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Contribution of the Reflected Waves Method in Structural Modeling of Albanides

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Abstract
Geophysical methods are widely used in Albania, both in terms of underground assets exploration, as well as geological modeling of depth. Through these methods is achieved to outline and to discover several oil and gas deposits, as well as to clarify and to resolve many problems and phenomena related to tectonic style, the relationship between units and structural-facial areas, with structural performance of rock formations to great depths, etc.
Method of seismic is considered as elite method, in the sense of bringing information to wide space and great depths of underground. It, through the panorama of seismic reflectors that offers, in coordination with data and the other methods in the field of geology, enables the interpretation and modeling of geologic construction to considerable depths. Also, enables the conception of the tectonic style, the outlining of the structural building and especially the forecast of structures with the possibility for detection of hydrocarbon deposits. Through this information, are made the important steps in conception, tectonic style and behavior of major structural-facial units, in terms of relations to each other.
Below some examples will help to show concrete contribution in the discovery of oil deposits, in the forecast of new oil-bearing areas, at bringing of new regional concepts to tectonic style, at explanation of the geological phenomena at depth, etc.
All examples are selected along the geological structure of Albanides as cases with abundant and diversified information, while the conception and interpretation is made under our scientific viewpoint.
Key words: Albanides, Method of reflected waves, Seismic reflector, Tectonic style, Structural-facial unit, Orogenic zone, Adriatic platform.

I. Introduction

Clarification of geological construction of Albanides structure from year to year has undergone significant developments, thanks to seismic, electrometric methods etc., used for depth analysis The contribution has been comprehensive, especially in terms of tectonic style, where are bringing new images, at the character of relationships of tectonic units, especially major ones, in relation to each other. Understandably, it is about essential changes, from almost vertical tectonic style in tectonic style dominated by wide horizontal motion. Approach of this concept is associated with other behaviors, increase the chance of detection of oil-bearing structures under major tectonic overthrustings, changes tectonic style of the depth conception, spatial extent of major units, etc.. Another contribution is the clarification and the outlining of important geological phenomena, such as transgression, settings of some stages, overfaultings, etc., to depth. Some of these new concepts of interpretation of geological structure of Albanides, will examine, through data brought, with the help of the method of reflected waves. Besides the scientific values, where some of the interpretations and models are given to for the first time, there are didactic value, especially for the students of the fields of geology and geophysics.

II. Data and Methods

Over the years, in the territory of geological structure of Albanides, are performed the numerous geological and geophysical works and generalizations, which in many cases are more associated with drilling of deep and shallow wells. This reality has enabled us two things, ample data for the depth and the surface, as by geophysical methods, drilled wells, field surveys as well the verification of tectonic style through drilled wells.

It is an abundant geological, geophysical and analytical information, for thousands of kilometers of seismic profiles, thousands of deep wells drilled in geological structure of Albanides. The problem lies in the selection, using, processing and bringing of this information to the scientific level of the time. The purpose of this paper is to expose the resolving of important geological phenomena, through the information brought by the method of reflected waves, combined with other data and coherence.

Thus, these data, we will bring under a concept and interpretation otherwise, thus indicating that the tectonic style which we describe in this paper, the relationships between major structural units, constitutes a significant scientific achievement. But another important will be the issuance seemingly of opportunities that offers the method of reflected waves, in solving of geological problems of depth, which undoubtedly characterized by a high degree of difficulty. In methodological terms, we have selected some interesting sectors (Fig. 1) that carry in themselves interesting data, and therefore the opportunities of interpretation and research.

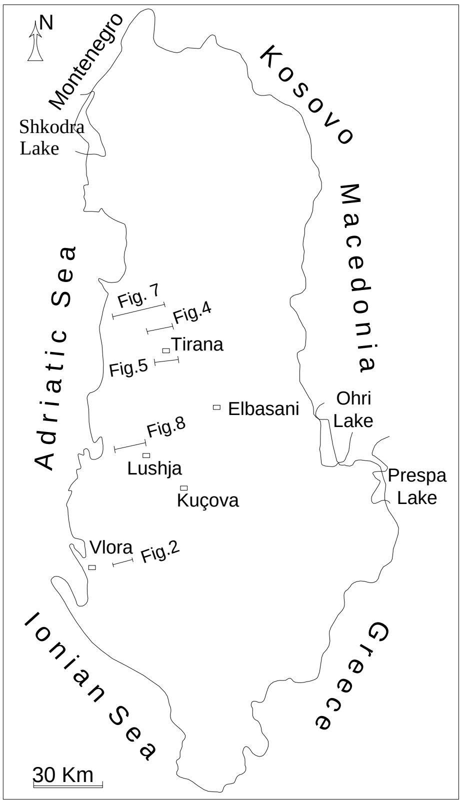

Figure 1. Albania scheme and the setting of seismic profiles used in this article.

