УДК 550.8.053 https://doi.org/10.51301/vest.su.2021.i2.03

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GEODYNAMIC REGIME OF FORMATION OF OIL AND GAS COMPLEXES IN THE ARYSKUM TROUGH

Abstract. Article discusses the conditions for the formation of oil and gas complexes (oil and gas play) in Aryskum trough. Geological and geophysical data of deep geological structure confirm that formation of sedimentary basin and lithological-stratigraphic complexes, oil and gas complexes (oil and gas plays) of Southern Torgay was influenced by the rift-induced geodynamic regime of oil and gas formation. The stages of rifting are divided: pre – rift, initial – formation (early Jurassic), middle – subsidence (early-middle jurassic) and final (late jurassic), which are associated with the formation of jurassic productive horizons. The Cretaceous productive horizons were formed during the epirift stage. The rift mode of oil and gas formation assumes high warming of the subsurface and conditions for the migration and accumulation of hydrocarbons and confirms the prospects for searching for hydrocarbon traps in the Aryskum trough.

Key words: South Torgay, Aryskum trough, oil and gas complex (oil and gas play), rifting stage, graben – syncline, field, productive horizon.

South Torgay depression encompasses southeastern part of Torgay syneclise and is a part of Turan plate. Rifting, covering initial and part of the main stage, occurred in the late triassic-early jurassic and up to the late jurassic in three stages: initial - formation (early jurassic), middle - subsidence (early - middle jurassic) and final (late jurassic). As a result of rifting, structure of South Torgay basin was formed. The depression consists of two troughs: Zhylanshik in the north and Aryskum in the south, separated by the Mynbulak saddle. [6,7].

There are three structural levels in the structure of the region:

- Lower heterogeneous folded basement composed of metamorphosed proterozoic-vendian and lower paleozoic volcanogenic-sedimentary sediments that underwent caledonian consolidation.
- Middle quasi-platform-composed of rocks of carbonate and terrigenous -carbonate formation of the devonian-lower carboniferous. Zone of increased level thicknesses (3 km or more) can be traced on the southwestern margin of Mynbulak saddle and in the western part of Aryskum trough in the juncture zone with Lower Syrdarya arch
- Upper platform level is subdivided into 2 structural stages: the jurassic orogenic, filling rift-induced graben-synclines in the Zhilanshik and Aryskum troughs and the cretaceous-quaternary, deposits of which cover more ancient sedimentary complexes(sequences).

A feature of the jurassic structural stage is its formation in exclusively intracontinental conditions, characterized by an active taphrogenic tectonic regime, which, in turn, led to the formation of narrow linearly elongated grabens expanding up the section along each rhythmic complex(sequence) of sediments and separated by basement highs.

Level of occurrence of the base of the jurassic complex in graben-synclines reaches 5-6 km, decreasing on horst-anticlines to -1000 -1600 m.

Aryskum trough is complicated by numerous local structures.

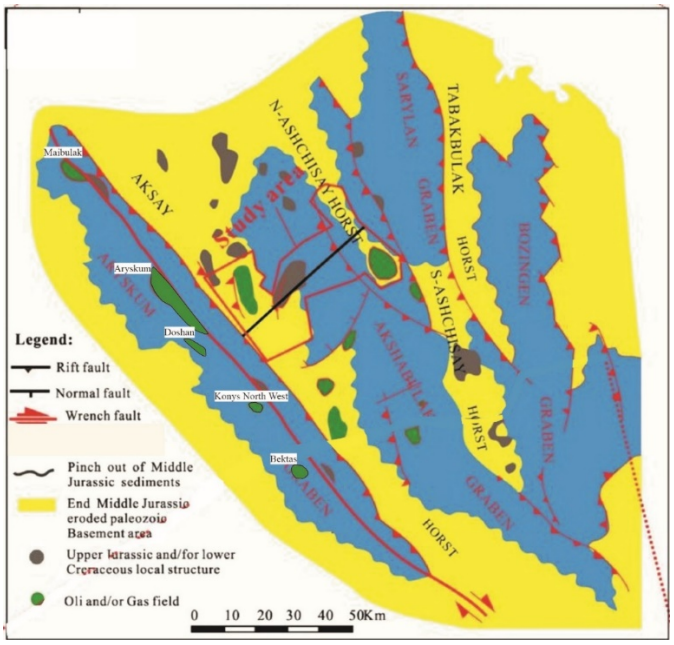
Most of the authors studying the South Torgay trough consider graben-synclinal components as structures of rift-induced origin, which formed at the beginning of the jurassic period.

