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# STRUCTURAL AND NEOTECTONIC FEATURES OF THE PERIADRIATIC DEPRESSION (ALBANIA) DETECTED BY SEISMIC INTERPRETATION

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## ABSTRACT

The Periadriatic Depression includes the western Lowland of Albania from Vlora to Ulqini.

The Periadriatic basin, formed after the main folding and thrusting of Ionian zone, is filled with molasse deposits. The molasse formation building this Depression is made up by Middle Miocene up to Pliocene sediments.

The Periadriatic Depression extends on its eastern and southern bordes over folded and thrusted structures of the Ionian and Kruja Zones.

The folding and thrusting of Periadriatic Depression is finally due to the Early Pleistocene compressional phase that is evidenced by some important structural unconformities.

The Periadriatic Depression is built by some linear relatively narrow anticlines, superimposed over thrust or backthrust faults, and wide synclines.

The Mio-Pliocene anticlinal folds generally do not outcrop with all their tectonic elements (flanks,periclines).

The positive structures of western coastal part are well expressed on the relief; so, the anticlines here build hills while the synclines are buried under Holocene plains between them.

The structural and neotectonic features are evidenced in the seismic lines.

## 1. INTRODUCTION

This paper deals briefly with the contribution of seismic data in evidencing the neotectonic features on Periadriatic Depression.

The author of this paper, working in the framework of his D.Sc.Thesis (in Albanian): **"Neotectonic elements on Periadriatic Depression deduced from seismic data"**, as well as in preparation of the **Neotectonic Map of Albania in scale 1:200 000 (1995)**, sponsored by the Committee of Science and Technology of Albania, has obtained many geological data from the interpretation of seismic lines carried out during the last decade. The exploratoty seismics, discovering the deep structure of Periadriatic Depression, gives us a lot of geological information. The entire morphology of Mio-Pliocene anticlinal and synclinal folds, part of which has been buried under Quaternary deposits, as well as the tectonic faults have become evident by the seismic lines. There have been observed thrust faults which complicate the flanks of anticlinal folds.

In this paper through different examples on seismic lines, we will show the types of logitudional faults, detected in Periadriatic Depression and their origin.

The Mio-Pliocene anticlines in Periadriatic Depression are superimposed over thrust or backthrust faults. Some of these faults represent the "flower" structures of "palm tree" type.

## 2. GEOLOGICAL SETTING

The Periadriatic Depression includes the western part of the External area of the Alpine folding, that are called the Albanides and represent the geological structures that lie on the territory of Albania. They are located between Hellenides in the South and Dinarides in the North, which together form the Dinaric branch of the Mediterranean Alpine Belt. Albanides are divided in two paleogeographic zones: the Inner Albanides (that consist of Korabi, Mirdita and Krasta-Cukali zones) and the Outer Albanides. The Outer Albanides include the Albanian Sedimentary Basin (Kruja, Ionian and Sazani zone and Periadriatic Depression) with a thickness up to 15 km. (Frasheri A.,1996) (Fig.1)

The Preadriatic basin is located in the western part of Albania, from Vlora to Ulqini, it is formed since Serravalian, subsequently to the main folding and thrusting of Ionian zone and is filled with molasse from Middle Miocene up to the end of Pliocene.

The seismic lines have evidenced that the Miocene molasses transgressively and with strong angular unconformity overly Ionian and Kruja folded structures, mainly along the eastern and southern margins of Periadriatic Depression (Aliaj, 1988,1994; Skrami J.& Aliaj Sh, 1995) (Fig. 3,4,6).

These structural unconformities express the compressive phases that occured during Mio-Pliocene and Plio-Quaternary boundary on Periadriatic Depression. The folding and thrusting of Periadriatic Depression is finally due to the Early Pleistocene compressional phase. As the result of the last tectonic phase, the Quaternary deposits horizontally overly with unconformity the folded Mio-Pliocene structures of the Periadriatic Depression (Skrami J.& Aliaj Sh, 1995).

The Preadriatic Depression is built by some Mio-Pliocene linear relatively narrow anticlines and wide synclines, which from the west to the east are as follows: Povelŋa-Semani anticline (Fig.2,4,10), Karavasta syncline (Fig.2), Panaja-Frakulla-Ardenica-Divjaka-Kryevidhi-Durrλsi anticline line (Fig.2,8,4,5,7,9,3), Myzeqe syncline (Fig.2,4,5,7), Lushnja-Golem-Kavaja anticline line (Fig.2,7), Erzeni i Poshtλm syncline (Fig.2,3), Preza monocline and Tirana syncline (Fig.3).