III. Applications and interpretations

The seismic method is called the queen of geophysical methods. Through information, that is brought in the form of seismic profiles, reflective horizons or reflective horizons group, is provided the possibility of structural modeling of underground to considerable depths. Thanks to this quality, it is used and continues to be widely used in the world of research and discovery of oil and gas deposits. Is widely used in Albania [8] [5], it is a fund of thousands of kilometers of seismic profiles, to bring endless possibilities of research, interpretation and modeling.

Gorrishti deposit is one of the richest underground assets, has given strong support to the Albanian economy in time when detected. The seismic profile shown behaves in the form of group of reflectors where the upper reflector is shown, which is identified as the ceiling of carbonate formation, Triassic - Eocene age (Fig. 2).

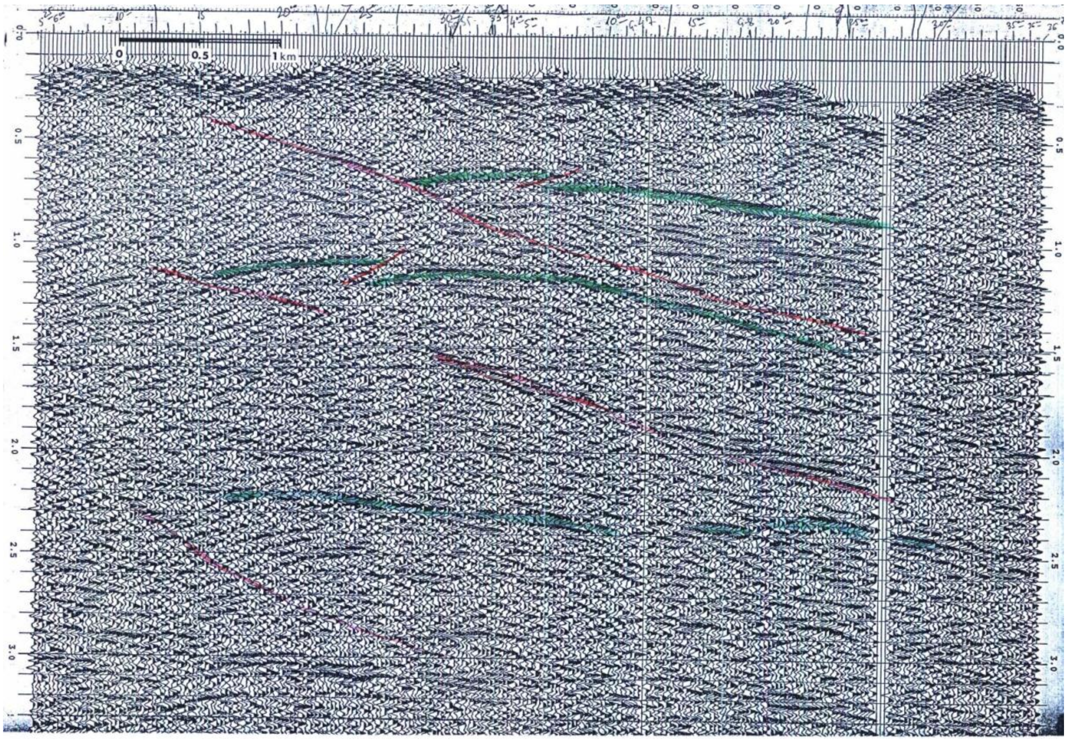

Figure 2. Seismic cross-section no. 110/79, Gorrishti region, the oil-gas bearing deposit of Gorrishti – Koculi.

The ceiling of carbonate formation is also at the same time the oil-bearing deposit ceiling. So, through seismic profiles is outlined oil-bearing structure in extension and in depth, while drillings proved and outlined oil-bearing deposit within it (Figure 3). Other information is the structural model, where we see that the Gorrishti brachyanticline structure is complicated by two tectonic fractures. One restricts the structure in the west, which is also responsible for its structural formation and evolution, while the another one interrupts in the middle, giving overthrusting character the eastern block on the western one (Fig. 2, 3).

