THE ROLE OF 3D SEISMIC INTERPRETATION FOR BUILDING STRUCTURAL MODEL – CASE STUDY IN THE MUNTENIA OIL FIELD (ROMANIA)

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ABSTRACT

The geological image which we can build on an oil reservoir plays an important role during its production life, from the appraisal phase (seismic works, exploration wells, appraisal wells) to the last stage of reservoir production. The geological image of the reservoir includes four sections: (1) structural schematization in which are defined the shape and external geometry of the reservoir, as well as the accidents (faults, erosions) affecting the reservoir; (2) architectural schematization that is referring to the internal geometry of the reservoir, the knowledge of the development of the various sedimentary facieses, the evolution of the reservoir petrophysical parameters in the saturated hydrocarbon zone and in the adjacent aquifer; (3) tectonic schematization that is referring to the building of a fracturing diagram considering the existing tensions regime inside the reservoir; (4) fluid media referring to the nature of the fluids stored into the reservoir and their distribution. Finally, understanding the hydrocarbon accumulation mechanism is one of the key issues that should be solved for effective hydrocarbon production.

Structural schematization is one of the important phases of the building geological image of the reservoir in which are defined the external geometry of the reservoir as well as the faults that affect the reservoir.

In the paper, the authors emphasize the importance of fault characterization and the structure model for an oilfield located in the Eastern Carpathians Foredeep known as Diapir Folds Zone. The Diapir Folds Zone is the most prolific petroleum province in Romania.

The oilfield studied is composed of two main zones: East and West. The east zone is a faulted monocline with oil reservoirs in the Meotian formations of deeper southern flank and shallower northern flank. The exploration of the east structure started in 1835 with the shallow Meotian of the northern flank, and in 1951 with the Meotian of the down-dropped of the southern flank.

The west zone was recently discovered (2011-2012) based on the new 3D seismic interpretation. The main geological formations are Oligocene represented by Kliwa sandstones (complexes I-V). Till now was completed only 2D model, but recently was delivered a 3D model using Schlumberger Petrel software.

Using modeling-while-interpreting capabilities of Petrel seismic interpretations we can easily move from seismic interpretation to structural model building. Integrated work analysis including all 3D geological data developed a new static model.

Keywords: *Diapir Folds Zone, 3D seismic, faults, Petrel static model, 3D modeling, uncertainties*

INTRODUCTION

Reservoir modeling includes the characterization of the internal gridded properties distribution and the simulation of fluid production (oil and water). Nonetheless, the distribution of the petrophysical model is often in relation to production data. This, conditioning static modeling to production data is a challenging but essential task to provide reservoir predictions.

The study focuses on the application of 3D static model using 3-D seismic and well log data for proper optimization and development of hydrocarbon potential in the oil field X from Romania.

Faults have always been a controversial and difficult topic in petroleum geology, because they control the evolution of basins, but also the essential factors and processes of the petroleum system.

The geological conditions of field reservoirs in Muntenia region (fig. 1) special with influence of Diapir Folds Zone are complicated and not easy to be defined. [1]

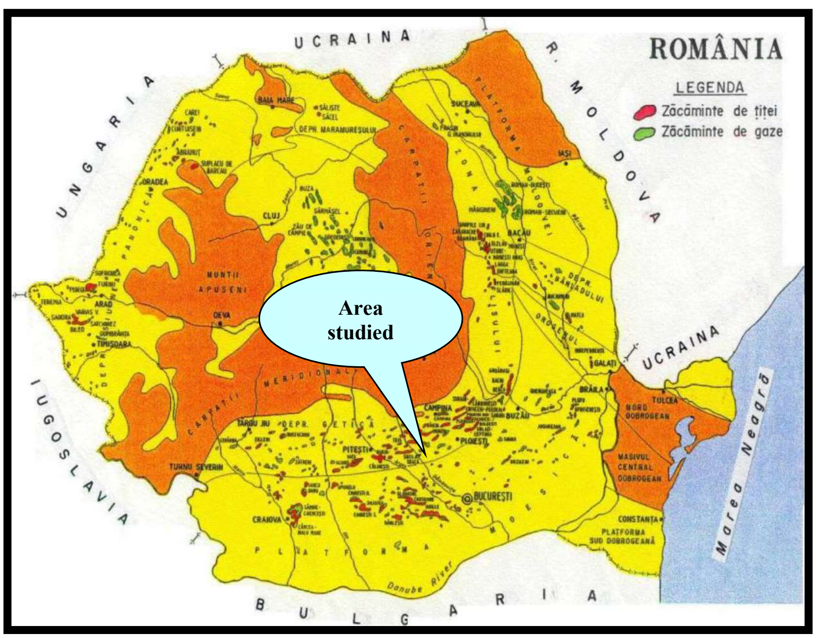

Fig. 1 Map showing location area

GEOLOGIC SETTINGS

The first time when was discover oil and gas accumulation on this area was in 1967 based on one exploration well. After this discovery were decided to do 2D seismic interpretation. Based on several seismic line the new structure looks to have a fault system-oriented W-E, but later the 3D seismic will give another face for the fault system.

