O16-14	SOME ASPECTS OF SEISMIC- GEOLOGIC INTERPRETATION IN THRUSTING BELTS, ALBANIA

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Introduction

Geological exploration in Albania is faced with difficulties relating both with hard conditions of the surface and subsurface. The presence of a mountainous terrain on the surface, associated frequently with seismically bad outcrops like limestone, marls, breccies, etc., presence of a complex geological model, characteristic of a thrust belt, make very complex the seismic and geologic interpretation as well.

Nevertheless, the long period of the petroleum exploration activity (1918 – today), with numerous drillings (only for exploration about 2 million linear meters) and a considerable database of seismic lines of over 25000 km, detailed geological surveys and many integrated geological-geophysical studies, have provided a great deal of experience and knowledge in geological image and consequently in petroleum exploration. This experience is based not only on discovering the oil and gas fields, but also especially on the failures that have not been small. Giving some aspects about the seismic - geological interpretation in petroleum exploration in External Albanides is the goal of this paper.

1. Adopted exploration criteria

For oil:

- Searching the positive carbonate structures through pursuing the flysch folds on the surface.
- Searching in the continuation of the known carbonate structural lines under the terrigenous cover.
- The detection of the eroded surfaces and transgressive settings
- Searching the HC traps related with salt and evaporite diapirs
- Searching the positive structures underthrusted the known structural lines on the surface.
- Depiction by seismic surveys of the paleobays in the piggyback basins that are set by an eroded surface direct onto the top of a carbonate structure.

For gas:

- Exploration of the sandstone bodies or beds at the top of a Neogene positive structure using the seismic stratigraphy analysis and well data.

1. Main tectonic features of the Ionian zone

The Ionian tectonic zone is a thrusting front zone, characterised by a complex geological model, where the main tectonic feature is the westward thrusting. Several secondary features related with this, like backthrusting, folding in the synclinal sectors, triangle zones, duplex and triplex carbonate structures, local unconformities, evaporate diapirism, etc., are also present. Study of the above features helps in finding new oil prospects in such tectonic belts.

- **Structural model**

The positive carbonate structures on the surface of the Ionian zone are set in three tectonic belts, made up of structural lines with a SE-NW general trend. Apart from this general trend, several individual units suffer frequently a deviation northeastward at their northern terminations, which are an index for old transversal faults.

In general, folds are very asymmetric with western limbs overturned or cut by tectonics. In some cases the structural model is a monoclinal with its older deposits in western side, where the tectonic fault appears. In these cases a free movement without any resistance of the tectonic unit has happened and the classic fold of anticline form had not achieved to be formed (Mali I Gjere, etc.). In other cases, where the microplate, during the compression process, encountering the resistance of the western units, are folded in anticlines (Kurvelesh unit) or in structural chains of anticlines (Berati units). This second type of carbonate structures in south part of the Ionian zone are in general eroded on the surface, whereas in their northern continuation most of carbonate oil fields have been discovered (Ballshi, Gorisht, Amonica, Cakran, Patos-Verbas)

- **Thrusting feature**

A joint characteristic of all structural belts of the Ionian and Kruja zone is the great scale of their thrusting westward that is estimated to be in the range of 15-20 km., whereas the very Ionian zone is of at least 50 km. This feature is reflected on the surface by regional faults in the western sides of the belts. Their extension in large distances that amounts to about 150-200 km is an index for such an overthrusting. The thrusting process is helped by the presence of the Triassic evaporite sheet under the carbonate section, which have erupted through fault planes and sometimes they outcrop as diapir (Dumrea, Xara, Kardhiq, etc.). So, the most general model of the duplex structures in the Ionian zone is carbonate structure on the surface, fault plane, evaporite, flysch and the underlying carbonate structure. This model, proven in some cases (example of the Delvina condesate field, Hekal – Karbunara´s, etc.), promises for exploration of new oil prospects under the known structural belts.

Another characteristic, that sometime is associated with the thrusting, is cutting of the underthrusted carbonate structure in small blocks or “chips” like the case of the Karbunara oil field or that of Plashnik´s.

- **Backthrusting feature**

Differently from that of Kruja zone, the Ionian zone has two distinctive tectonic features : 1) it is a transfer zone and 2) it has had the chance of the collision with the Otranto high of the Apulia platform. Just because of these two features, backthrust tectonics has considerably developed at the front part of the Ionian zone. This geological evidence has played its role in the structural style of the zone: the structural lines are approached with each other, many carbonate anticlines are separated from their limbs as tectonic blocks, the synclinal parts are also complicated and positive structures, buried in it, might be found.

The more classical example for a backthrust is the Tragjas carbonate structure that is located just at the front of the Ionian zone. It is the westernmost structure of the Ionian zone that has suffered a collision with the Apulia (Sazani) platform high. This collision is observed on the surface by a contact of the carbonates of two different facial-tectonic zones at the place called “Qafa e Llogarase”. As a result of this collision a strike slip fault is observed on the surface that has displaced the Tragjas structure backward (eastward) relatively more than the southern part, Çika structure. The strike separation of this two units, measured on the surface, is of about 3 Km. The surface trace of this fault loses in the Burdigalian deposits that means that the timing of the strike slip is during Burdigalian. Seismic lines show very clearly the backthrust feature of this structure as well.