Rift-induced nature of graben-synclines emphasized by the stepped structure of basement surface, formed by faults, consedimentary to the structural layer. All graben synclines are

asymmetric. Steeper margins represent large amplitude steps that limit distribution of all or most of the lower part of the jurassic deposits.

According to G.Zh. Zholtaev, graben-synclines are hydrocarbon generation zones. Flattened margins are complicated by longitudinal, in some places transverse steps, controlling the spread of main rhythmcomplexes(sequences) of Jurassic section and fragments. Horst anticlines (oil and gas accumulation zones) separating these structures are complicated by highs and troughs with a relatively small amplitude.[1,2].

In general, Aryskum trough, as a structure of a thrust origin, fits into a wide band of discontinuous faults of Karatau deep fault(MKF).



Pic. 1. Structural division map of the Torgay Basin by composed Chenlin Hu

Aryskum graben-syncline, located in the western part of Aryskum trough, strikes northwest and stretches for more than 200 km with a width of 20-25 km. In the most submerged central part of the Aryskum graben - syncline, the thickness of the sedimentary cover reaches 6000 meters. Rift basins similar to South Torgay basin are characterized by linear structural forms and their connection with long-lived deep faults.[10]

Within South Torgay (Aryskum) trough, there are four largest grabens linearly elongated in the sublatitudinal direction - synclines of rift origin: Bozingen, Sarylansk, Akshabulak, Aryskum, divided from each other by horst uplifts, called horst-anticline - Tabak-Bulak, Ashisay and Aksay (Fig.1). Axial part of Aryskum graben-syncline is complicated by a large ruptured zone, which is a continuation of the Main Karatau fault (MKF). Amplitude of fault in the northwest reaches 2000 meters, decreasing to the southeast to 400 meters in the southeast. Northeastern slope of the graben-syncline is steeper than southwestern one. The fault crosses the entire section of the paleozoic and meso - cenozoic.[9] Group of anticlinal structures with which the Maibulak, Aryskum, Konys, North-West Konys, and Bektas fields are associated is confined to it in inner part of the graben-syncline.

In the region, according to 3D seismic data, various regional and zonal benchmarks of reflecting horizons II^1, IIa, III, IIIa, IV, Pz are confidently identified, with which regional oil and gas complexes(plays) are associated.

In the Aryskum trough, set oil and gas reservoir and shows in general have a clear stratigraphic association.

In the section of this major structural-tectonic element of the depression, three oil-and-gas bearing complexes are identified: the lower cretaceous (neocomian), the jurassic and the pre-mesozoic, formation of which is associated with the rift-induced stage of oil and gas formation.

Until recently, the pre-mesozoic oil and gas complex was not distinguished, since it was believed that it did not have its own generation potential, and oil and gas deposits in the upper, disintegrated part of the basement were considered secondary, formed as a result of the migration of hydrocarbons from the source rocks of the jurassic age.

However, the discovery of the Kenlyk field, confined to paleozoic carbonate formations, fundamentally changes existing ideas. In this connection, the paleozoic formations should be considered as an independent oil-and-gas-bearing basement complex.

It is associated with cavernous-fractured carbonate-terrigenous formations of the quasiplatform complex of the upper paleozoic. Accumulations of oil and gas associated with weathering residues along sediments of the paleozoic-proterozoic basement are quite frequent. Flow rates at individual structures are 5.49 m3 / day at h din. - 1385.5 m, and at Kenlyk field up to 200 m3/day. This complex is characterized by the I-pre-rift stage. [3]

The jurassic petroleum complex is associated with three major sedimentation cycles corresponding to triassic-early jurassic, middle jurassic and late jurassic periods, which were formed in stages II- deposition, III- subsidence and IV-final (Fig. 2,3). Each of the cycles began with formation of coarse-clastic coarse-grained rocks and ended with the accumulation of predominantly clayey sediments. Up to 80% of the reservoir beds of the jurassic section, with which the main producing horizons are associated with the lower parts of the rhythmocomplexes (sequences).

The upper, predominantly clayey strata of the rhythmocomplexes plays a role of a zonal cap rock.