The Adriatic shoreline obliquely cut the northwestern prolongation of the Mio-Pliocene structures. These structures in the seawaters are buried under the marine Quaternary deposits.

The Mio-Pliocene anticlines are superimposed over thrust or backthrust faults, detected by means of the exploration seismic (Fig.2,3,4,5,7,8,9). Some of these faults represent the "flower" structures of "palm tree" type (Fig.5,7,8) (Aliaj Sh.,1988; Skrami J. & Aliaj Sh.,1995).

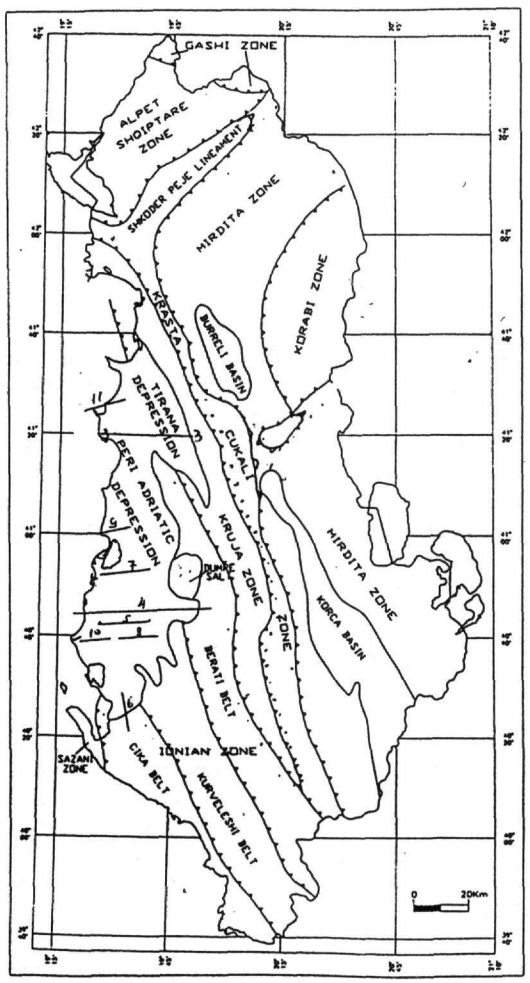


*Fig.1. Tectonic map of Albania with the posistions of seismic lines.*

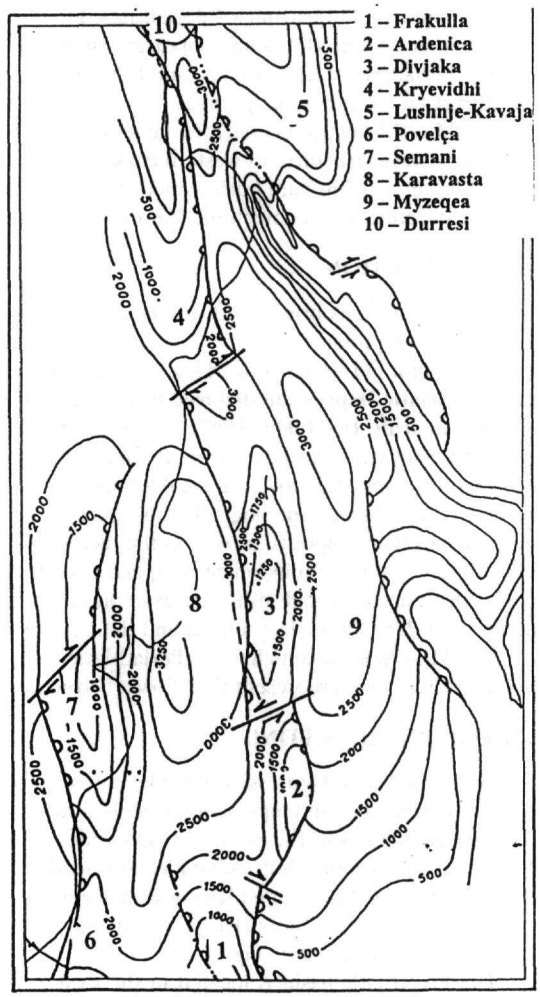


