Delineation of faults by 2D and 3D common depth point methods in hydrocarbon fields of Kazakhstan

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One of the major objectives of non-quantitative interpretation of seismic data is the delineation of tectonic deformations (faults). The importance of information on the presence and location of faults for the development of the fields is difficult to overestimate - they can appear as structural barriers and have a dominant impact both on the flows of recoverable oil and injected water. They also have effect on the distribution of pressure in the deposit (Ampilov, 2004). According to the data of two-dimensional seismic profiling, the faults can be reliably delineated in some points, but tracking them is extremely difficult and controversial. Delineation of faults using 3D seismic data is an important and feasible objective. However, not all faults are mappable, and the degree of reliability is always variable (Voskresenskiy, 2001).

The solution to these problems was considered by the example of the Dunga field, located in Kazakhstan, near the Caspian Sea, and confined to the western pericline of Beke-Bashkuduk swell related to Mangyshlak-Ustyurt dislocation pattern. According to the results of exploration on the Dunga structure there were found two oil fields in the Aptian sediments (A, B), one gas (Ю-I А) and one oil and gas (Ю-I Б) deposit in the Callovian deposits of the Upper Jurassic (Fig. 1.) (Golonka, 2007).

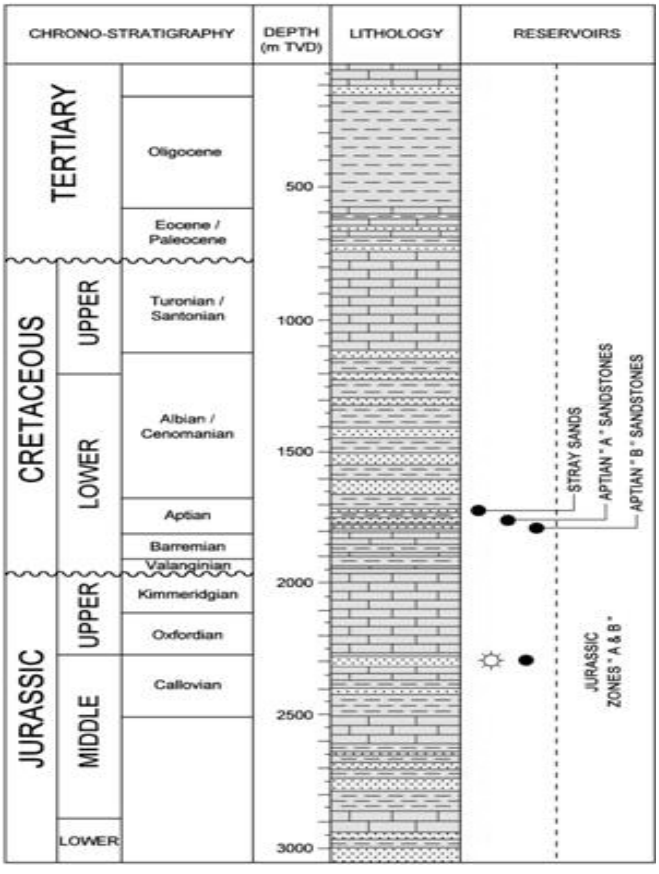

Fig. 1.: Stratigraphic section of the field Dunga.

In 1991-1992, the CDP exploratory seismic operations carried out in the area of Western Beke-Bashkuduk. For the Dunga field the top of Aptian productive reservoir structure map was developed. A set of low-amplitude transverse faults is delineated on the map, whose presence was justified previously by well test data at the stage of exploration. The occurrence of these faults according to seismic data was mostly confirmed, although small amplitudes define some convention of them. In 1997, the re-interpretation of 2D seismic lines located within the Zholaskan-Dunga-Espelisay area was carried out. As a result, the top Aptian reservoirs A and B structural maps were presented, which are in good coincidence with each other, but have more complex structure compared with the data of CDP conducted in 1991-92. The fundamental difference is in the greater number of faults. The amplitude of these faults does not exceed 10 m, and for most of them is in the order of 5 m. In 2006, another re-interpretation of previous 2D seismic data obtained directly within the Dunga field area was carried out. As a result, the general structural pattern of the field was confirmed, the Dunga uplift, which has a block structure, was revealed, the location of previously known faults (F1, F2, F3) was updated, the presence of faults (F4) in the central part of the uplift was confirmed. The occurrence of fault (F4) is supported by the test data of wells 23, 16 and logging data of well 32. Seismic faults have north-east and north-west bearing and displacement amplitude of 10 m to 15 m.

Geological model of the field required further elaboration and for this purpose, 3D seismic investigations carried out at the end of 2006, beginning of 2007. A high-quality full-offset three-dimensional seismic record was developed almost over the area of mine allotment of the Dunga field based on the results of processing of three-dimensional seismic data, which confirms the location and the overall shape of the Dunga structure and significantly details the reservoir of Aptian horizon. Interpretation of faults was conducted using variable-based and coherent data. Faults with significant dislocations were found in areas of low folding of recording on the three-dimensional seismic survey. Most likely these faults would not have been discovered without the high spatial resolution of the three-dimensional seismic survey. Previous studies have suggested that tectonic deformation in the north-south direction eastwards of the main structural closure, will appear as a sealing fault in the east of the field. It is important to note that no evidences of the occurrence of such a fault were found, either on the variable-based data, or on the seismic data.

Thus, the developed faults model can explain the distribution of hydrocarbons in the Aptian interval on the Dunga field. In particular, it is assumed that there is a tectonically screened trap in the east from the border of the mine allotment.

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