The late triassic – jurassic sedimentation was generally dominated by lacustrine sediments. Riverbed sediments were also widespread, especially in the early and middle jurassic, with a clear predominance of lake and floodplain clay deposits.[5]

Producing horizons are composed of interbedded sandstones, siltstones, and clays. Shallow depths of productive(producing) strata caused the presence of weakly cemented, up to loose, reservoirs. Reservoir rocks are of the granular type and are represented by sandstones, sands, and siltstones.

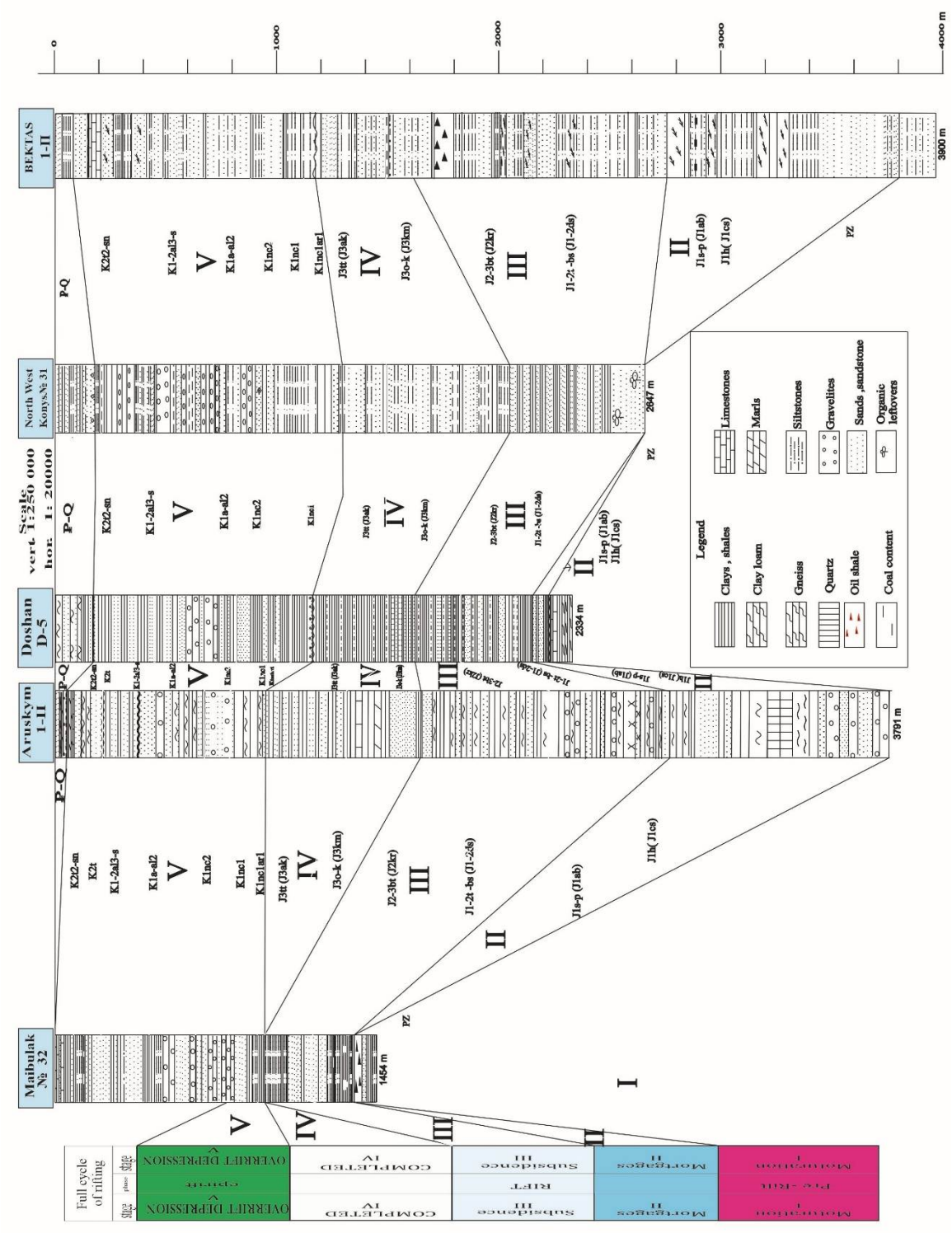
The complex consists of three subcomplexes: the lower, lower-middle and the upper jurassic, each of which is composed in the lower part of more coarse-grained rocks with numerous horizons in sandy reservoirs, and in the upper part of clay strata that are impermeable. The lower oil and gas subcomplex stratigraphically covers two formations: sazymbai and aibaly, represented, by sand-conglomerate and silt-sand-mudstone strata.