*Fig. 2. Structural scheme for the Pliocene base.*

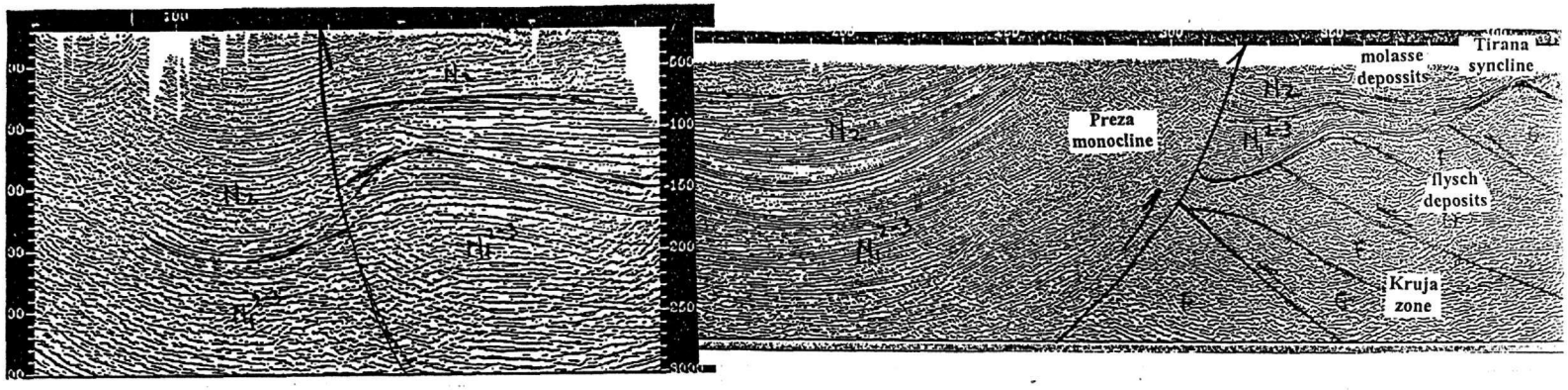


Fig.3 – Seismic line from Durresi to Tirana
The Miocene molasses overlies Ionian and Kruja folded structures with strong angular unconformity and the backthrust fault in Preza monocline are shown.



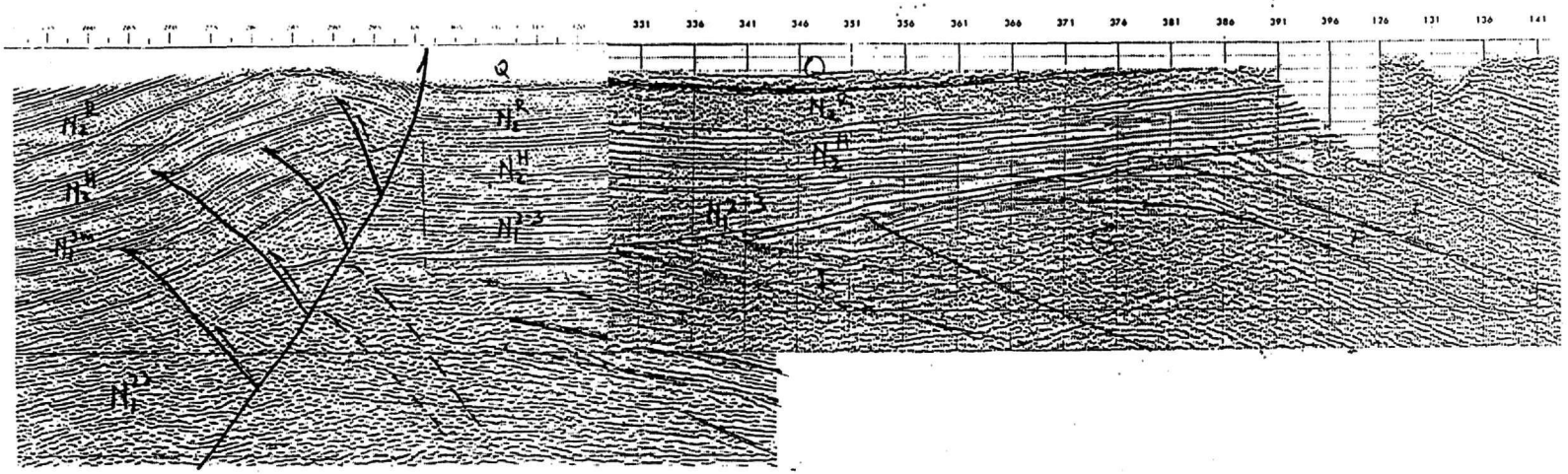

Fig. 5 – Seismic line in Ardenica – Marinza region
The "flower" structure faults of "palm tree" type in Ardenica anticline, the unconformity between Miocene molasses and underlying folded flyschs and carbonatic deposits of Ionian zone andthe slight unconformity between the Pliocene molasse and the Miocene molasses are shown.