Through the drilling of Gorrishti - 6 is proved thickness of the oil-bearing stage (Fig. 3), an important parameter for the calculation of reserves and drafting of project- methodology for the exploitation of oil deposit. With the discovery of oil-bearing deposit of Gorrishti, within carbonate formation of Triassic - Eocene age, was confirmed also oil-generative potential of this sedimentary formation, which until now was considered very unlikely to generate and create hydrocarbons deposits. So the discovery of Gorrishti deposit, decided researchers of oil in Albania, before a new time of research studies, which is present even today.

If that would look a little more visually research the seismic cross-section (Fig. 2), it points out the idea of outlining of a structure, with the oil-gas bearing possibility, under overthrust of known carbonate structure of Gorrishti-Koculi. This possible object is slightly outlined in the west of the known deposit of Gorrishti-Koculi, with his higher set at the time about 2.2 seconds. The idea becomes even more interesting if we consider the fact that the forecasted object located near two powerful hydrocarbon resources, oil and gas resourse of Gorrishti - Koculi and bitumen one of Selenica. So, we are dealing with a territory which is characterized by strong generation and migration of hydrocarbons. In these circumstances, we think that the forecasted object should be given much more importance than the other case, in the same structural conditions.

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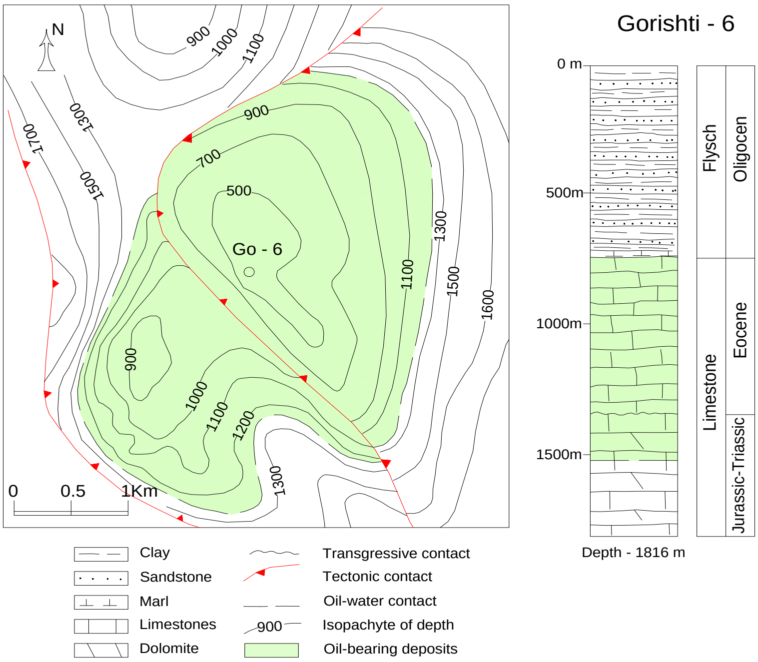

Figure 3. Structural scheme of oil deposit of Gorrishti-Koculi and the cross-section of drilling Gorrishti-6.

Special importance is the seismic method for forecasting and delineating in space the regions or structures with oil-gas bearing opportunities [2], [6]. Figure 4 shows one such example, where is presented a powerful seismic reflector in the form of an anticline structure.

This reflector recording in Field Kruja region we conceive as ceiling of carbonate formation, Triassic-Eocene age, representing an anticline structure, with significant oil-gas bearing opportunities. Its exploration constitutes a difficult test for interpretation of the seismic facies, both in terms of detection of oil-gas bearing deposit, as well as its identification as stratigraphic lithofacie. To build this tectonic-structural-research model are based on qualitative information that provides seismic cross-section shown in figure 4, but even at that, to bring the other seismic cross-sections with the help of the correlation technique.