To date, it contains producing horizons established within Aryskum graben-syncline at Doshan, Maibulak and other fields. At Doshan field the oil flow rate reached 22.1 m3 / day.

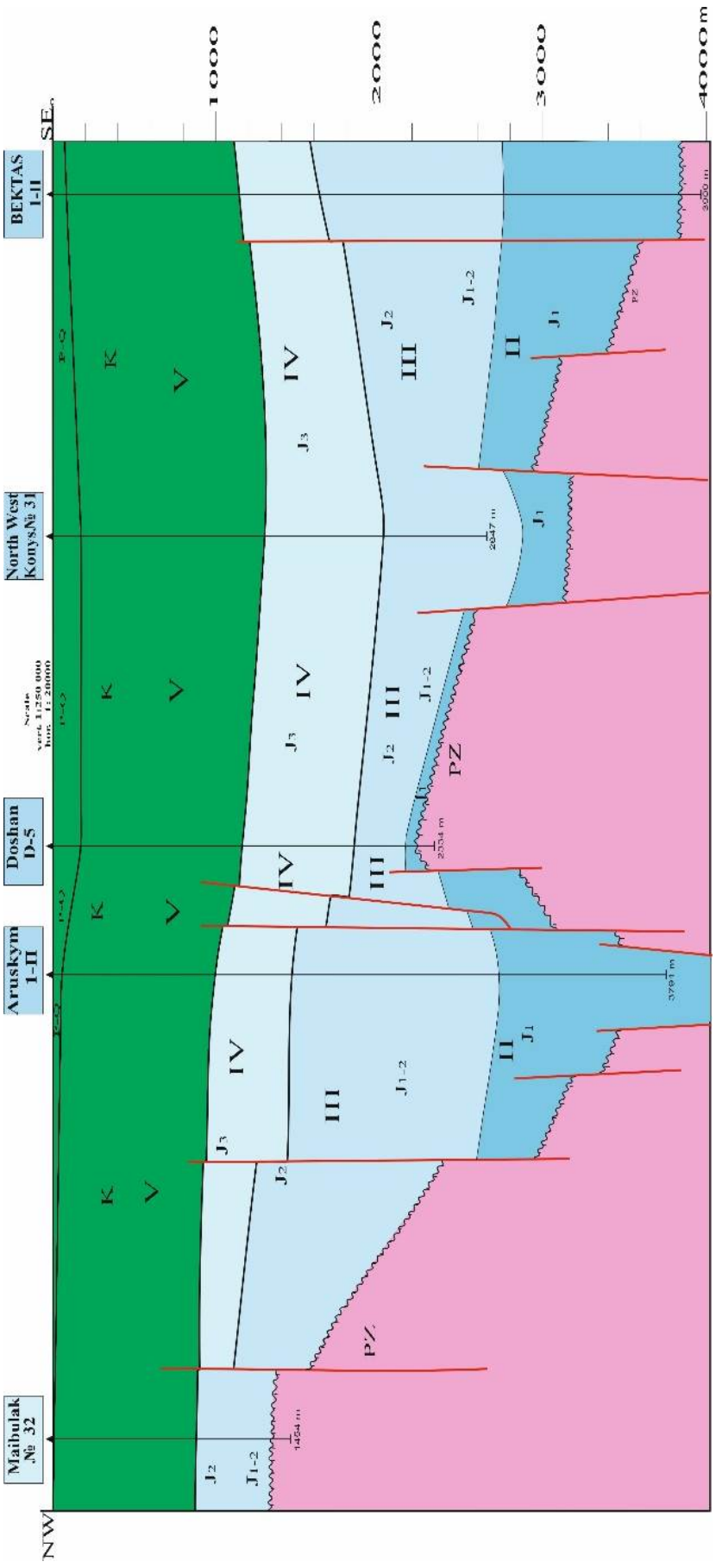
At Maibulak field, producing horizons in lower jurassic sediments were also identified. Oil flow rates in these producing horizons vary from 14.4 m3 / day to 73.4 m3/day.