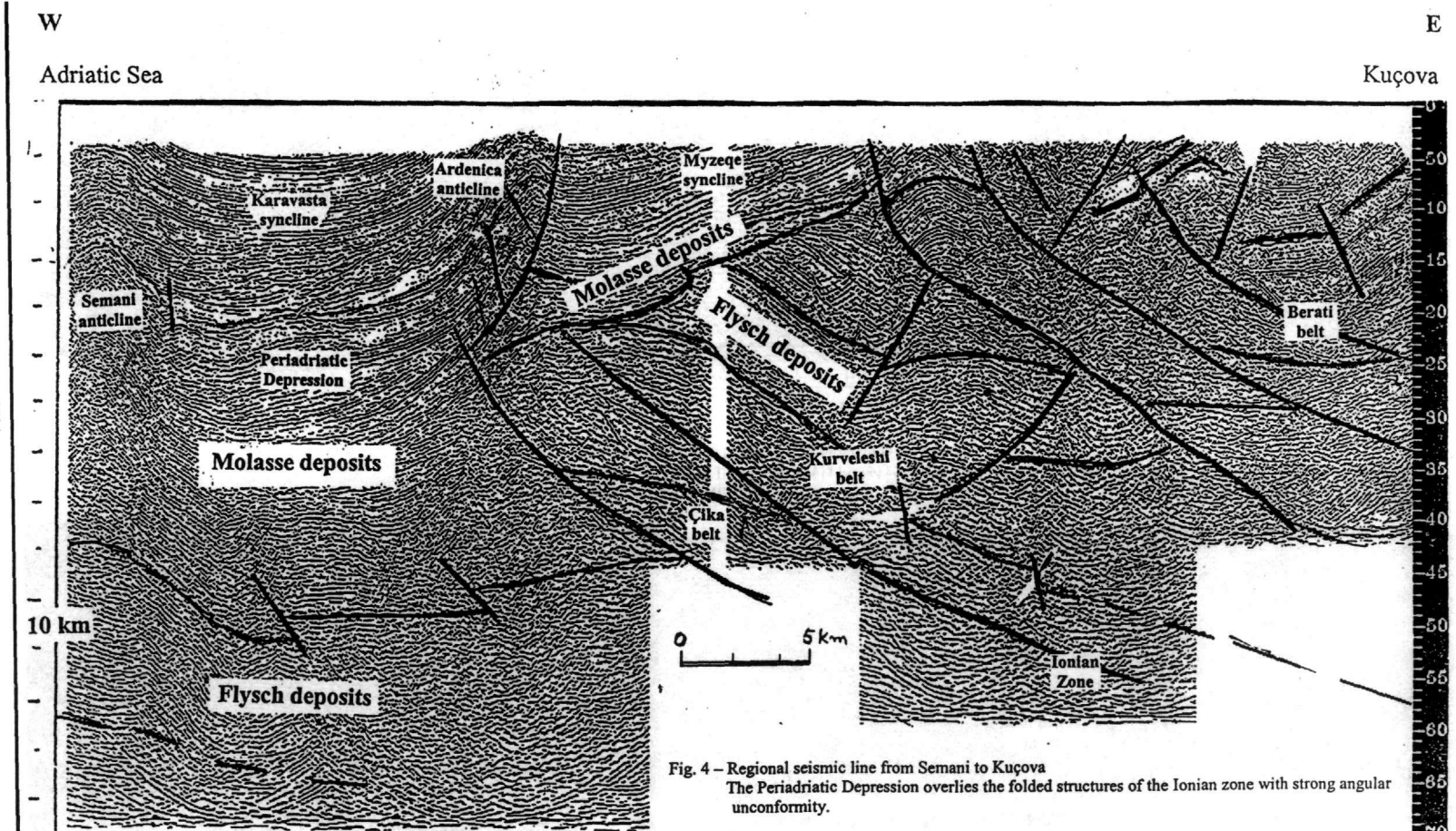


Fig. 4 – Regional seismic line from Semani to Kuçova
The Periadriatic Depression overlies the folded structures of the Ionian zone with strong angular unconformity.