The bacthrust is noted by seismic data in many structures of the westernmost units of the Ionian zone like: Saranda’s, Bogas’, Kurveleshi’s, Fterra’s, etc.

What is important to be noted from the exploration point of view, is that the backthrust phenomenon is associated with complications of the adjacent syncline sector. Such a feature is observed by seismic sections like in the Shushica syncline where the Amantia positive fold is verified by drilling and other oil prospects (Ramica, Bolena) are under exploration. In the Memaliaj syncline the drilling data (well M-2/s) has proven the seismic model with an anticline and tectonic complications underneath the surface syncline. The Vurgu syncline is also presented by seismic with tectonic complications, etc. The syncline, being in a compression of two opposite sides, has been folded and faulted.

As a result of the thrusting and backthrusting phenomenon the structural lines have been approached and a triangle zone is formed. Due to this model, new structural line might be masked. The structural trend of the Delvina oil field has been interpreted using this model. It is located between two structural lines very close with each other on the surface, that of Mali Gjere and that of Fterra.

- **Salt and evaporite diapirs**

Three types of evaporite diapirs are recognized in the Ionian zone: a) diapir of the cupola model that is formed after it has erupted through fault plane of a carbonate unit, like Dumrea, b) diapir that has remained in the tectonic plane of a sheet form (chiefly at the western one, Dhrovjan-Delvina, etc., but in a case and at the eastern limb fault, Picar-Kardhiqi). c) Diapir at the center of the carbonate structure (anticline) like in the Xara-Butrinti diapir. The three cases are of interest from the exploration point of view. Seismic data promise positive structures under the Dumrea diapir (first case). The Delvina condesate field of model partly structural - partly diapir related is a positive index for further exploration (second case). Exploration in the third model of diapir, eruption in the center of the carbonate structure, would be of interest for controlling the geological formations of the underthrusted tectonic zone, which is that of Sazani. This would be the more attractive project to be achieved by drilling.

1. Problematics drawn from the seismic-geological interpretation experience.

It is obtained a good experience in applying the criterion of finding the positive carbonate structures through pursuing and studying the flysch folds on the surface. So, the Gorishti oil field is discovered chiefly basing on the Middle Oligocene flysch positive fold on the surface. The Cakran oil field is discovered basing also on the Burdigalian deposits fold on the surface.

On the other hand, many failures in exploratory wells, projected in respect to this interpretation, show that it must be taken care in applying the flysch fold criterion. The analysis of these cases leads in the conclusion that the flysch folds on the surface do not reflect always the carbonate ones at depth. There are two cases in interpretation of such an evidence: 1) A large disharmony may exist between these two folds up to that measure that their relationship has lost. In this case the flysch fold has advanced forward more than the cabonate one and underneath the flysch fold there will not exist the carbonate structure. This allowed the interpretation of the folded flysch belts at the western wedge of the structural belts on the surface, like the Sqepur –Vagalat flysch belt at the western side of the Berati belt, etc.. The respective carbonate structures are expected to be more to East than the flysch folds and underthrusting to the surface carbonate structures.

2) The second possibility is that the flysch folds are not related with the carbonate structures in the subsurface. There are many examples from this kind of folds, verified by dry wells, such as: surface flysch folds of Kalcat, Koder, Fitore in the Vurgu syncline, Erindi, Antigone, Libohova, in the Drinos syncline, Ninesh, Bregas, Panahor, Kutalli, in the Memaliaj syncline, Rexhepaj, Plloçe, in the Mertiraj syncline, etc. These folds are in general younger than the carbonate ones and they are formed in a compressional regime that has affected only the terrigenous deposits. Sometimes the compression has caused also “flowing”of the flysch in the contrary direction with the general movement westward (e. g. the Rexhepaj flysch back thrust. A joint characteristic of these “false folds” is that they have a small wavelength compared to the expected carbonate depth. This ratio, drawn from different

examples, results much less than unit. Another joint characteristic of these folds is that they are not reflected in the seismic data, those contain diffractions instead.

The seismic exploration in such complex geological models has its difficulties both in field acquisition and in obtaining through processing a depth imaging as real as possible. Information obtained by particular seismic lines has helped to locate the oil prospect. But in such thrusting belts only parts of the structure are achieved to be recorded by seismic. So, only the eastern flank and partly the top of the structure is recorded. In some cases the seismic line lengths, because of the presence of the Limestone Mountain on the surface, have not been enough to provide information from the dip limb of the structure (e.g. Delvina structure). In other cases the presence of bad surface conditions like breccies or marls have caused the loss of the structure on the seismic section (Velça's). Even known carbonate structures of the oil fields are not reflected by seismic (like Cakran, Ballshi, etc.). In these conditions, advanced processing technologies, especially in using of statics correction and prestack depth migration, are necessary.

Diffraction pitfalls in seismic interpretation have been in the majority of the failure cases of the geological exploration. Picking of non-believable seismic horizons, being influenced by the expected geological idea, has been another wrong experience in seismic data interpretation.