Middle oil and gas subcomplex is confined to the strata stratigraphically uniting the sediments of the doshan and karagansai formations. The first one is mainly represented by sandstones with rare interbeds of mudstones, and the second one is overwhelmingly composed of clay sediments, defined mainly by mudstones.

In some cases, they, acquiring a thin stratification and fracturing, can act as reservoirs similar to Bazhenov formation of West Siberian oil and gas province.This petroleum complex is established in Arysskoe, North West Konys, Doshan, Maibulak and other fields.



Pic. 2. Correlation scheme the wells 32(Maibulak) ,1-P(Aryskum), D-5 (Doshan), 31 (North West Konys) , 1-P (Bektas) by composed Yerbolat A.B.



Development stages: I-Maturation (pre-rift); II- mortgages; III - subsidence (rift);
IV-completed ; V-overrift depression (epirift).

Pic. 3 - Regional geological and geophysical profile of the Aryskum trough by composed

At the Maibulak field, producing horizons J-IV, J-V, J-VI, J-VII, J-VIII are confined to the middle jurassic deposits. Oil flow rate vary from 16.75 m3/day to 139.9 m3 / day.

In North West Konys field, according to the LOG data reservoirs of the J_{2kr} oil horizon are oil-saturated.

The upper oil and gas subcomplex is confined to the upper jurassic strata, composed of sandy-siltstone and clay-mudstone members of the Kumkol and Akshabulak formations. Overlying the Cretaceous sediments in full stratigraphic volume and paleogene sediments with a total thickness of 700 to 1700 m act as a seal for both this sub-complex and all other productive parts of the jurassic formations.

The upper jurassic terrigenous reservoirs are associated with producing horizons J-0 (subdivided into subhorizons J-0-0, J-0-1, J-0-2, J-0-3, J-0-4), J-I, J -II, J-III. Oil and gas content of the sub-complex was determined at Kumkol, Aryskum, Nuraly, Aksai, Kyzylkiya, Akshabulak, Maibulak, Konys, Khairkeldy Severny, Doshan South and Bektas fields, etc.

In these producing horizons at Aryskum field, the flow rates range from 20.26 m3/ day to 177.5 m3 / day.

At North West Konys field, the following deposits were identified: structural - stratal, fault-bounded and non-structural, associated with channel sediments. Productivity of the channel horizons has been proven by well testing. Oil flow rates vary from 24.95 m3 / day to 74.8 m3 / day.

Outside the channel zone, during well-testing reservoir, an oil inflow with a flow rate of 15.3 m3/day to 30 m3/day was obtained.

Cretaceous oil and gas complex is widely developed within the South Torgai basin. It was formed in V – epi- rifting stage. Producing horizons are composed of interbedded sandstones, siltstones and clays. Shallow depths of the producing strata led to the presence of poorly cemented, up to loose, reservoirs. Rocks - reservoirs are of the granular type and are represented by sandstones, sands and siltstones

Oil and gas content of the M-II horizon (spatially coincides with the halo of productivity of the upper jurassic complex, which may indicate formation of cretaceous oil pools due to vertical migration of hydrocarbons). Oil and gas content of this complex is proved by discovery of commercial oil and gas accumulations at fields of Kumkol, Aksai, Kzylkiya, Nuraly, Doshan, Kenlyk, Aryskum, Konys, Arysskoe, Bektas, Konys, Konys North-West, South Doshan and many others.

In its strata, producing horizons M-0, M-I, M-II, which, in turn, are subdivided into subhorizons and are confined to the daul formation, are identified. In addition, the producing horizons - K1a+al2 , K1-2al3-c, which are associated with aptian-albian and albian-cenomanian fields, were identified in South Doshan field.

The clayey rocks of the lower daul formation of the lower neocomian serve as the regional cap rock for the productive horizons.

Regional cap rock for producing horizons is a member of clayey rocks of the lower daul formation of the lower neocomian.

Seal rock are the dark gray mudstone strata separating them.

At Aryskum field in M-II producing horizon oil flow rate is 26 m3 / day, and at the North West Konys field - from 12.8 m3 / day to 73 m3/day and at Bektas field-from 4.6 m3 / day to 33.4 m3/day , gas flow rate from the M-3 oil and gas horizon reaches 39.31 thousand m3 / day.).