## 3. THE NEOTECTONIC STRUCTURE ON PERIADRIATIC DEPRESSION

### *3.1. STRUCTURAL UNCONFORMITIES AND THE COMPRESSIVE PHASES DETERMINED BY THEM*

Three main structural unconformities are well evidenced from the seismic data:

a.- The unconformity between the Mio-Pliocene molasses and underlying folded flyschs and carbonatic deposits of Kruja, Ionian and Sazani zones.

The seismic lines of the Eastern and Southern part of the Periadriatic Depression (Tirana, Marinza and Selenica areas) clearly show that the Miocene molasse overlies with strong unconformity and transgressively the folded structures of Ionian and Kruja zones (Skrami J.,1999).

This structural unconformity testifies the pre-Serravalian (pre-molasse) compressional phase that has caused the folding and thrusting of the External Ionian zone.

The Pliocene molasse transgressively overlies and with angular unconformity on the margins of Periadriatic Depression the deposits of Kruja, Ionian and Sazani zone too (Fig. 3,4,5,6).

b.- The unconformity between the Pliocene molasse and the Miocene molasse.

The Pliocene molasse overlies with strong unconformity the Upper Miocene molasse in the eastern flank of Myzeqe and Erzeni i Poshtem synclines. On the seismic lines of Durresi and Preza backthrusts is seen that the Pliocene molasses transgressively overlies with slight unconformity the Upper Miocene molasse (Fig. 3,4,5).

On Povelŋa area this structural unconformity is more evident: in the seismic line the strong angular unconformity between Pliocene and Miocene molasses is very well observed (Fig.4). It is verified from drilling data.

The above-mentioned structural unconformity testify the compressional phase at Miocene-Pliocene boundary, probably at the end of Late Miocene, the first one causing the slight deformation of Miocene molasses in Preadriatic Depression, as well as the folding of Sazani zone.

c.-The unconformity between the Quaternary deposits and the Pliocene molasse.

The Quaternary deposits are widely developed in the Periadriatic Depression they have a maximum thickness of 150-200 m. onshore and are horizontally lying on Mio-Pliocene folded molasses

On the Durresi offshore seismic line it is very well seen that the marine Quaternary deposits horizontally overlie the strongly folded Mio-Pliocene molasses (Fig. 11).

This unconformity testifies the Lower Pleistocene compressional phase, which has caused the final strong deformation of Mio-Pliocene molasses in Preadriatic Depression.

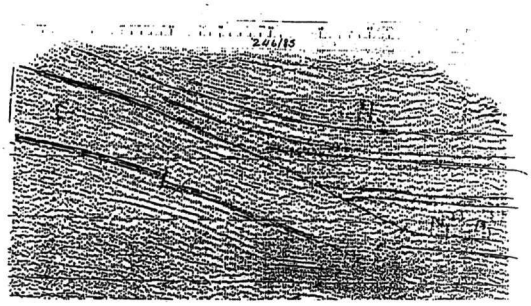

*Fig. 6. Seismic line in southern part of Periadriatic Depression the unconformity between Miocene molasses and underlying folded flysch and carbonate deposits of Ionian zone is shown.*

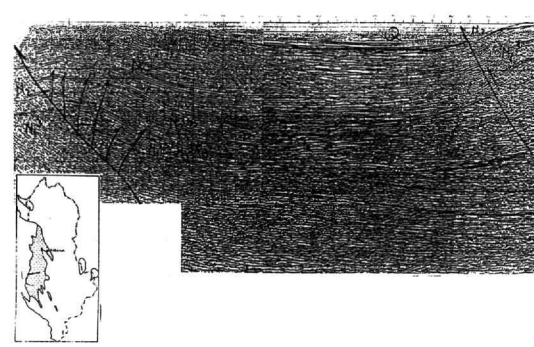

*Fig. 7. Seismic line in Divjaka - Lushja region. The "flower" structure faults of "palm tree" type of Divjaka anticline, the thrust fault in Lushnje-Kavaja-Golem anticline line and the slight unconfornity between the Miocene molasse and the flysch deposits of Ionian zone is shown.*

Here it is also well observed that the Durresi backthrust cuts even the marine Quaternary deposits, which are deformed in accordance with the underlying top of Mio-Pliocene molasses. These data demonstrate that the compressional deformations are still acting in present days, although not so strongly as before.