Wells drilled (145 wells) on the studied structure intercepted a stratigraphic column of sedimentary formations of the last two cycles, also deposits belonging to Paleocene and Neogene. [2]

In this paper will be presented the changes done in a structural model for the Oligocene Upper Kliwa. The entire column of Oligocene is around 500 m and is typically met in this area of Romania.

In the current model can be seen stratiform reservoirs, delimited on the vertical by impermeable layers with continuity on the surface. Hence, on the basis of the correlations of good logs and of the vertical distribution of the rock properties, the Upper Kliwa (Oligocene), was divided into five complexes, named from up to down ″KI″, ″KII″, ″KIII″, ″KIV″and ″KV″ (Fig 2).

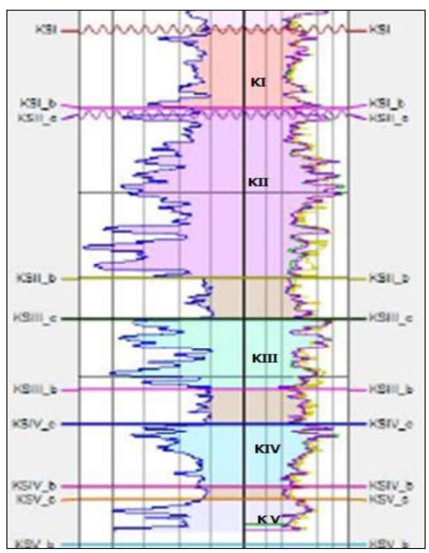

Fig.2 Electric profile showing KI, KII, KIII, KIV, KV

Using the core description, FMI analysis and all existing logs for all 145 wells drilled on this field, the main characteristics of the productive layers have been summarize in table 1.

Table 1. Main characteristics of Upper Kliwa complexes

Layer	Thickness of layer (m)	Lithology description
Upper Kliwa I	30-40	Intercalated sands
Upper Kliwa II	100-120	Sandstones
Upper Kliwa III	30-40	Siliceous sandstones
Upper Kliwa IV	40-50	Shaly sandstones
Upper Kliwa V	30-40	Sandstones

TECTONIC SETTINGS

In the actual study was a challenge for a geologist to merge together from the tectonic point of view the major zones of the field east area and west area (Fig 3). Based on network wells correlations and using the new 3D seismic information was demonstrated that between west and east area is a strong geological relation .the local tectonic system is comparable with the regional fault system. [3]

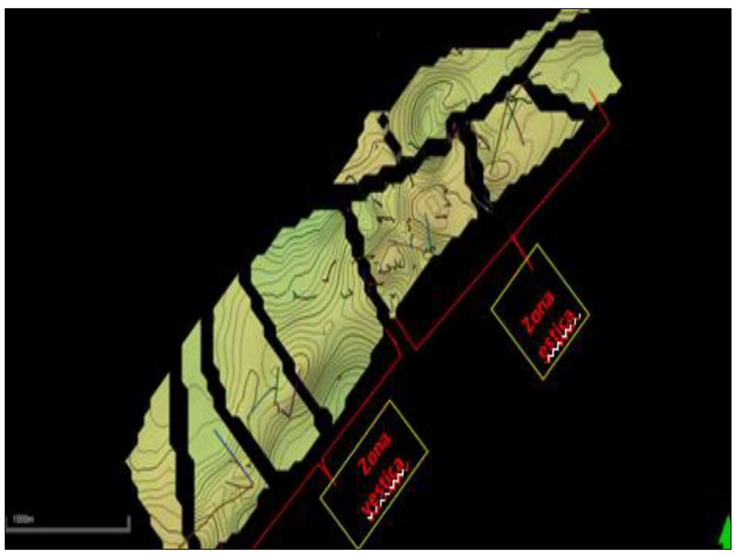

Fig. 3 Major zones for X structure – old interpretation

As a result of the 3D seismic interpretation (Fig. 4) the local geology was changed from previous studies. A new structural image has been created by the geologist in order to capture seismic information, well log correlations, production data.

During analysis have met many uncertainties and were included in the usual workflow. [5]

All the data, interpretation and uncertainties have been run with Petrel Software. [6]

In the old geological model, the fault’s trend was W- E and in the actual interpretation the faults have NE-SW trend.

