International Journal of Geology, Earth & Environmental Sciences ISSN: 2277-2081
An Open Access, Online International Journal Available at http://www.cibtech.org/jgee.htm
2018 Vol. 8 (3) September-December, pp. 81-86/Radjabov and Yanbukhtin
Research Article

EVOLUTION, GEOLOGICAL STRUCTURE AND BASIN MODELING OF SEDIMENT COVER OF SURKHANDARYA DEPRESSION

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ABSTRACT
An extremely intensive dislocation of Mesozoic and Cenozoic sediments characterizes Surkhandarya depression, being one of the richest oil and gas provinces in Uzbekistan, against the background of neighboring oil and gas regions. The study of evolution and geological structure, as well as basin modeling, allows us to trace the history of the geological development of the Surkhandarya depression and assess its potential for hydrocarbons.

Keywords: *Evolution, Geological structure, History of development, Basin modeling, Hydrocarbons, Megasyncline*

INTRODUCTION
On the formation of modern views on the geological and tectonic structure, a significant contribution was made by research of Abidov (2001), Tal-Virsky (1982), Akramkhodjaev (1986), Khain (1998) etc.
From geological point of view, the central part of the Surkhandarya depression covered by quaternary age sediments. In arched parts and on wings of anticlinal uplifts, sedimentary rocks of Paleogene age are outcropped on the surface, and sediments of Cretaceous and Jurassic age penetrated by exploration wells. Rocks of Mesozoic-Cenozoic sedimentation are represented by sedimentary cover: the platform type of sediments is the Triassic-Paleogene sequence and the orogenic - Neogene-Quaternary sediments.
The specific features of geological development inherent in a particular region determine the tectonic regime, patterns of sedimentation, magmatism and metamorphism and ultimately, the distribution of mineral deposits within this territory. Thus, the study of deep horizons is considered as a means of deepening information about the structural features of the upper part of the crust, when searching for hydrocarbon accumulations in it is difficult (as is observed within the Surkhandarya depression) due to the complexity of mapping the structures containing hydrocarbons by seismic methods. This is due to the deterioration of traceability of target reflections, up to their complete absence, and the reason for it may be postsedimentary changes in the physical properties of rocks and superimposed tectonic processes which lead to a sharp complication of deep seismic and geological conditions.

Study area
The Surkhandarya megasyncline is one of the constituent parts of a complexly constructed heterogeneous Afghan-Tajik intermountain depression (ATD). In the section of the Meso-Cenozoic sedimentary complex of the Surkhandarya depression, three oil and gas bearing complexes are distinguished: Paleogene, Cretaceous and Jurassic.

MATERIALS AND METHODS
Research Method
The information used for study of the Mesozoic-Cenozoic stratum within Surkhandarya depression were data from CMP 2D seismic surveys on the profiles most clearly reflecting the structure of the complex under study, the results of wire line log data and the analysis of core material. The research methodology is based on the integrated interpretation of geological and geophysical information. The available geological and structural maps, deep and stratigraphic sections, thickness maps, as well as materials on the stages of the geological development of the Afghan-Tajik basin were analyzed. To study the evolution

of the depression, the method of paleotectonic reconstructions was used, based on the reflection of the thickness of sediments along the profile at a certain stage of sedimentation. Such profiles are built by laying down from the horizontal line of the stratigraphic units. To study the degree of maturity of the parent rocks and the time of the onset of the transformation of kerogen into hydrocarbons (HC), basin modeling was performed in the PetroMod 1D (Schlumberger) software. The modeling was carried out using geological data, wire lone log data, as well as data on the boundary conditions and paleolevel of the sea. Modern basin modeling software allows to simultaneously explore a range of processes, from sedimentation and immersion to the maturation of kerogen and multiphase flow of fluids.

RESULTS AND DISCUSSION

Results of Application of Estimation Method

The formation of the sedimentary cover within Surkhandarya depression began with the post-rift phase and ended in the period of alpine folding. From the early Jurassic till the early Neogene, the Amudarya Basin (AB) and the Afghan-Tajik Depression developed as a single basin. The following describes the stages of formation of the sedimentary cover AB and ATD. The Meso-Cenozoic history of the development of the Afghan-Tajik Depression is divided into two distinctly different stages: the epigercin - platform and epiplatform - orogenic (Latifov, 2016).

Epigercin - platform (Jurassic-Eocene)

The marine transgression reached its maximum in Callovian time, completely covering the entire AB and ATD. In the shelf conditions, terrigenous sediments were deposited. At the end of the sedimentation of the Callovian stage, leveling and smooth embedding of the relief observed. From this time, carbonate sediments began to deposit. The Middle Jurassic sediments are the main source rocks generating oil and gas for the AB and ATD sediments. During the Late Jurassic, the climate becomes hotter with significant paleogeographic changes. In Oxford time, intensive compression occurs in the southern part of the basins under consideration due to subduction of the Tethys bark. As a result, the sea strip in AB and ATD separated from the ocean, forming deep sea, semi-closed depressions with accumulation of black calcareous carbonate formations containing reef limestone at the edges, with subsequent deposition of evaporates in the Tithonians age. All AB and ATD turned into land at the end of the sedimentation of the Tithonian stage.