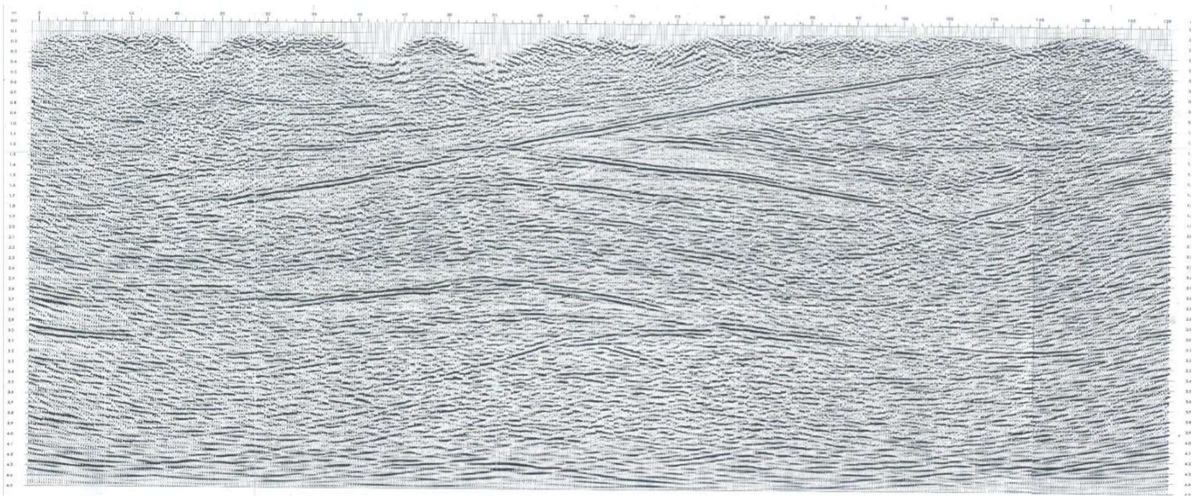

Figure 4. Seismic cross-section No. 37/80, Field Kruja region. Powerful seismic horizon, possible oil-gas bearing anticline.

This technique makes it possible to outline the tectonic units in space, through correlation and transfer of information from one to the other seismic cross-section, therefore the approximation of a model closer to that real, this work expressed as the concrete product of structural depth maps. Meanwhile, following the performance of this seismic horizon in space, we make sure, for what it represents because the information that it contains is added the additional data from other seismic cross-sections.

In Figure 5, are showing the possibilities that offers the seismic method [2], at the solving of the difficult problems and phenomena of depth, such as the structural model, tectonic style [6], the relationships between the major geological units [8], etc.

In this respect is distinguished a three-stage establishment of tectonic units on each other, their complication with thrusting and backthrusting tectonics and the confrontation of orogenic zone with a quiet and deep tectonic unit, extending to its west. Apparently, we are in the area of orogenic collision of Albanides with Adriatic platform or Apuliane, as it is called differently. Adriatic platform characterized by a quiet tectonic and large thickness of rock formations, especially those of pre-molasses and molasses, confirmed these in drilling Peza-1, while the orogenic zone characterized by a pronounced geodynamism [3], structuring and powerful overthrustings of tectonic units on each other [4]. In terms of relationship of tectonic units, we see that Near-Adriatic Lowland is layered with the apparent angular and azimuthal discordance, on structures of lower structural stage. This fact proves, not only for transgressive placement, but also for a powerful orogenic process that has occurred during the geological time range. Thanks to this process, developed through several stages, the region is including in the powerful structural, depressive and orogenic movement [6], which we find recorded at seismic cross-sections that we are discussing.

During the structural and malformer phases the region is dominated by compressive regime, therefore the structures are formed in depth and mountains on the surface, associated with the retreat of sedimentary basin westward and strong erosion of those spaces that were transformed in the continent.