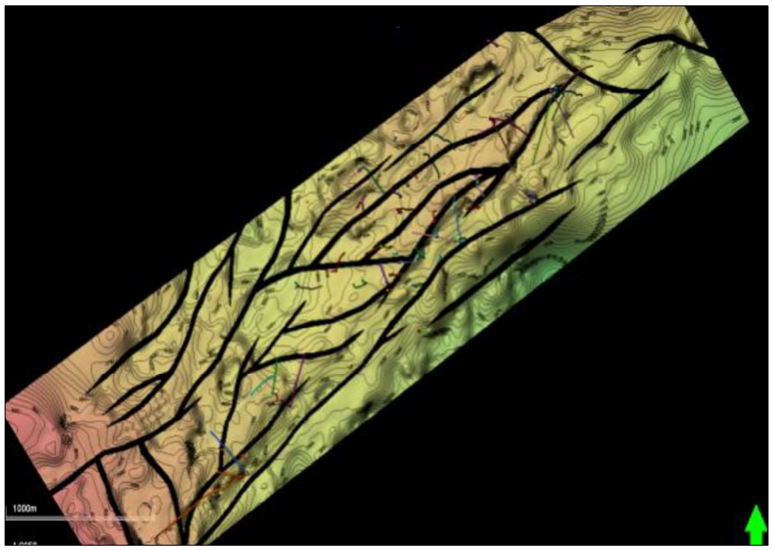

Fig. 4 The new structure surface from 3D seismic – new interpretation

The structure X has a system of longitudinal faults along the NE- SW direction and a system of transversal faults oriented almost perpendicular on the first system .These two fault systems are compartmenting the structure in few tectonic blocks (Fig. 5).

The current structural image of X field has been modified from old images (Fig.3) as a consequence of drilling the new wells. The interpretation of the 3D seismic and the conceptual model built tries to put together in a good agreement all the available data.[4] The recent wells drilled on the western part confirmed the geological model.

The new west area was an area with strong impact in the next future analysis giving the possibility for future drillings.

The west zone was recently discovered based on new drillings and confirmed by the new 3D seismic interpretation.

The entire analysis have been done with Petrel software which help the geologist in including different uncertainties. [5,6]

Using computer modeling to simulate hydrocarbon reservoir behavior is an arduous task. And the static model, especially the fault system, are playing a major role in modeling. It is very important for the geologist to understand his role in manipulating all existing data and to provide the most significant geological model.[7]

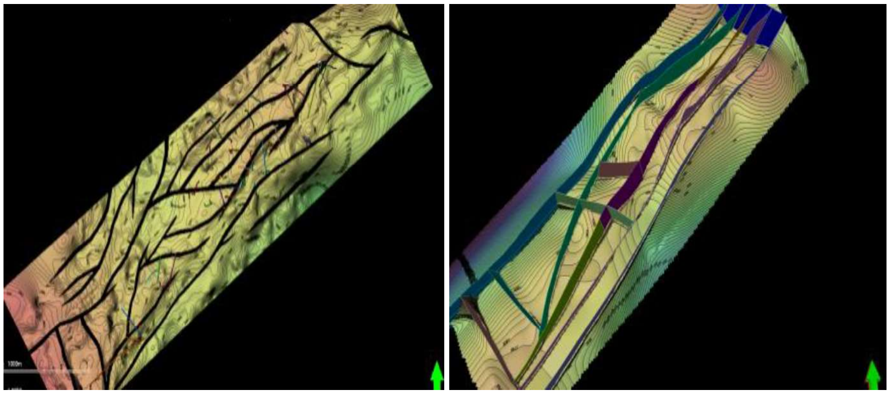

Fig. 5 The new structural image including 3D seismic interpretation

CONCLUSIONS

1. On the X structure, hydrocarbon reservoirs have been found at the level of Oligocene – Upper Kliwa (KI, KII, KIII, KIV, KV).
2. Reservoirs rocks consists of alternating siliceous sandstone and anoxic shale in the Oligocene.
3. The evolution of production, the information obtained by drilling the new wells and the interpretation of the 3D seismic lead to the change of the structural image and the reconsidering of the values of the physical properties.
4. In the actual interpretation the structural model has been changed because of new faults interpretation from 3D.
5. For designing the future production of the reservoir on the X structure, the following were taken into consideration: aspects related to the present displacement drives, current wells, the level of production of the wells by infill/redrill wells including sidetracks.
6. For a better understanding for the geological model is very important to have an integrated and multidisciplinary analysis.
7. The need for reservoir simulation stems from the requirement for petroleum engineers to obtain accurate performance predictions for a hydrocarbon reservoir under different operating conditions. Factors contributing to this risk include the complexity of the reservoir.

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