EXTENSIONAL TECTONICS IN THE TERTIARY OF THE BLACK SEA SHELF - ROMANIAN OFFSHORE

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Abstract. In this paper the author analyses several structures in post-Oligocene formations, that could become potential hydrocarbons traps. The prospected area is situated in the Eastern Romanian Continental Platform and it was covered by 2D seismics. This very extended area presents falls that make evident the presence of a series of faults and associated structures, being in an apparent disorder. Still, these structures have their inner order and we will make an attempt to its deciphering. On the seismic lines a succession of the faults and their associated structures was observed, showing a characteristic setting related to the distance from a paleoshelf to basin. This remark led to the conclusion of a typical cycle of the sliding. Thus, four stages could be distinguished: domino, roll over, " overthrust " and graben - horst. After that the cycle was repeated. It was named the "listric cycle" and it shows a multitude of hydrocarbons traps.

Key words: seismics, listric fault, trap, Romanian offshore.

The hydrocarbon presence on the Black Sea Shelf has been proved until now only in pre-Oligocene formations and traps. This fact led to the focusing of investigations only on this section.

Therefore we like to present here a series of structures in post-Oligocene formations, which can become potential hydrocarbon traps.

The study area is situated in the Eastern part of the Romanian shelf, within the so called Hystria Depression (Fig.1).

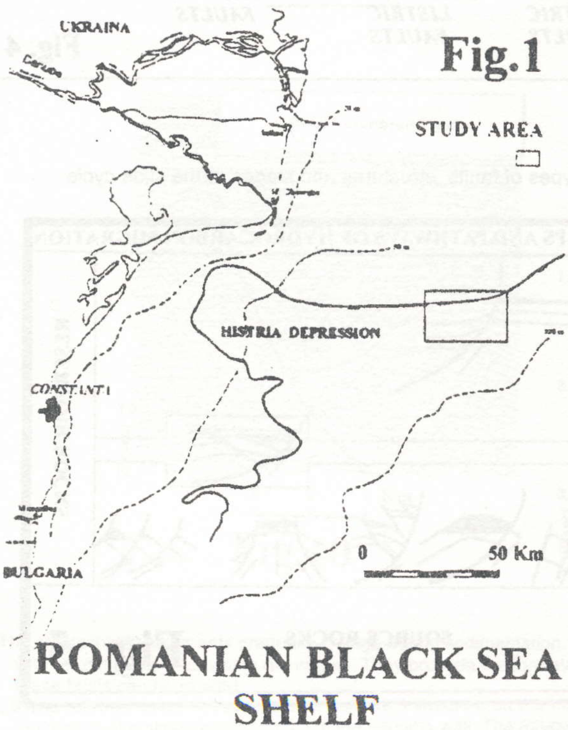


Fig. 1 Location map

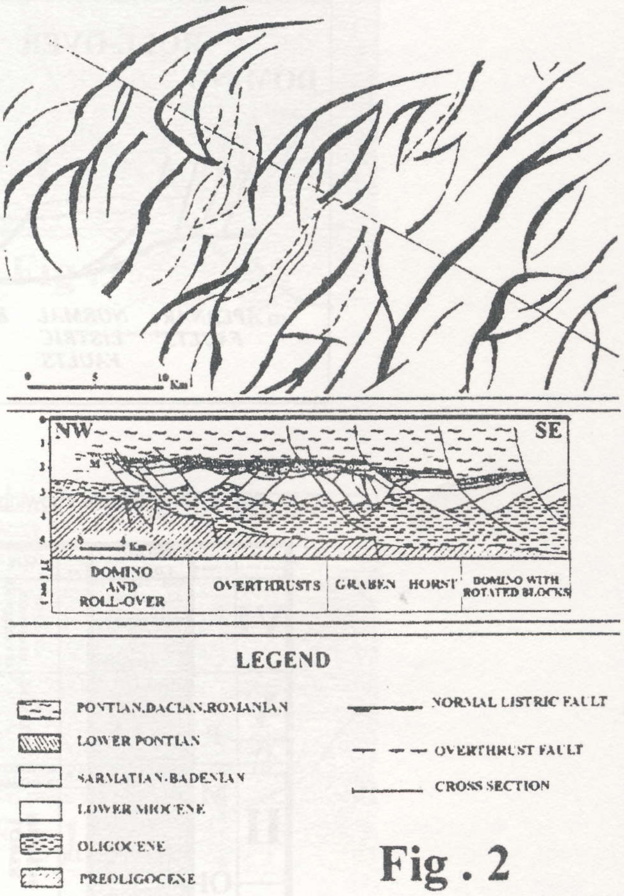


Fig . 2

It represents an important negative paleorelief formed in pre-Oligocene formations.