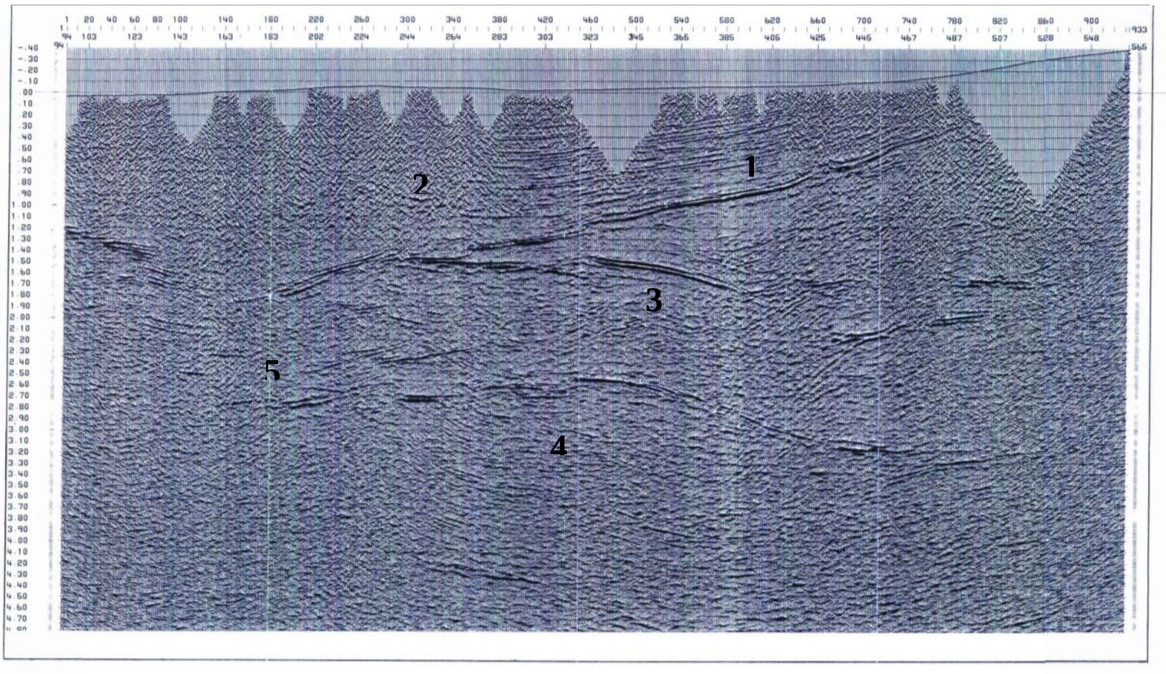

Figure 5. Seismic cross-section no. E01/95, Beshir Bridge region. Cross-section is characterized by good seismic information, which helps to modeling of the structural construction of depth.

1. Upper structural stage, 2. Tectonic backthrust, 3. Secondary structural stage, 4. Lower structural stage, 5. Collision of the orogenic zone of Albanides with Adriatic platform.

While, during the depressive phase the regions is dominated by regime in strain, accompanied by a decline of geological terrains, in the form of graben, mulde and syncline valley. This is the moment that the sedimentary basin of southern Adriatic surges into mainland, while marking the start of training of molasses cycle, and consequently the structural upper stage. Of course, everything is analyzed regarding the information that brings us seismic cross-section, which in Figure 6 we present the model, in the form of tectonic-litho-stratigraphic units.

Seems to us quite interesting the element modeled as flysch folding (Fig. 6), which is characterized in seismic section as chaotic facie (Fig. 5), while according to the surface geological data, coincides with a plicative flysch zone. We are dealing with a large anticline structure, positioned on the forehead of orogenic area, which is captured by powerful tectonic movements, overthrusting and backthrusting. Flysch formation as more sensitive to strain, has moved more rapidly to westward than its carbonate basement, giving us the impression of a false flysch wrinkle. Meanwhile, the latter one, namely the thickness of carbonates, as more old as more solid, and therefore less sensitive to strain, in the form of lower structural stage, is resulted covered structurally from overthrusts of easternmost tectonic units, which belong to the secondary structural stage. Precisely this thickness, or tectonic-facial unit, presents great interest for petroleum exploration [2], [6].