Conclusion. Summarizing the above it can be noted that rifts and the process of their development play an important role in formation of oil and gas basins. Rifting controls the processes of oil and gas formation and oil and gas accumulation and the patterns of distribution of hydrocarbon accumulations. In Aryskum trough, the producing horizons of the lower and middle jurassic sediments were formed during stages of rift evolution, and the upper jurassic and cretaceous in the final stage of the development of the rift and in the plate stage.

It can be noted that positive factors of the petroleum potential in the study area are:

1. Presence of deeply submerged parts of the Jurassic section (Aryskum graben-syncline), which serve as hydrocarbon generation zones;

2. Discovering fields in the rifting zone of petroleum formation, which presupposes a high temperature of the earth interior and conditions for the migration and accumulation of hydrocarbons;

3. Presence of extended tectonic faults, which are both seals for traps of hydrocarbons, and migration routes from underlying sediments, zones of decompaction of rocks and improvement of their reservoir properties.

4. Presence of reservoirs and cap rocks in the section;

5. Prospects for the discovery of layer-uplifted fault-bounded fields in the Cretaceous and Jurassic horizons and non-structural deposits in paleochannels.

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ГЕОДИНАМИКАЛЫҚ РЕЖИМДЕ АРЫСҚҰМ ОЙЫСЫМЫНДАҒЫ МҰНАЙ-ГАЗ КЕШЕНДЕРІНІҢ ҚАЛЫПТАСУЫ

Андатпа. Мақалада Арысқұм ойысымындағы мұнай-газ кешендерінің (мұнай-газ қабатын) қалыптасу шарттары қарастырылады. Терең құрылымның геологиялық- геофизикалық деректері Оңтүстік Торғай шөгінді бассейні мен литологиялық-стратиграфиялық кешендерінің, мұнай-газ кешендерінің (мұнай-газ қабаттарының) қалыптасуы мұнай-газ түзілуінің рифтогендік геодинамикалық режимінің әсерінен болғанын растайды. Рифтогенез кезеңдері бөлінеді: рифтқа

дейінгі, бастапқы – қалыптасу (төменгі юра), ортаңғы – шөгу (төменгі – ортаңғы юра) және соңғы (жоғарғы юра), олар юра өнімді горизонттарының қалыптасуымен байланысты. Бор өнімді горизонттары эпирифтік кезеңде қалыптасқан. Мұнай-газ түзілуінің рифтогендік режимі жер қойнауының жоғары жылынуын және көмірсутектердің орын ауыстыруы мен жинақталуы үшін жағдайларды болжайды және Арысқұм ойысымында көмірсутек тұтқыштарын іздеу перспективаларын растайды.

Негізгі сөздер: Оңтүстік Торғай, Арысқұм ойысымы, мұнай –газ кешені (мұнай –газ қабаты), рифтогенез сатылары, грабен-синклиналь, кен орын, өнімді горизонт.

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ГЕОДИНАМИЧЕСКИЙ РЕЖИМ ФОРМИРОВАНИЯ НЕФТЕГАЗОНОСНЫХ КОМПЛЕКСОВ АРЫСКУМСКОГО ПРОГИБА

Аннотация. В статье рассматриваются условия формирования нефтегазовых комплексов(нефтегазоносного пласта) в Арыскумском прогибе. Геолого-геофизические данные глубинного строения подтверждают, что формирование осадочного бассейна и литолого-стратиграфических комплексов, нефтегазовых комплексов (нефтегазоносных пластов) Южного Торгая происходило под влиянием рифтогенного геодинамического режима нефтегазообразования. Выделены этапы рифтогенеза: дорифтовый, начальный – заложения (ранняя юра), средний – проседания (ранняя – средняя юра) и завершающий (поздняя юра), с которыми связано формирование юрских продуктивных горизонтов. Меловые продуктивные горизонты сформировались в эпирифтовую стадию. Рифтогенный режим нефтегазообразования предполагает высокую прогретость недр и условия для миграции и аккумуляции углеводородов и подтверждает перспективы поисков ловушек углеводородов в Арыскумском прогибе.

Ключевые слова: Южный Тургай, Арыскумский прогиб, нефтегазовый комплекс (нефтегазоносный пласт), этапы рифтогенеза, грабен –синклиналь, месторождение, продуктивный горизонт.