

*Research article***Joint analysis of seismic and well log data applied for prediction of oil presence in Maykop deposits in Naftalan area****Maleyka Agha Ali Aghayeva***

Azerbaijan State Oil and Industry University, Baku, Azerbaijan

* **Correspondence:** Email: maleyka.agayeva@asoiu.edu.az; Tel: +9940124935011.

Abstract: The paper is devoted to joint application of 3D seismic survey and well logging techniques to study oil and gas presence in Maykop deposits in Naftalan oil field. The field is located in Naftalan-Northern Naftalan area of Ganja oil and gas province, Azerbaijan. The paper brings data about Naftalan field, the ancient brachianticline type of field in Azerbaijan. The paper also considers the history of study of the field by use of geological and geophysical techniques. Despite the studies cover the area since 1873, the oil and gas presence in Maykop has not been studied sufficiently due to sparse network of wells and insufficient amount of core samples. To avoid this gap the results of previous studies have been revised. Joint interpretation of well logging data acquired from 22 wells and data of 3D seismic survey covering the area has been done. On the basis of oil-saturation cube, we have designed the map (the area between the top and the foot of I horizon of Maykop) and 3D model of target interval. It has been defined that uneven distribution of oil saturation and poor oil recovery depends also on sedimentation environment, characterized by rapid subsidence of the basin and increasing amount of clay in the process of sedimentation. Our studies revealed that the average value of oil saturation varies as 0.5–0.6 and increases towards the North-East of the study area. In the final stage of the study we have presented the oil saturation cube and the map drawn on the basis of this cube.

Keywords: 3D seismic survey; Maykop deposits; Naftalan; Yevlakh-Aghjabadi depression; oil saturation; core

Famous Italian traveler Marco Polo wrote about the curative effect of oil named “naphtha” used to cure skin diseases in the past.

Oil and gas presence is observed mainly in reservoirs of Maykop in the study area and neighbouring oil fields (Terter, Naftalan, Gazanbulaq, Aghdere). Natural oil and gas shows are met in Duzdagh and Naftalan areas. Oil and gas shows have been identified while drilling of structural and exploration wells. In Godekboz area the oil was extracted from Eocene. In Dalimammedli, Borsunlu and Duzdagh areas the oil was produced from fractured limestone reservoirs of Upper Cretaceous. Several oil horizons (I horizon of 43–56 m thickness; marl of 38–46 m thickness; II horizon of 70 m thickness) have been identified in Maykop deposits in the Naftalan area. Heavy oil with curative effect has been produced from the upper three horizons. Relatively light oil was produced from the lower horizons (III horizon of 10–25 m thickness; IV horizon of 20 m thickness; V horizon of 50–70 m thickness; VI horizon of 55–70 m thickness; VII horizon of 79 m thickness). Oil presence was discovered in horizons III, IV, V, VI and VII and in clay interlayers between thin sand layers. The clay interlayer between horizons II and III has been adopted as a lower border of curative oil layer [8,9].

Perspectives of oil and gas presence in the area are related to Maykop, Eocene and Upper Cretaceous.

2. Methods of study

140 wells (appraisal and exploration) have been drilled in the area starting from 1873. Of these, 94 wells are deep and 46 wells are shallow. Oil is produced from horizons I-VII of Maykop series.

Despite the long-term studies covering the study area, the hydrocarbon presence in Maykop is not sufficiently studied until now [10]. This is due to absence of core samples from deep wells. To fill this gap, the oil and gas presence in the target interval has been studied by joint analysis of 3D seismic data, well log data and core samples acquired from adjacent areas [11–13]. Petrophysical studies were based on joint analysis of 3D seismic data acquired from Maykop (horizons approximately reflecting the top and foot of horizon I of Maykop) and electric log data acquired from deep wells in Naftalan field (Figure 2).

Results of the studies covered the interval between seismic horizons traced within Maykop (approximately between top and foot of Maykop) on the basis of 3D seismic data, Apparent Resistivity values from 22 wells, mathematical transformations of SP (spontaneous potential) curves and the regression relations between core samples acquired from adjacent areas (Delimammedli and Duzdagh). Tie of seismic horizons to well data, as well as designing of 3D model and the map have been done by use of “Petrel” software package [14–16].