### *3.2. THE FOLDS*

The folded structure of the Preadriatic Depression is due to two compressional phases: the one, weakest, at Miocene-Pliocene boundary and the other, the strongest one, in Early Pleistocene.

As the result of the last tectonic phase, the Quaternary (marine or continental) deposits horizontally overlie with unconformity the folded Mio-Pliocene structures of the Preadriatic Depression. The compressional deformations are following up to the presentdays.

The Preadriatic Depression is built by some Mio-Pliocene linear relatively narrow anticlines and wide synclines, which from the west to the east are as follows: Povelŋa-Semani anticline, Karavasta syncline, Panaja-Frakulla-Ardenica-Divjaka-Kryevidhi-Durrλsi anticline line, Myzeqe syncline, Lushnja-Golem-Kavaja anticline line, Erzeni i Poshtλm syncline, Preza monocline and Tirana syncline.

In (Fig.8), there is presented the anticlinal structure of Frakulla situated over a "flower" structure of faults, among which the western overthrust is primary.

In Ardenica anticlinal structure (Fig.5), the primary fault is that which complicates its eastern flank, with a western dip $60^0$-$70^0$. It intersects the whole Pliocene thickness. In the western flank of Ardenica structures there are observed some of small amplitude, with an eastern dip, which intersect only the deposits of Pliocene base and a little bit above it, forming "flower" structure of fault.

The Adriatic shoreline obliquely cut the northern and northwestern prolongation of the Mio-Pliocene structures, which in the seawaters are buried under the marine, Quaternary deposits.

The positive structures of the western coastal part are well expressed on the relief, except the Povelŋa-Semani anticline buried under Quaternary deposits (Fig.4); so, the anticlines build hills, while the synclines are buried under Holocene plains between them.

The Mio-Pliocene anticlines are superimposed over thrust or backthrust faults, detected by means of the exploration seismics. Some of these faults represent the **"flower"** structures of "**palm tree"** type.

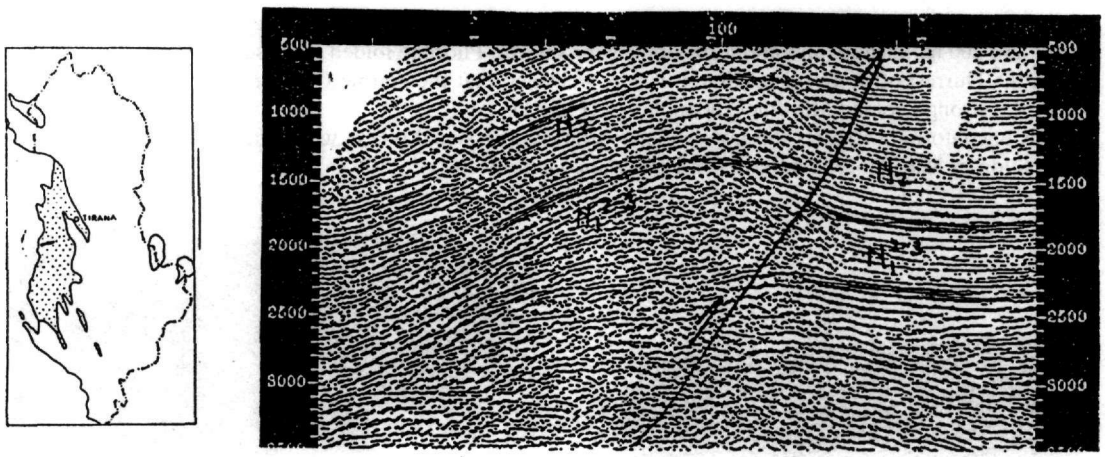


***Fig. 9. Seismic line in Kryevidhi region. The backthrust fault in Kryevidhi anticline is shown.***

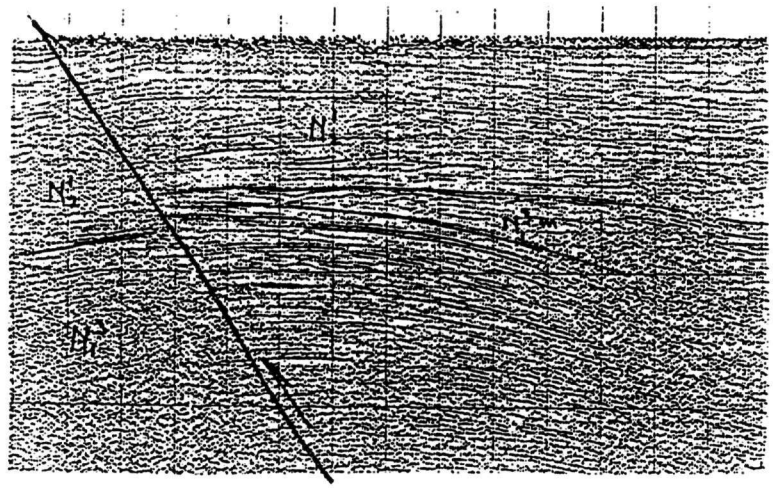

*Fig. 10. Seismic line in Poverca region. The uncorformity between the Pliocene molasses is shown.*

