west)

3.2 VLORA ANTICLINAL STRUCTURE

Vlora anticlinal structure in the southern part is almost completely masked by the overlapp of Tragjasi anticlinal structure, while in the northern part this structure dips in the north direction. Several wells were drilled in this structure for oil and gas exploration without positive results. To the west of the Cike-Tragjasi anticlinal structure, the Dukati synclinal structure is observed.

3.3 DUKATI SYNCLINAL STRUCTURE

This structural unit, based on well data, seismic data and field survey, is filled with Langhian and Seravalian deposits. The depth of carbonate formation is about 4000 m. This synclinal structure in the Llogara pass is the contact between the Ionian with the Sazani tectonic zones. (Photo 1). Further to the north direction this structure extends it's width of about 3-4 km. In the southern part this structural unit is masked by the overlapp with different directions of the Ionian and the Sazan zone.

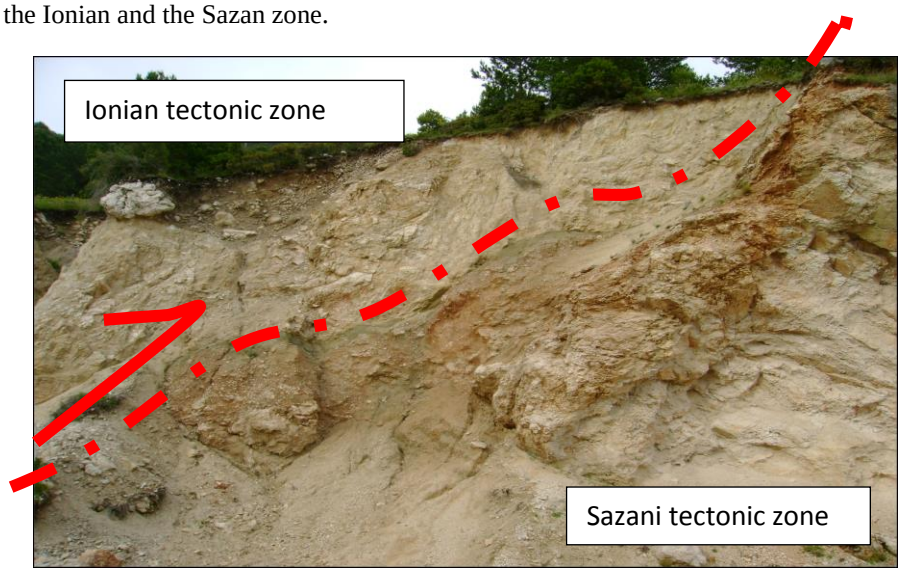

Photo 1 - Relationships between the Ionian and Sazani tectonic zone (Llogara pass, Photo Nazaj.Sh)

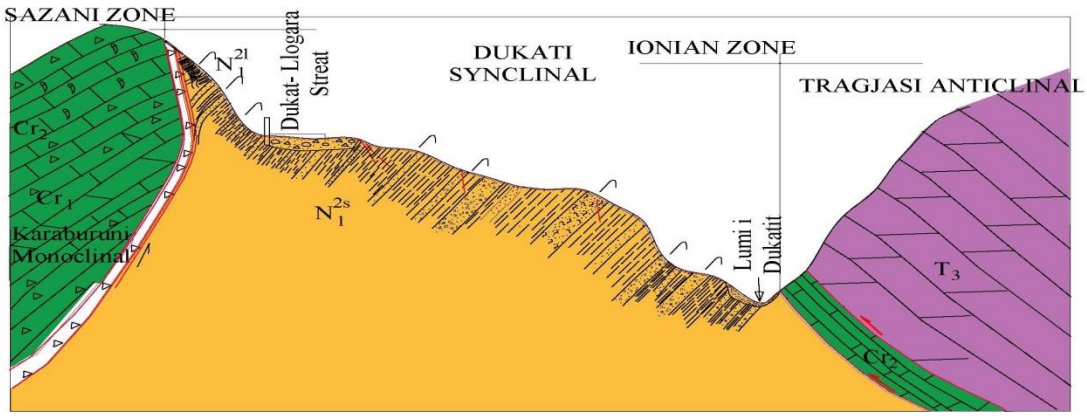

Figure 4 - Geological cross section showing the relationship between the Ionian and the Sazani zone (Dukati Synclinal).