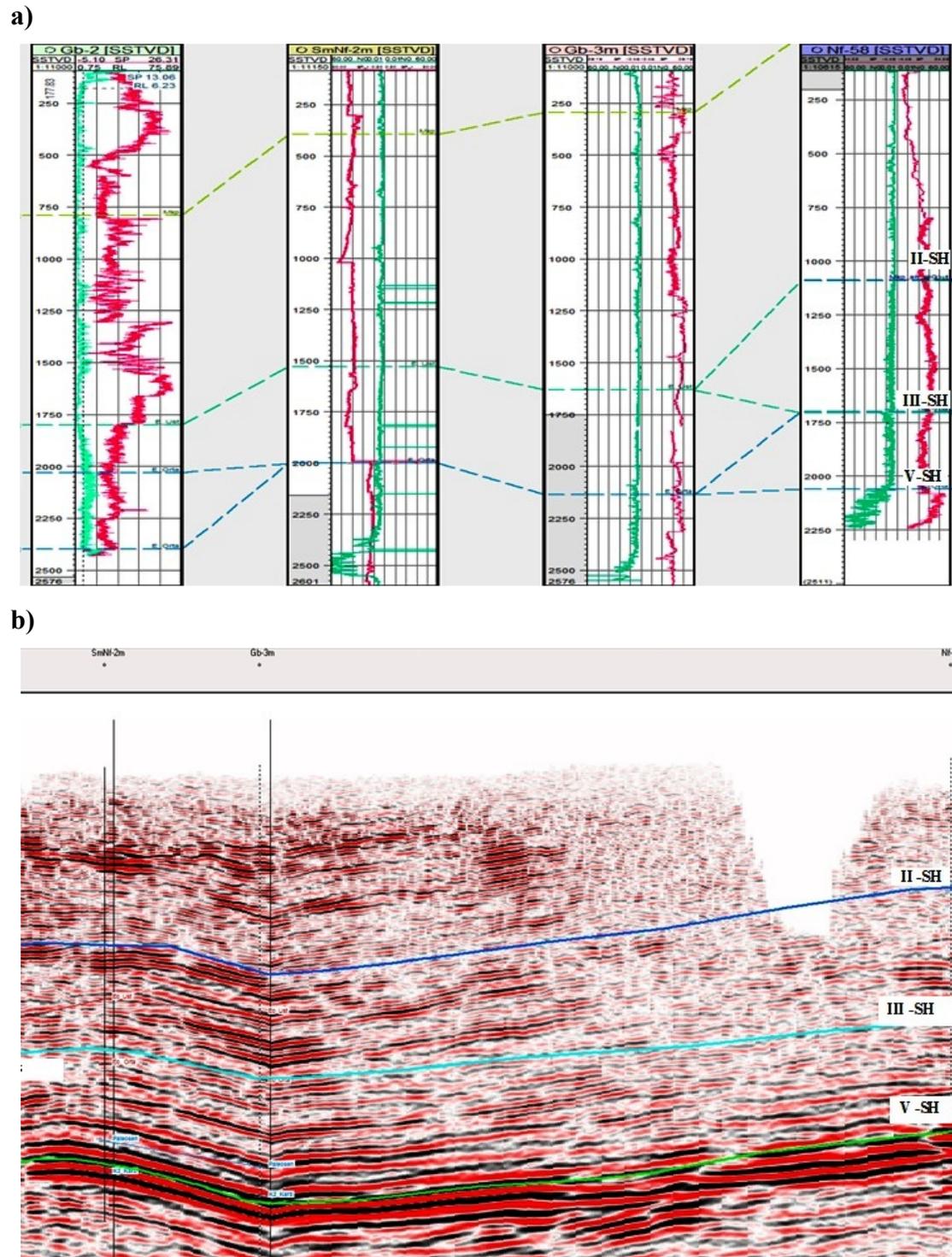


Figure 2. Correlation of wells in Godekboz, Northern Naftalan and Naftalan areas: a) correlation of electric log curves (SP: spontaneous potential and Apparaent Resistivity); b) dynamic depth section along a random line across the wells (SH: seismic horizon).

Sparse network of wells and insufficiency of core data do not impact the study quality negatively. In this respect the results of our studies are rather prognostic.

The study stages are as the following: SP curves were transformed into porosity curves; Oil saturation of the target interval has been calculated by Apparent Resistivity curves.

The last stage of the study has been finalized by design of oil-saturation map and 3D model.

3. Results and discussion

Analysis of resistivity values in wells reflects low values of resistivity (3–4 Ohm). This is probably related to poor clay and sandy-clay layers presence. This is displayed in irregular oil-saturation and low oil recovery across the study area. Distribution of oil accumulations is influenced by variation of porosity and permeability. The accuracy of results of our study has been diminished as no permeability data were available for the study area.