During the Neocomian stage, within AB and ATD, sedimentation mainly occurs with the formation of continental facies (red-colored strata), which are at times subjected to shallow marine sedimentation conditions. The marine transgression from the south and southwest of the ATD characterizes the beginning of the formation of the Apt-Albian stratum, with the corresponding formation of gray clays with sandstone and limestone interlayers.

The change of sea level in the Late Cretaceous within the limits of AB and ATD contributed to the formation of shallow-sea sediments, and in some areas sedimentation began, associated with the lagoon processes of sedimentation. In general, at this time ATD was located within the coastal part of the sea. As a result, clay sediments have accumulated with interlayers of limestone and gypsum. In the Turonian stage, the sea transgression reached its maximum and the AB and ATD seas connected with the seas of the Syrdarya and Fergana basins.

At the beginning of the Paleocene epoch, the marine transgression occurred due to the reduction of the Tethys water surface and its subduction under the southwestern slope of Eurasia. As a result, lagoons were formed in the Afghan-Tajik, Syrdarya, Fergana and Tarim depressions in which gypsum-anhydrite strata were deposited.

At the end of the Paleocene period, the transgression is successfully spread from the southwest to the central part of the ATD. As a result, limestone with a thickness of about 100–300 m was accumulated and formed Bukhara layers. By the middle of the Eocene, the transgression reached its maximum limit. In ATD, there was an environment of the deep-sea shelf, where dark gray clays of thickness from 50 to 195 meters with layers of shaly coal from 30cm till 3m thick, were deposited. The open sea strip joined the southwestern seas of Eurasia.

At the end of the Late Eocene, marine conditions continued to exist, but at times the coverage area decreased due to changes in sea level. Clay with layers of limestone and sandstone was precipitated.

Epiplatform - orogenic (oligocene-anthropogen)

During the Oligocene period, the Tethys Ocean in Iran was completely closed, while the Arabic and Indian subcontinents collided with the Eurasian continent. The marine environment completely regressed from AB and ATD. In the eastern part of the ATD, i.e. in a limited part of the regressive depression, red clay and aleurite were accumulated from marine fauna. The gradual shallowing of the lagoon depression led to the formation of continental lagoon deposits.

The clash of the Arab and Hindustan microcontinents in the Neogene-Quaternary period led to the development of the Alpine-Himalayan mountain system. The mountains of Pamir, Tien Shan, Ural and Altai were formed. The intrusion of granites and volcanic phenomena occurred in the mountains of the Pamirs. The formation of the Gissar Range led to the separation of AB and ATD.

The ATD was deformed by the northwestern movement of the Pamir Block, which formed a series of complex anticlines and synclines of the northeast strike, supported by faults. The synclines were filled with orogenic molasses clastic rocks with a thickness of 1000–6000 meters.

The modern tectonic model of the Surkhandarya megasyncline is represented by the following main structural tectonic elements (Figure 1).