4. TECTONIC MODEL OF SAZANI (APULIA) ZONE

Sazani (Apulia) zone is the most western tectonic zone of the Outer Albanides. In the south direction it is covered by Ionian Sea Water and outcorps again in Greece (Paxos Island). While in northwest direction Sazan (Apulia) tectonic zone is covered by the Adriatic Sea Water and outcorps again in Apulia, south of Italy. Based on seismic work shooted in offshore area are provided sufficient data on the extention of the Sazani tectonic zone and relationships with other tectonic zones. (Frashëri A., 1996) (Naco P., 2014) (Milia A., 2017). This tectonic zone represents the eastern margin of the Apulian platform. This margin dips gradually toward the east with the presence of normal tectonic fault (Fig. 5). Based on the data collected, the conclusion has been reached that over the carbonate blocks formed at the rifting time are transgressively placed the Neogene deposits (Burdigallian to Pliocene). Sazani tectonic zone outcorps in the southern part of Albanian territory with the monoclinal structure of Kanali Mountain (Mali i Kanalit). The deposits of this structure bed dips westward direction with angle of about 20° - 30° and 50 °. This monoclonal has tectonic contact with the carbonate deposits of Triassic-Jurassic age of the Cika anticlinal structure of Ionian zone (Photo 1). The tectonic fault which has southeast to northwest direction looks like a normal fault in the Dukati area, but in depth it changes its orientation and is backthust fault. This backthrust fault is caused by the collision of the Ionian with the Sazani tectonic zone. (Fig.4 & Photo 2).

Photo 2- The plan of the tectonic fault that looks like a normal fault, but in depth change its orientation (Photo Nazaj.Sh)

Further to the northwest direction through a tectonic fault, continues the monoclinal structure of Karaburun – Sazani, with bed dips in eastward direction of about 15^o-30^o. In the east part it is affected by various normal faults. In the east direction it is interpreted as the continuation of the Southern Adriatic zone, where deposits are thought to be successive. We thought that this tectonic fault is after the Pliocene age (Fig. 2 & 5). It should be noted that the Sazan tectonic zone in southern part is affected by orogenesis (Stampfli, 2005) and overlapped in the west direction. The north part of Sazani tectonic zone is not affected by alpine orogenesis and has maintained its horst and graben structure, the same as it was during the rifting time. (Fig.5)

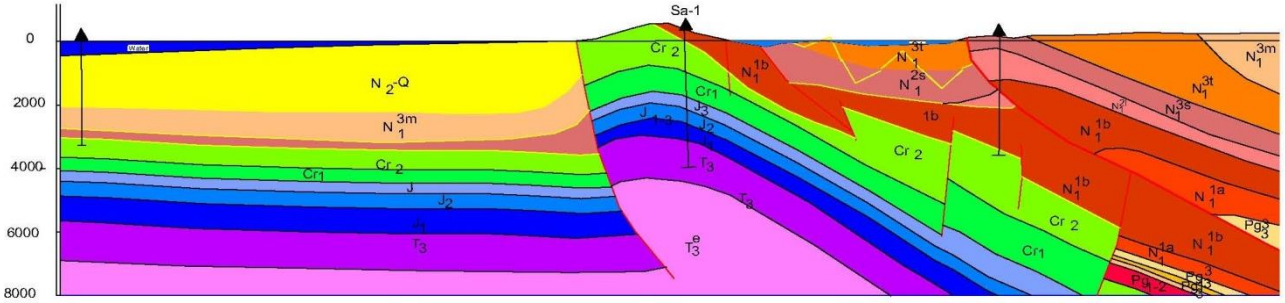

Figure 5 – Geological profile BB' the shows the Sazani zone in the south it is affected by Alpine orogenesis and overlapped in west.