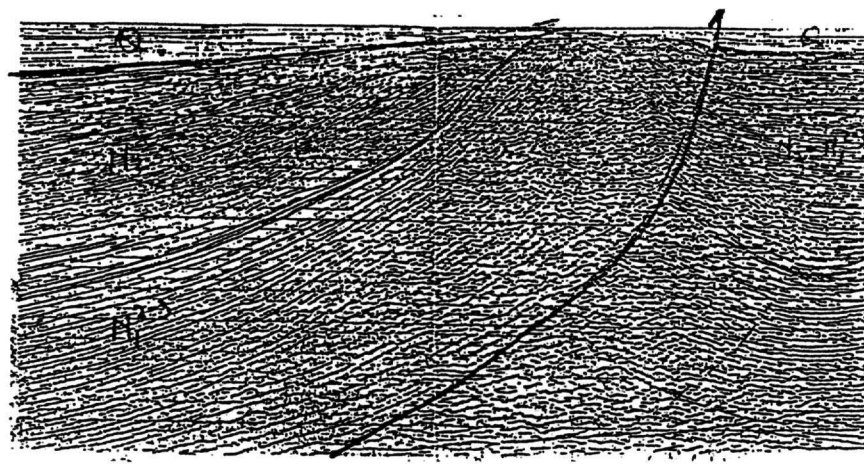

*Fig. 11. Seismic line in Durresi offshore. The unconformity between the Quaternary deposits and the Pliocene molasses and the backthrust fault are shown.*

### *3.3. LONGITUDINAL FAULTS*

The geological structure of the Periadriatic Depression is well known from the exploration seismics carried out on its territory. The last years the exploratory seismic is also performed by foreign companies in Albanian Adriatic and Ionian offshore.

Geologists on usually do not mark the faults on the geological maps of the Periadriatic Depression, because they are not visible, on the surface. Generally, we must say that almost all the faults on the Periadriatic Depression are detected from the seismic data.

Below, through different examples in seismic lines, in Periadriatic Depression, we will show the main types of longitudinal faults: **thrusts** and **backthrusts,** some of which are the **"flower"** structure faults of "**palm tree**" type.

Along the Panaja-Durrλsi anticline line, over 100-km long, **thrust** and **backthrust** faults are evidenced. "**Flower"** structures of **"palm tree"** type also observed. (Aliaj Sh.1988; Skrami J.et al,1994).

So, in Frakulla, Ardenica and Divjaka anticlines the **"flower"** structure of **"palm tree"** type are observed. As they are very well seen on the seismic line, the "**flower**" structure faults cut all the section of Pliocene molasses

up to the earth surface. The thrusts and backthrusts cut all the thickness of Miocene molasses, while the secondary minor faults cut only partially upper part of Mio-Pliocene molasses, as a rule(Fig.8,5,7). This is a direct testimony for the post-Pliocene timing of the formation of the "flower" structure faults (Skrami J.et al.,1994).

In Frakulla and Divjaka anticlines the main fault is the eastdipping one of **thrust type** (Fig.8,7), whereas in Ardenica and Kryevidhi anticlines, the main fault, a weastdipping one, is of **backthrust type** (Fig.4,5,9)

In Durresi anticline and Preza monocline, in seismic lines, they are not observed the "flower" structures of fault but the **backthrust** fault type (Fig.3)

In seismic lines across the Frakulla-Durres anticline line, it is evidenced a remarkable difference in the thickness of molasses deposits passing from one side to the other of the thrusts or the backthrusts (Skrami J & Aliaj Sh., 1995). Miocene molasses deposits in Myzeqe syncline are around 1500 m. thick, while to the west of Ardenica backthrust they are over 4000 m. thick (Fig.6). Almost the same thickness difference of Miocene molasses is observed in Preza backthrust, passing from Tirana syncline in the east to the Preza monocline to the west (Fig. 3).