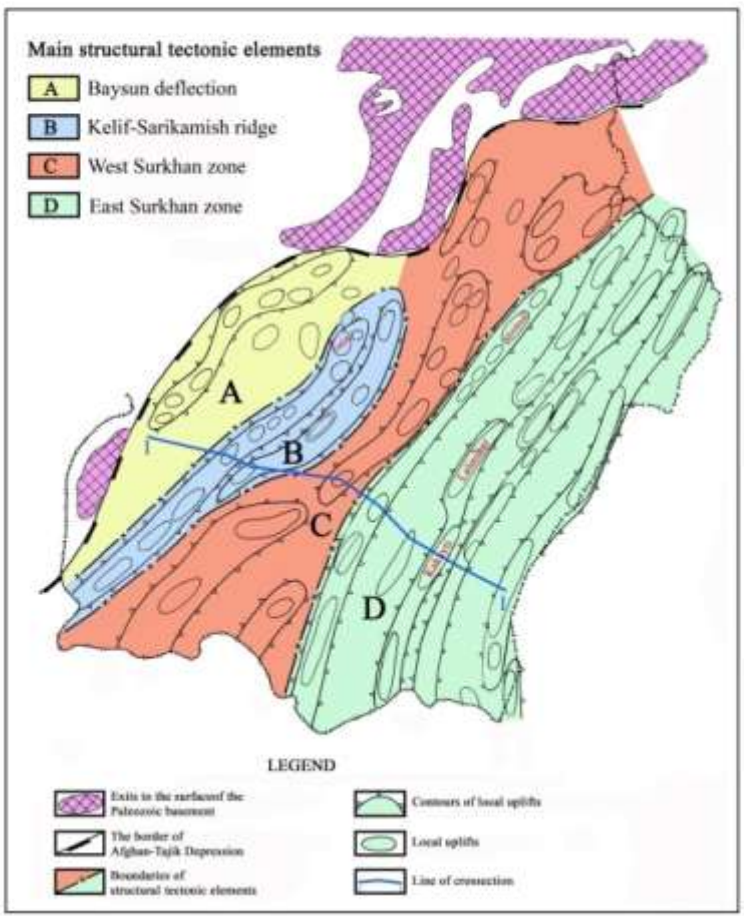

Figure 1: The modern tectonic model of the Surkhandarya megasyncline (Abidov *et al.*, 2001).

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As a result of the analysis of geological and geophysical information, deep geological sections were constructed characterizing the composition and structure of the Meso-Cenozoic complex of the Surkhandarya Depression.

The Zarabag-Dasmanaga profile crosses the central part of the Surkhandarya Depression. This profile is oriented from west to east and crosses the Beshkyz, Djalair, Djarkurgan and Kakaitisites (Figure 2). The profile shows that the structure of the Surkhandarya region is a megasyncline, complicated by local anticlines within each site. In its turn, most of these local anticlines are complicated by faults. As a result, in some areas it is possible to trace two and threefold repetition of layers (Kakayti, Beshkyz, Lyaylyakan).

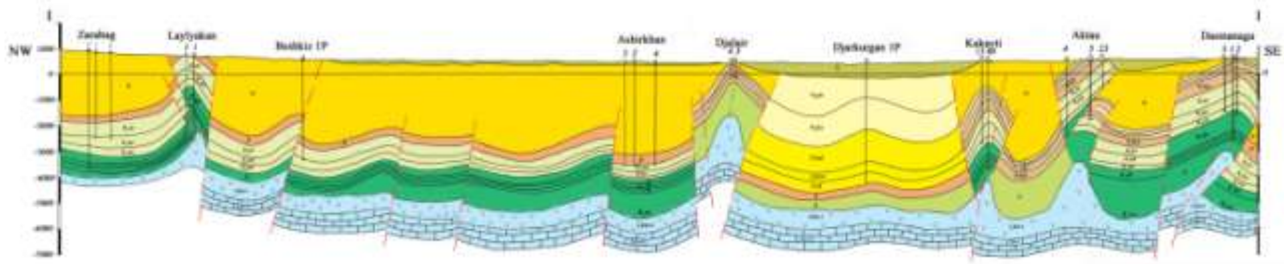

Figure 2: Geological section along the line I-I.

The deepest wells drilled in these areas penetrate Cretaceous sediments (not completely). Analysis of the thickness variation showed the following picture.

Neogene-Quaternary deposits have a large thickness in the central part of the section. Within the Kakayti site, their thickness is about 990 m, Djarkurgan - 4500 m, Beshkiz - 2145 m. In the Jalair site, the thickness of these sediments is insignificant - 60 m, due to the presence of a local anticlinal uplift here. Near the marginal sites of Dasmanaga and Laylyak, the thickness of Neogene-Quaternary sediments decreases till complete pinching-out.

Paleogene sediments have a maximum thickness in the eastern part of the section. Within the Dasmanaga area, their thickness is about 820 m, Kakayti is 890 m. Analysis of the section of Paleogene sediments in the western direction, shows a gradual decrease in their thickness: Jalair - 445 m (not fully opened), Beshkiz - 325 m. and LyailyakPaleogene deposits come to the surface.

In regional conditions, Cretaceous sediments also occurred and tend to decrease in thickness from east to west. However, within the local areas, the thickness of the Cretaceous sediments has small variations. So, in particular, within the Dasmanaga area, their thickness is about 2360 m, Kakayti - 2270 m, Laylyak - 2210 m. Within the area of Laylyak, Cretaceous sediments appear on the out cropped to the surface in the core of the local horst - anticlinal structure.

One of the ways to obtain more reliable information about the presence of the proposed of hydrocarbon traps or deposits during the process of exploration for oil and gas is conducting basin modeling. Cost-effective exploration needs a methodology to predict the likelihood of success, given the available data and associated uncertainties. The main task of modeling sedimentary basins and oil and gas systems is to track the evolution of a sedimentary basin over time as it is filled with fluids and sediments, in which hydrocarbons can ultimately form or contain (Al-Hajery *et al.*, 2009).

The high-tech software of Schlumberger's PetroMod allows a comprehensive assessment of available data on the geological structure of the basin, well data and available geochemical analyzes to assess the maturity of the source rocks and predict migration paths, possibility generation volumes of hydrocarbons and their characteristics.