5. CONCLUSION

1. Three rock formations are distinguished from the geological studies, which are as follow: Evaporitic formation, carbonate formation and terrigenous (flysch and molasse) formation.
2. Carbonate formation is divided into two sequences: sequence of neritic and sequence of pelagic facies.
3. The geological setting of the study area is very complex, with large-scale overlapping structures until the masking of some structural belts. The combination of transverse and longitudinal faults, from south to north direction has brought the reduction of the width of the structural belts in the Ionian zone. The Ionian zone does not continue north of Shkumbini River, but it is replaced with the South Adriatic zone.
4. The Ionian tectonic zone collides with the Sazan tectonic zone in the Vlora area (Albania) creating a triangular zone of the most beautiful in the Outer Albanides.
5. The Sazan tectonic zone in southern part is affected by orogenesis and overlapped in the west direction but in he north part not affected by orogenesis and has maintained its horst and graben structure, the same as it was during the rifting.

REFERENCES

Bega Z., S. I. (2017). Chapter 24. In J. F. Juan I. Soto., *Permo-Triassic Salt Provinces of Europe, North Africa and the Atlantic Margins* (pp. 517 - 538). Elsevier Science Publishing Co Inc.

Frashëri A., Nishani P., Bushati S., Hyseni A. (1996). Relationship between tectonic zone of the Albanides based on results of geophysical studies. *In Ziegler and Hareath Ed.*, 485-511.

Konomi N. (2000). *Harta Gjeologo - Inxhinierike e Shqipërisë Sh 1:200 000.* Tiranë: .

Mavrovi P. (2018). Analizë mbi moshën e evaporiteve të zonës Jonike. *Buletini i Shkencave Gjeologjike*, 93 - 101.

Melo V., Hyseni A.,. (1999). Thyerjet aktive ne territorin Orikum - Dukat - Llogara - Palasë dhe zhvendosja e blloqeve tektonike. *Studimet gjeografike 10*.

Milia A., T. M. (2017). Pliocene-Quaternary orogenic systems in Central Mediterranean: The Apulia-Southern Apennines-Tyrrhenian Sea example. *Tectonics , 36*, 1614 - 1631.

Naco P., Kaza Gj.,Doda V., Vinçani F., Cara F. (2014). Contribution of the reflected Waves Method in structural modeling of albanides,. *Jour J. Engeinering Res. Appl. Vol.4*, 299-309.

Roure F, Nazaj Sh, et al. (2004). Kinematic Evolution and Petroleum System - An Apprasal of the Outer Albanides. *K.R. McClay, Thrust tectonic and hydrocarbon system. Vol 83, AAPG Mem.,*, 474-493.

Stampfli, G. M. (2005). Plate tectonic of the Apulia - Adria Microcontinents. *CROP PROJECT: Deep Seismic Exploration of the Central Mediterranean and Italy*, Chapter 33 pp 747 - 766.

Velaj T. (2015). New ideas on the tectonic of the Kurveleshi anticlinal belt in Albania and the prespective for exploration in its subthrust. *Petroleum 1*, 269-288.

Velaj T., Devison I., Seriani A., Alsop I. (1999). Thrust tectonic and the role of Evaporite in the Ionian zone of the Albanides. *AAPG Bulletin Vol. 83 No.9*, 1408-1425.

Xhafa Z, Sadushi P, et al . (2000). New geological and Biostratigraphical data on Eocene and Oligocene deposits in the Sazani zone. *AJNTS.Nr.9* , 135-146.

Xhomo A., Kodra A., Shallo M., Nazaj Sh., Nakuçi V., Yzeiraj D., Lula F., Vranaj A., Melo V., Dimo Ll., Sadushi P.,. (2002). *Gjeologjia e Shqipërisë.* Tiranë: F.GJ.M.