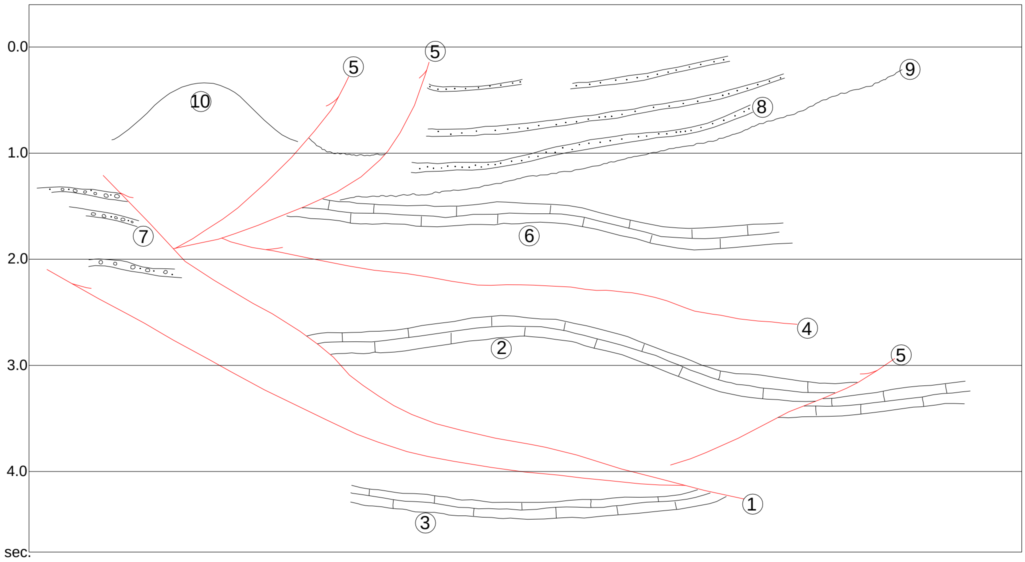

Figure 6. The interpretation and tectonic-structural-formacional modeling of seismic cross-section of Figure 5.
1. Tectonic covering contact, 2. Orogenic zone, upper structural stage, 3. Adriatic platform, 4. Tectonic overthrusting among stages contact, 5. Tectonic backthrusting contact, 6. Eroded anticline structure, secondary structural stage, 7. Conglomeratic package, Burdigalian, Pre-Adriatic Lowland, 8. Molasse formation, upper structural stage, 9. Transgressive contact, 10. Flysch folding, getted from thrusting and backthrusting tectonic movements.

Migrated section, presented in Figure 7, we consider a very significant example for the study of large depths underground through data, brought with the help of the method of reflected waves. It represents a qualitative information to demonstrate the contribution and opportunities that provides this approach in tectonic, structural, litofacial decoding, and oil-gas-bearing opportunities. As shown in the figure, the information that obtained in it can be considered a very high quality.

The data recorded in the form of seismic facies, or horizons group or powerful seismic horizons, provide interpretation and modeling opportunities to considerable depths.

Below will treat briefly some of these modeled elements, expressed mainly in the form of brutal collisions or stratigraphic discordance. The first case (Fig. 7, No. 4) is the example of the brutal collision between seismic facie accompanied with pronounced angular discontinuity. Seismic facie which is located in the right falls to west with slight decrease angle, while that which is on the left with the strong decrease angle, where nearly two group facies collide with each other with angle of 90 degrees. The collision expressed through a thickness without signal or seismic signal somewhat disheveled, but within its are encountered the fragments approximated to seismic facie, both in the left and right of its.

Based on the physical nature of seismic facie, they resemble each other (Fig. 7, No. 3), since the expression and continuation of the same lithofacial formation, but injured tectonically in later time. Facie which is identified seismic collision regards molasses formation, Messinian-Serravallian age, while the area of the crash represents a tectonic backthrusting contact in the form of a tectonic voluminous zone, expression of a powerful anti-movement from west to east direction. Contact tectonic is outlined up in 3.3 seconds, approximately 6 km depth. Such cases in tectonic structure of Albanides are rarely seen, but are important events and expressions of new tectonic movements [1].