The thickness of Pliocene molasses is around 1000 m. in Myzeqe syncline, while it is around 2000 m. in Karavasta syncline, to the west of Ardenica backthrust (Fig.3,4,5,7)

These data demonstrate that the above-mentioned backthrusts (Ardenica and Preza) have functioned as synsedimentary normal faults during the accumulation of Mio-Pliocene molasses (Aliaj Sh, 1988).

In "flower" structures, the main faults (thrust or backthrust ones) cut all the thickness of Mio-Pliocene molasses, even the basement of the molasses depression, while the secondary minor faults only partially cut the upper part of the Mio-Pliocene molasses, not reaching the earth surface, generally.

The above-mentioned data favor the interpretation that the inversion of synsedimentary normal faults into thrusts or backthrusts is due to the post-Pliocene compressional phase. Thrusts or backthrusts are formed depending respectively upon the eastdipping or westdipping planes of pre-existing synsedimentaty normal faults (Skrami J & Aliaj Sh.,1995).

Generally we have to say that, all the faults, observed in the seismic lines on Preadriatic Depression, are active in now-days.

## 4. CONCLUSIONS

According to the geological interpretation, the seismic data these structural and neotectonic features are evidenced on Periadriatic Depression:

The Periadriatic Depression is located in the western part of the External area of the Alpine folding, is formed since Serravalian, subsequently to the main folding and thrusting of the Ionian zone and is filled with molasse from Middle Miocene up to the end of Pliocene

1- The Periadriatic Depression is built by some Mio-Pliocene wide synclines and linear relatively narrow anticlines, which are superimposed over thrust and backthrust faults, some of them present the "flower" structures of "palm tree" type.
2- The positive structures of the western coastal part are well expressed on the relief, the anticlines build hills, while the synclines are buried under Holocene plains between them.
3- The Mio-Pliocene anticline folds do not outcrop with all their elements whereas the synclinal structures are buried under Quaternary deposits.
   The tectonic faults are especially unobservable by surface geology.
4- Three main structural unconformities and the compressive phases determined by them are evidenced in seismic lines:

a.- The unconformity between the Mio-Pliocene molasses and underlying folded flyschs and carbonatic deposits of Kruja, Ionian and Sazani zones.
   This structural unconformity testifies the pre-Serravalian (pre-molasse) compressional phase that has caused the folding and thrusting of the External Ionian zone.

b.- The unconformity between the Pliocene molasse and the Miocene molasse.
   This structural unconformity testify the compressional phase at Miocene-Pliocene boundary, the first one causing the slight deformation of Miocene molasses in Periadriatic Depression, as well as the folding of Sazani zone.

c.- The unconformity between the Quaternary deposits and the Pliocene molasse.
   This unconformity testifies the Lower Pleistocene compressional phase, which has caused the final strong deformation of Mio-Pliocene molasses in Periadriatic Depression.

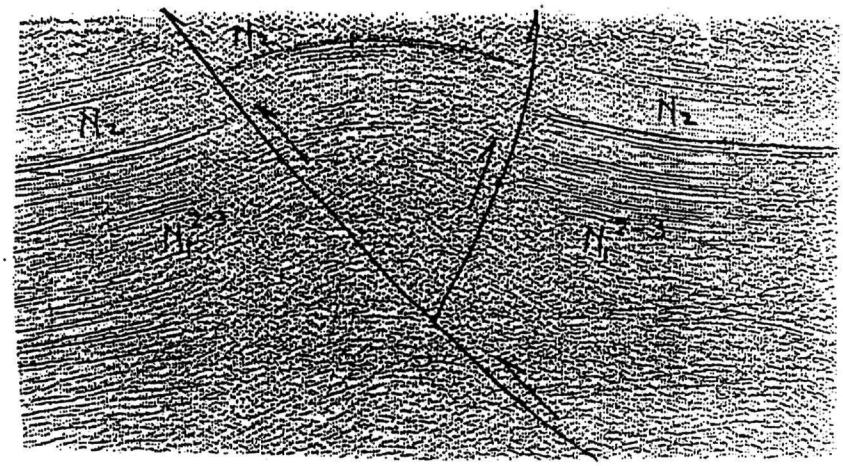

*Fig. 8. Seismic line in Frakulla anticline. The 'flower" structure faults of "palm tree" type is shown.*

The compressional deformations are following up to the present-days.

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