The formations of interest are situated in the Oligo-Mio-Pliocene section. This interval consists of six seismic sequences, very well expressed and distinguished between them (Fig. 2).

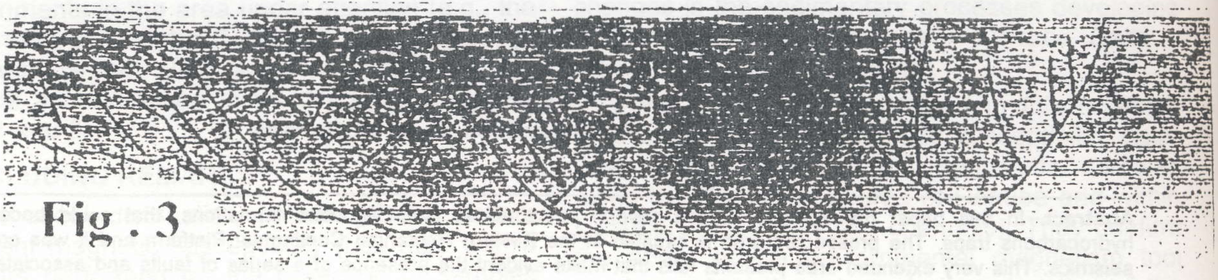


Fig. 3 Regional seismic line showing the structural and depositional patterns

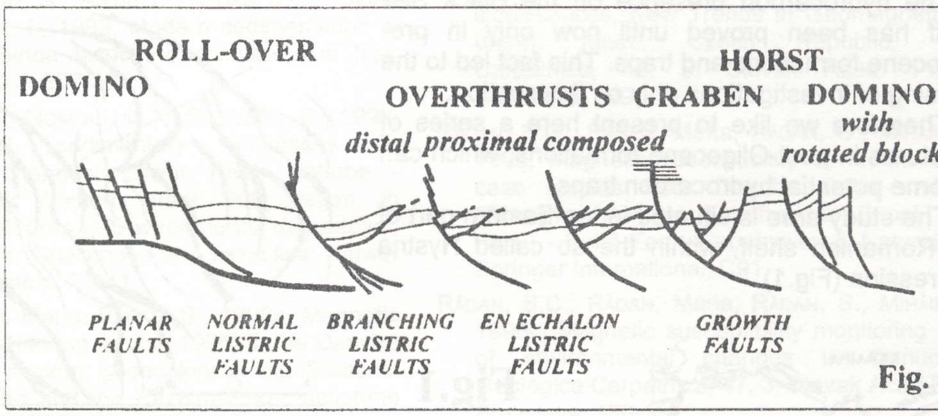


Fig. 4 Sketch table showing the types of faults, structures and stages of the slide cycle

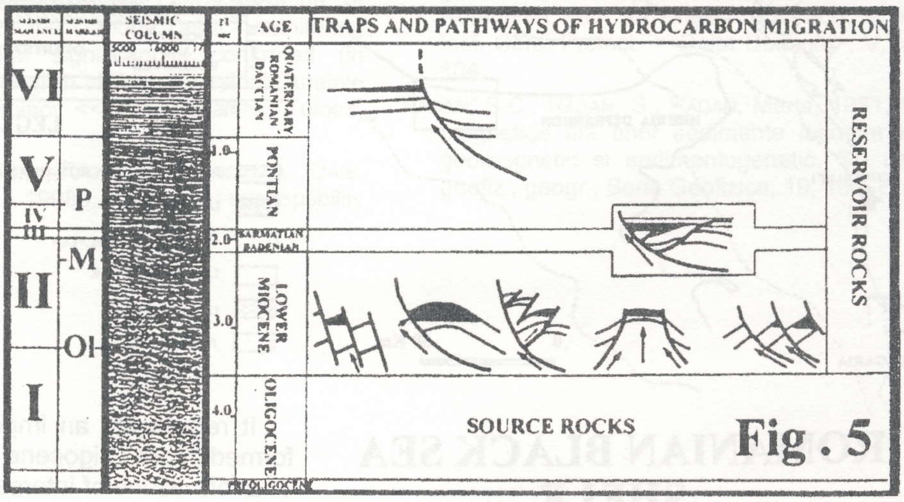


Fig. 5 Sketch table showing the succession of the seismic sequence and type of the traps in each sequence