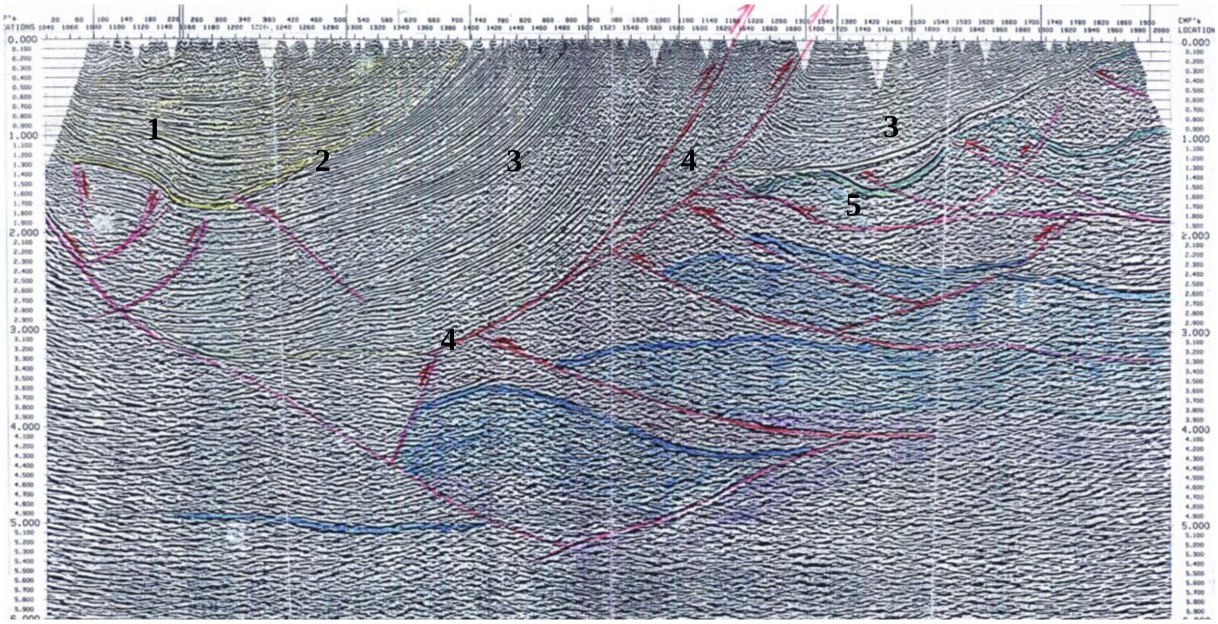

Figure 7. Seismic cross-section no. 95ASB 116, Shijak-Field Kruja region. Cross-section is characterized by good seismic information, which enables tectonic-structural modeling of this region.

1. Molasse formation of Pliocene, Shijaku syncline, 2. Transgressive contact, also among stages contact, 3. Molasse formation of Serravallian-Messinian, monocline of Preza-Ishmi and depression of Tirana, 4. Tectonic backthrust of Preza-Ishmi, 5. Carbonatic formation of Cretaceous – Eocene, anticline structures of tectonic zone of Kruja.

The second case is the example of a stratigraphic discordance (Fig. 7, No. 2), where seismic facie contact each other by a line, which we have identified as transgressive boundaries. Contact area in the physical sense, can be thought of as an area where seismic facie in both its sides are expressions of two different sedimentation regimes. While, in geological time sense, can be thought of as a missing thickness. More specifically, we are dealing with transgressive setting of molasses Pliocene formation, on the molasses formation of Messinian-Serravallian. It is an important geological event, which was called pre-Pliocene tectonic phase (Aliaj Sh., etc.., 1996). This event is regional, known to all Albanides and wider still, as folding tectonic phase, which is evolved over time between Messinian and Pliocene.

It is associated with the structuring and the increase of geological regions, the strain of sedimentary basin and powerful erosion of regions returning mainland. Then, again decrease of the wide geological units, sea flood on them, accompanied with large accumulations of sediment, marking the beginning of a new sedimentary cycle. This important event becomes present to considerable depths with the aid of seismic sections, but also associated with surface geological data. In this case it comes to neogenic syncline of Shijaku, where the thickness of molasses formation, Serravallian-Pliocene age, is greater than 6000 m. (Fig. 7). Interestingly it seems to us that the decreased geological unit, characterized by large thicknesses of sediments, is located in front of orogenic zone, in the space of its collision with the Adriatic platform [7].

Apparently, this has to do with the regime of tectonic strain field, experiencing this collision zone, where besides compressive regime, which is the premotor of this structural evolution, frontal part of the orogenic zone experiences the element of regime in strain, particulary the sector which is located on the block that sinks. In these circumstances we think that the Shijaku syncline along thrusting and backthrusting regime has also experienced a situation of continuous dipping, turning in a depot center of sediments. So explain how great thickness of molasses sediments, as well as the establishment of this tectonic decreassing unit on the forefront of orogenic zone.

The third case (Fig. 7, No. 3, 5) is the example of angular, azimuthal, stratigraphic and structural collision, in the form of two stages. Lower structural stage is represented by limestone structures, eroded of Kruja tectonic zone (Fig. 7, No. 5). While the upper structural stage represented by the overlapping molasses units of Pre-Adriatic Lowland (Fig. 7, No. 3).

More specifically, we are dealing with transgressive setting of molasses formation of Serravallian-Tortonian on wrinkled structures of Albanides orogenic zone, belonging to the Ionian and Kruja tectonic zones [9], [10]. It is an important geological event, known as tectonic phase of Serravallian starting. During this phase occurred powerful tectonic movement, in the form of thrustings, backthrustings, but also of distensive regimes, which we look recorded at the diagraphy of seismic section of the figure 7.