Using the PetroMod 1D module, models were constructed for a number of wells in the Surkhandarya depression. As a rule, boreholes penetrated mainly Paleogene oil and gas sediments. Cretaceous and

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Jurassic sediments, which are also oil and gas bearing, are practically not penetrated, as they occur at a fairly large depth.

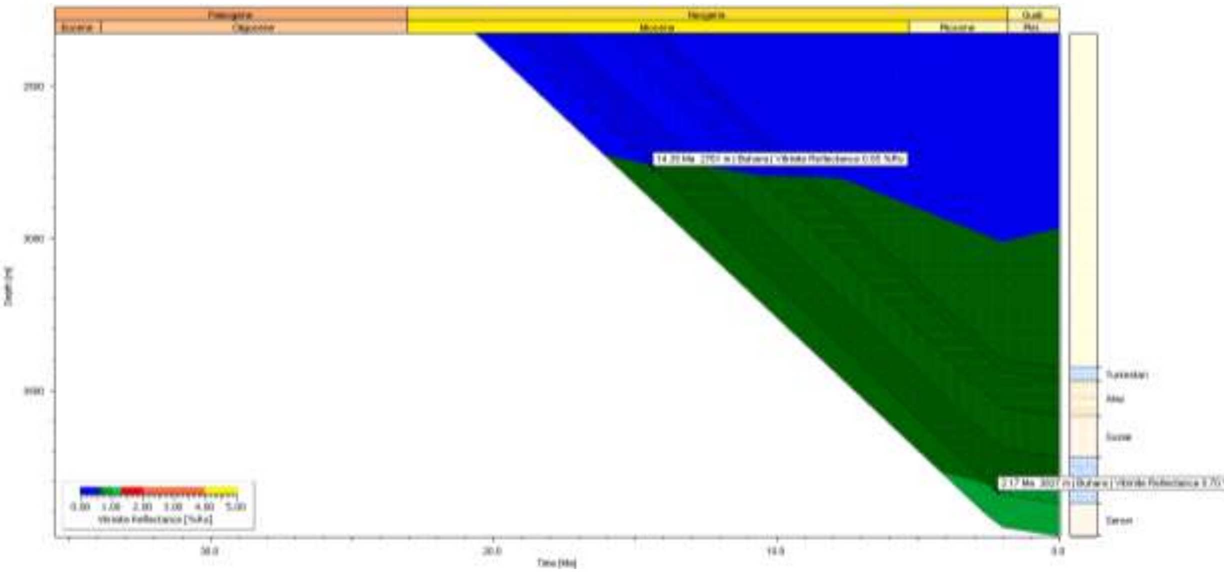

Figure 3: 1D Model of generation of hydrocarbons in well No. 4 Ashirkhan

Figure 3 shows a one-dimensional model of hydrocarbon generation, built in the PetroMod 1D software, for well No. 4 in Ashirkhan area. As a result of the simulation, one-dimensional models of porosity, temperature, pressure and maturity of the parent rocks were constructed. So, in particular, Bukhara limestone, which is the main reservoir of the Paleogene, is characterized by a decrease in porosity from 30% to 9% and an increase in density from 2.19 g/cm3 to 2.55 g/cm3 with time and as they dive to a depth of 3870m. The simulation results on the vitrinite reflection (% Ro) showed that having reached a depth of 2761 m (14.35 Ma, 0.55% Ro), Bukhara limestone fall into the window of early oil, the process of transformation of kerogen into hydrocarbon (type II kerogen) proceeds and at this stage transformation ratio amounts to 5.12%. Upon further immersion to a depth of 3827 m (2.17 Ma, 0.70% Ro), Bukhara limestone came into the main oil window, the transformation ratio of which is 10.51%. At the present stage, Bukhara limestone is located in the main oil window, and the transformation ratio is 12.18%.

Conclusion

According to the analysis of the available geological and geophysical data of the studied region, it can be concluded that the Surkhandarya depression is represented by a very complex tectonics and peculiar geological structure. This manifests itself in the form of tectonic disturbances of a different nature (uplifts, throws, thrusts, faults, etc.), which in its turn form positive and negative structures of different order, affect the physical properties of the rocks of the strata. It is entirely possible to detect new traps of various types in those strata, and thus they attract special attention of many geologists, tectonics, geophysicists and reservoir engineers.

Based on the above, it can be claimed that the geodynamics and tectonic evolution of ATB have formed structural conditions favorable for the formation of oil and gas traps, reservoirs and source rocks capable of generating oil and gas. The discovery of oil and gas deposits in the Paleogene, Cretaceous and Upper Jurassic complexes confirms the obviously working hydrocarbon system. Further modeling (2D, 3D) will make it possible to predict the conditions for the generation and migration of hydrocarbons in the lateral and vertical directions.

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