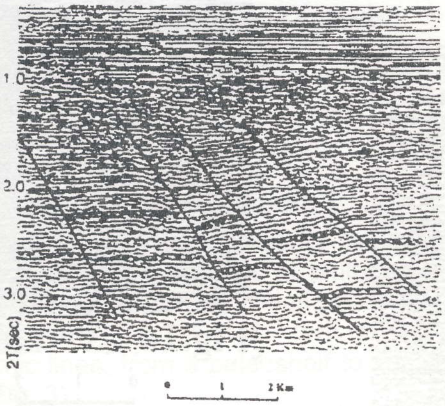
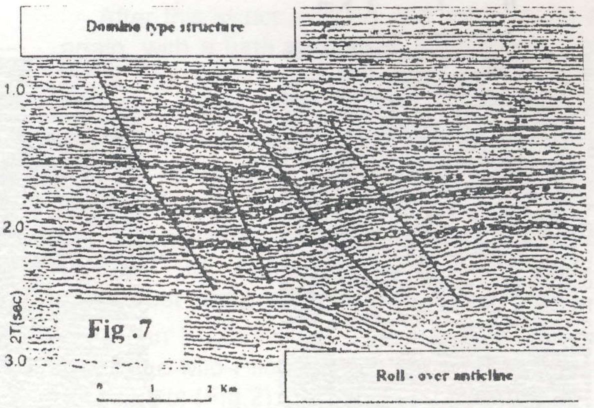
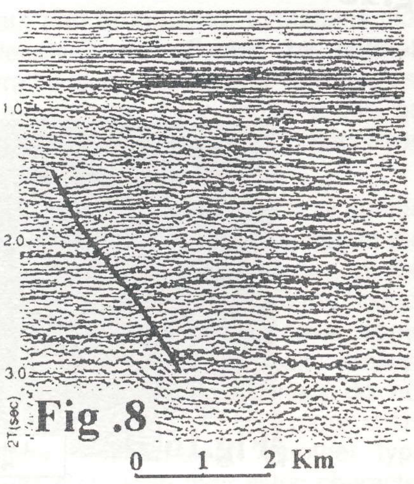
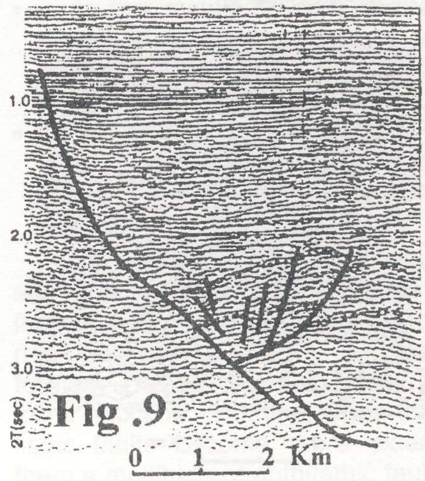


Fig . 6







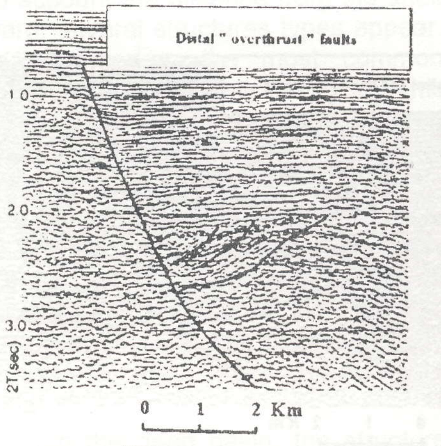


Fig.10

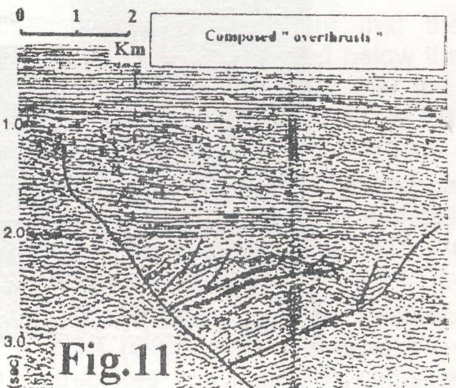


Fig. 6 The stress inside sediments gradually change during sedimentation. In association with this stress changes, parallel fault planes develop with successively decreasing dip angles. They precede the formation of a basal slip-plane, so called "listric fault". The hanging walls of these faults can be rotated.

Figs. 7, 8 The roll-over anticline represents a deformed structure on the hanging wall of the listric fault. The shape of the roll-over structures is induced by the slide-velocity profile of the hanging wall. The roll-over anticline, faulted or not, occurred from the shelf edge to seaward.