Commercial oil accumulations in Naftalan area are related to Maykop deposits as aleurites and sand layers possess reservoir properties. One of the major reasons of low porosity and permeability consists in high percentage of clay fraction (<0.01 mm). Maykop consists mainly of frequent alternation of clay, sandy clay, sandstone and partially marl. Upper part of Maykop is featured by alternation of clay, marl, thin sandstone and aleurolites. The upper subseries of Maykop is made of clay and sandstone, and the lower amount of sand rocks.

The map and 3D model designed on the basis of calculated oil-saturation cube are shown in Figure 3 and Figure 4. The oil saturation value varies within the ranges of 0.5–0.6. It is known that layers of Maykop are separated from each other by thick clay, sand and marl layers. The study displays that the reasons of poor oil recovery are related also to reservoir properties and permeability of layers. Increase of oil saturation in the horizon is observed in the North-East direction.

Analysis of average values of oil saturation has displayed dependence of oil and gas presence on sedimentation environment. It should be noted that in the sedimentation process of Maykop the oil saturation is deteriorated due to increased clay presence during the rapid subsidence of the basin. The large part of the structure is divided by a number of faults into the separate blocks, which impede hydrocarbon migration and accumulation.

4. Conclusions

According to the map designed based on calculated oil-saturation cube and the 3D model the following has been derived: Average value of oil-saturation varies between the ranges of 0.5–0.6; Deterioration of oil saturation is caused by sedimentation environment, variation of porosity and permeability; Increase of oil saturation is observed towards the North-East of the study area.

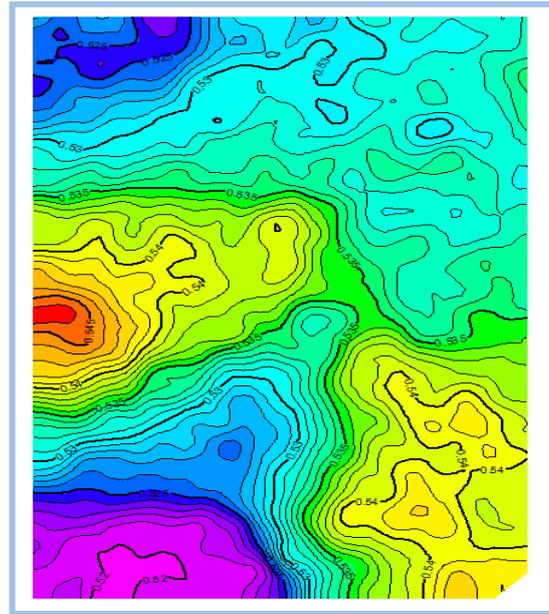


Figure 3. The map of average values of oil-saturation between the top and the foot of horizon I of Maykop in Naftalan area.

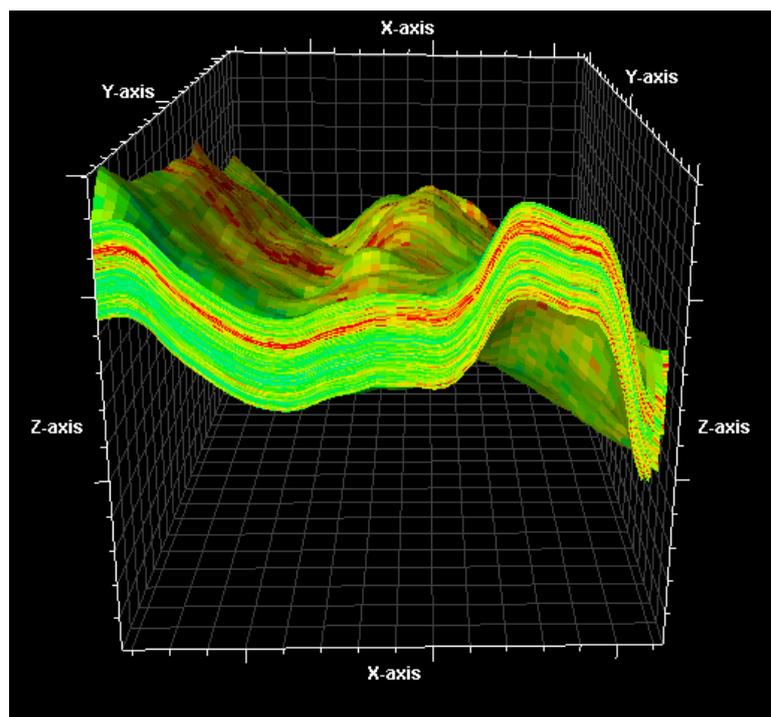


Figure 4. 3D model characterising oil saturation between the top and the foot of horizon I of Maykop in Naftalan field.

Conflict of interest

The authors declare no conflict of interest.

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