In some cases, seismic profiles are characterized by an uninterrupted continuation of the seismic signal, both in extension and in depth (Fig. 8), in the continuous form, from levels near the surface to considerable depths, which goes well over 5000 m. Seismic facie registered creates the impression of a diagraphy for layer to layer, thus giving you the image of performance lithofacial formations in extension and in depth. In such cases the seismic section creates secure modeling and interpretation opportunities, in structural terms of the tectonic complications, the manner of placing lithofacial formations on each other etc..

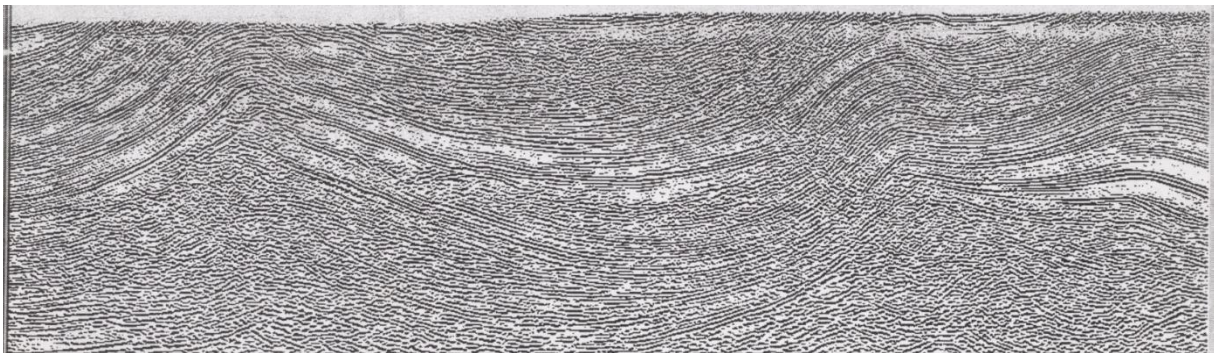

Figure 8 Seismic cross-section in Near-Adriatic Lowland, that express very good structural modeling of depth.

At present seismic section are clearly two anticline structures, divided between them by a broad syncline, which in this case coincides with the Myzeqe syncline. Immediately drops to the eye, that the west of these structures falls with stronger angle than the eastern side, a fact that goes in unison with the direction of Albanides structuring. Another look, that the side in eastern anticline is an even greater decline, even tectonically complicated, showing us a larger wrinkled intensity of this structural unit. As shown in the figure, the structure is captured by two strain tensors, and consequently by the two directions of movement, thrusting and backthrusting, experiencing the geodynamic situation of creating a horst. If you look a little more detail eastern anticline note that we are dealing with a meganticline; so, with two anticlines divided between them by a shallow syncline.

Specifically it comes to molasses anticline wrinkles of Lushnja in west and of southern pericline anticline wrinkles of Kavaja in east. An interesting moment, when you look carefully the performance in extension of seismic reflectors community, is the changing of its thickness, for the same time range, indicating the sedimentative nature of these structural units.

As argued, with more examples of overhead, we think it is enough to understand the importance of methods of reflected waves in modeling, research and structural detection of Albanides.

IV. Conclusions

- Method of reflected waves is widely used in Albania, especially in the exploration of oil and gas. Thanks to its necessity in petroleum exploration, is available today a large number of seismic profiles, representing a considerable data base for research and scientific studies.
- Seismic survey, through the product that bring in the form of seismic facies, reflective horizons, or group reflective horizons, to give the possibility of the structural modeling of the underground to considerable depths as any other method.
- Map of distribution of seismic profiles is associated with those sectors that have an search interest for hydrocarbons. From this point, we understand two things, great exploration power of seismic survey and the high cost associated with these.

- The priority of this approach consists in providing of data for large depths of the underground, helping, along with the surface geological data, tectonic-structural modeling in depth. Another priority is the ensuring of data for dumb regions, such as those covered by the sea, thus by being the only possibility for modeling and research in these areas.
- Seismic survey carried out in Albania has given an extraordinary contribution, as in the discovery of oil and gas deposits as well as in the conception of tectonic and structural model of depth. They still keep many opportunities to explore the modeling.
- Thanks to this information, bring through this method, in the form of seismic facies and its identification with the help of drillings, tectonic-structural model of Albanides has undergone significant changes, especially the last 20 years.

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