Figs. 9 -11 The "overthrust" or imbricate regime was generated when the overpressure relaxation of fluids from sediments, increases faster than sediment accumulation, new antithetic faults occurred and a new equilibrum was established. When the rate of accumulation exceed the rate at which the overpressure of fluid sediments is reduced, these imbricated regions move closer to the main listric fault and successive imbricate regions may develop up slope. All of these "thrust" would branch of from the same basal slip-plane.

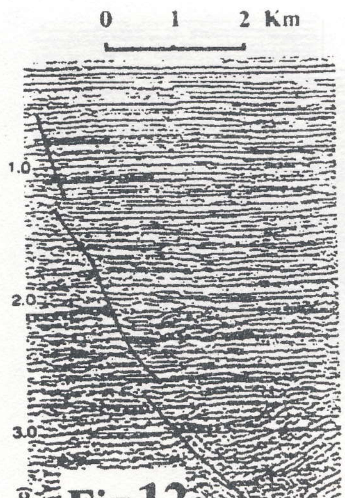


Fig.12

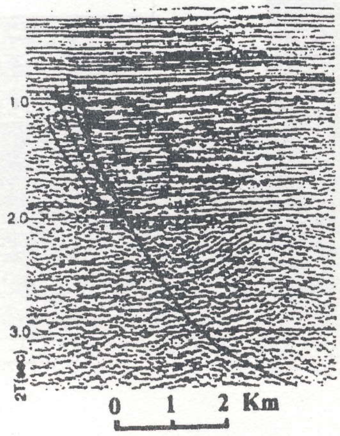


Fig.13

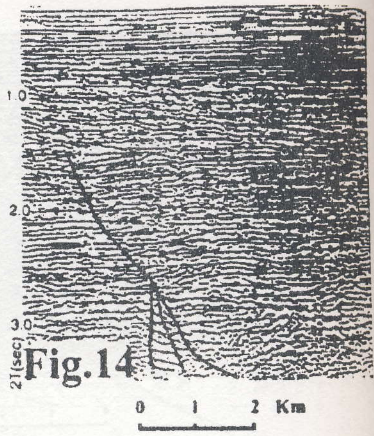


Fig.14

Branching (horsetailing) of listric fault

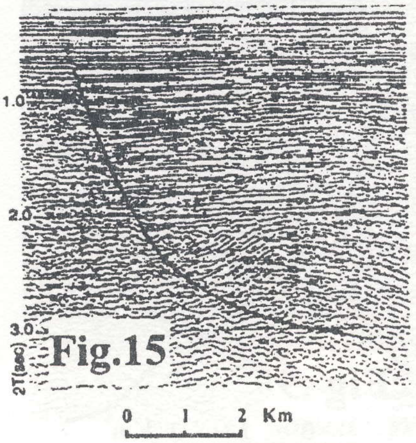


Fig.15

Growth fault

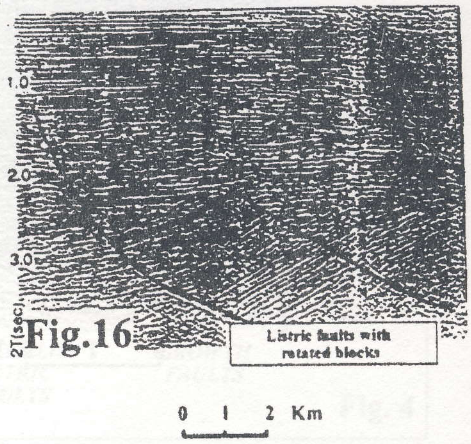
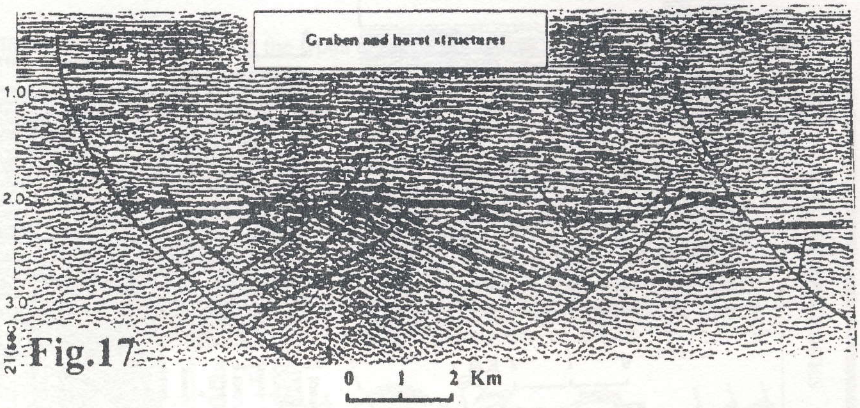


Fig.16

Listric faults with rotated blocks



Graben and horst structures

Fig.17

Fig. 12 This type of faults are discontinue developed upward. They are postsedimentary and show that overpressure of fluids from sediments decrease, discontinue also.

Figs. 13,14 The subsequently activated growth faults branch of from the basal slip-plane at the same point. The result is typical fault configuration like horsetailing. This convergence of subsequent faults, may be associated with the facial changes, which favoured the drainage from the top of the overpressured sediments, or drainage from below, which might be a result from fluid flow along the basal slip-plane.

Fig. 15 Sedimentary growth fault occurred as a result of differential compaction of unconsolidated sedimentary packages (i.e. sands over clays)

Fig. 16 The stress inside sediments gradually change during sedimentation. In association with these stress changes, parallel fault planes develop with successively decreasing dip angles. They precede the formation of a basal slip-plane, so called "listric fault". The hanging walls of these faults can be rotated.

Fig. 17 The grabens and horsts structures represent the last deformation stage of the sliding unit. They are the result of the occurrence of antitethic faults. Usually, they are the farthest structures of the main listric fault and preceding the occurrence of a new sliding cycle.

The sequences are dated as follow:

1. Oligocene
2. Lower Miocene
3. Sarmatian - Badenian
4. Lower Pontian
5. Upper Pontian
6. Dacian - Quaternary

The study area represents an intensive falls zone highlighting a series of faults and structures in an apparent disorder. It was observed that, there is the same way of there carried out on the all seismic lines, from a paleoshelf to seaward, (W to E) (Fig. 3).

This led us to conclude that there is a cycle with several development stages of the sliding faults and their associated structures (Fig.4).

In the Western part of the area, formations that covered a paleoshelf are affected by normal, straight and parallel faults deepening basinwards. The formation affected by these faults shows an evident rhythmicity in its displacements, becoming similar to the domino parts.

From the shelf edge basinwards broadly curved faults occur and these tend to be connected in the lower part to a quasihorizontal surface, in the upper part becoming vertical. These are the "listric" faults. Besides, these faults can have some complications. For instance, some faults present up or down "horsetail" branches, others do not have only one sliding plane, but show more short, successive planes, "en echalon". Another type contains the faults that loose their listric character and become growth faults in the upper part.

Taking into account the distance from the shelf edge to seaward, several structures types appear. Thus, at the shelf edge, the most common structure is of a roll - over anticline type. This anticline can be affected by antitethic faults and these are also able to form secondary graben or halfgraben type structures (Fig.5).

Seawards of the shelf edge, a special structure type appears on the slope. Here the antitethic faults play an important role, because these enable the appearance of the "overthrust" type special structures. Taking in account their approaching to the listric fault line, these structures can be either proximal or distal.

Further on, into the deep basin, the structure type changes again. Here a new stage appears, belonging to the graben and horst type. These structures occur because of the antitethic faults have a contrary dip.

After this structure type, the listric faults appear again, with a high degree of parallelism. On these faults, the blocks fall seawards similar to the first stage, but the difference lies in the fact that the blocks are rotated. We consider this to be a new sliding cycle that can be partially or totally repeated.

In conclusion, we consider that a sliding cycle consists of four stages: domino, roll over, overthrust and graben - horst stage.

It can be observed from the seismic lines that the Oligo-Mio-Pliocene section can be divided into three units (Fig.2):

- at the bottom, a unit corresponding to the seismic sequence - 1, affected only by several major listric faults;
- in the middle, a unit corresponding to the seismic sequences 2 - 3 - 4, affected by listric faults as well as by multiple anthitethic faults; this is the most tectonized unit;
- at the upper part, a unit also affected only by main listric faults, which penetrate from the lower to upper part, thus becoming growth faults.

This vertical organization shows that the structure was formed at least in two stages. The first one took place within Oligocene when the main listric faults were released and partially formed. The second stage took place during the lower Miocene - Pontian, when the already formed listric faults become more extended, adding to them a multitude of anthitethic faults, thus resulting specific structures (Fig. 6 - 17).

Finally, from upper Pontian to Quaternary, the listric faults do not act anymore in their specific way and become growth faults.

Taking into account that the source rocks (Oligocene) are situated below the Mio - Pliocene formations, we consider that the Post-Oligocene structures, formed owing to the listric cycle, can be favourable traps for hydrocarbons.

The hydrocarbons migrating paths are both the main listric faults and their anthitetics (Fig.5), being accumulated especially in the middle unit described above.

As a conclusion, the existence of the source rocks (Oligocene), the reservoir rocks, the traps structures and migration paths, we consider that the Tertiary formations of the Black Sea are new targets for oil exploration.

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