UDC 553.982.2; https://doi.org/10.37878/2708-0080/2024-2.04
https://orcid.org/0000-0002-8005-6324

INVESTIGATION OF THE STRUCTURAL AND TECTONIC DEVELOPMENT OF THE ALAKOL DEPRESSION TO DETERMINE THE PROBABILITY OF THE PRESENCE OF HYDROCARBONS

M.E. SANATBEKOV,
Master of Technical Sciences,
Lecturer at the Department
of Hydrogeology, Engineering
and Oil-Gas Geology,
m.sanatbekov@satbayev.university

SATBAYEV UNIVERSITY
Republic of Kazakhstan, 050043, Almaty, Satpayev st., 22

This article provides a brief analysis of the tectonic structure of the Alakol depression, which is located in Central Asia. The Alakol has a high potential for discovering hydrocarbons. This study aims to examine the structural and tectonic evolution of the depression in order to determine the likelihood of finding hydrocarbons within it. Various geological techniques, such as gravimetry, magnetic surveys, seismic tomography and geological mapping, are used to analyze the region. These techniques help identify structural features such as folds, faults, and fractures, which could potentially serve as traps for hydrocarbons. In addition, the geological history of the region, including its sedimentary deposits and tectonic activity, is also analyzed to understand the conditions that have led to the formation and preservation of hydrocarbon resources in the area.

When assessing the oil and gas content of the sedimentary cover of the Alakol basin, it is necessary to take into account the presence of coal-bearing horizons, such as the Alakol field, as well as numerous manifestations of mud volcanism. These factors indicate the presence of a positive "hydrocarbon background" in the territory under consideration. Given these features, it is possible to identify promising sites for further exploration and development of hydrocarbon deposits in this region.

As a result of the study, an attempt is being made to assess the potential presence of hydrocarbon deposits in the Alakol depression.

KEY WORDS: *Geology, deposits, tectonics, depression, oil and gas content, hydrocarbons.*

КӨМІРСУТЕКТЕРДІҢ БОЛУ ЫҚТИМАЛДЫҒЫН АНЫҚТАУ ҮШІН АЛАКӨЛ ОЙПАТЫНЫҢ ҚҰРЫЛЫМДЫҚ ЖӘНЕ ТЕКТОНИКАЛЫҚ ДАМУЫН ЗЕРТТЕУ

М.Е. САНАТБЕКОВ, техника ғылымдарының магистрі, Гидрогеология, инженерлік және мұнай-газ геологиясы кафедрасының оқытушысы, *m.sanatbekov@satbayev.university*

SATBAYEV UNIVERSITY,
Қазақстан Республикасы, 050013, Алматы қ., Сәтбаев к-сі, 22

Бұл мақалада Алакөл ойпатының тектоникалық құрылымына қысқаша талдау жасалған. Орталық Азияда орналасқан Алакөл ойпаты көмірсутектерді анықтау үшін әлеуеті жоғары аймақ болып табылады. Бұл зерттеуде оның жер қойнауында көмірсутектердің болу ықтималдығын анықтау үшін осы бассейннің құрылымдық және тектоникалық дамуына талдау жасалады. Осы мақсатқа жету үшін әртүрлі геологиялық әдістер қолданылады, соның ішінде гравиметриялық және магниттік зерттеулер, сейсмикалық томография және геологиялық картография. Зерттеу ықтимал көмірсутек шоғырлары болуы мүмкін қатпарлану, жарылымдар және жыртылу сияқты құрылымдық ерекшеліктерді анықтауға бағытталған. Сонымен қатар, көмірсутек қорларының қалыптасуы мен сақталу жағдайларын анықтау үшін шөгінді шөгінділер мен тектоникалық бұзылыстар тарихын қоса алғанда, аймақтың геологиялық тарихына талдау жасалды.

Алакөл бассейнінің шөгінді қабатының мұнай-газдылығын бағалау кезінде Алакөл кен орны сияқты көміртекті горизонттардың болуын, сондай-ақ балшық вулканизмінің көптеген көріністерін ескеру қажет. Бұл факторлар қарастырылып отырған аумақта оң "көмірсутек фонының" болуын көрсетеді. Осы ерекшеліктерді ескере отырып, осы аймақтағы көмірсутек кен орындарын одан әрі зерттеу және игеру үшін перспективалы учаскелерді анықтауға болады.

Зерттеу нәтижесінде Алакөл ойпатында көмірсутек кен орындарының болуы мүмкін екендігін бағалауға әрекет жасалуда.

ТҮЙІНДІ СӨЗДЕР: *Геология, кен орын, тектоника, ойпат, мұнайгаздылық, көмірсутектер.*

ИССЛЕДОВАНИЕ СТРУКТУРНОГО И ТЕКТОНИЧЕСКОГО РАЗВИТИЯ АЛАКОЛЬСКОЙ ВПАДИНЫ ДЛЯ ОПРЕДЕЛЕНИЯ ВЕРОЯТНОСТИ НАЛИЧИЯ УГЛЕВОДОРОДОВ

М.Е. САНАТБЕКОВ, магистр технических наук, преподаватель кафедры гидрогеологии, инженерной и нефтегазовой геологии, *m.sanatbekov@satbayev.university*

SATBAYEV UNIVERSITY,
Республика Казахстан, 050013, г. Алматы, ул. Сатпаева, 22а

Рассмотрен краткий анализ тектонической структуры Алакольской впадины. Алакольская впадина, расположенная в Центральной Азии, представляет собой регион с высоким потенциалом для обнаружения углеводородов.

В данном исследовании проводится анализ структурного и тектонического развития этой впадины с целью определения вероятности наличия углеводородов в ее недрах. Для достижения этой цели используются различные геологические методы, включая гравиметрическое и магнитное исследования, сейсмическую томографию и геологическое *картографирование. Исследование направлено на выявление структурных особенностей, таких как складчатость, разломы и разрывы, которые могут представлять собой потенциальные ловушки для углеводородов. Кроме того, осуществляется анализ геологической истории региона, включая осадочные отложения и историю тектонических событий, для определения условий формирования и сохранения углеводородных запасов.*

При оценке нефтегазоносности осадочного чехла Алакольского бассейна необходимо учитывать наличие угленосных горизонтов, таких как Алакольское месторождение, а также многочисленные проявления грязевого вулканизма. Эти факторы свидетельствуют о наличии положительного "углеводородного фона" в рассматриваемой территории. Учитывая данные особенности, возможно определение перспективных участков для дальнейшего изучения и разработки углеводородных месторождений в этом регионе.

В результате исследования предпринимается попытка оценить потенциальную наличие углеводородных месторождений в Алакольской впадине.

КЛЮЧЕВЫЕ СЛОВА: *геология, месторождения, тектоника, впадина, нефтегазоносность, углеводороды.*

Introduction. The Alakol depression is situated between the alpine uplifts of the Tarbagatay, Barlyk, and Dzungarian Alatau mountains from the southwest, it is bounded by the Alakol-Dzungarian fault and from the northeast – by the Ayaguz-Urzhar fault the dimensions of the depression within Kazakhstan are 300x250 km [1-2].

The Eastern and Southeastern depressions have a complex dynamic of the geological section ranging from Paleozoic to Quaternary sediments, with a wide development of sedimentary carbonate-terrigenous strata and significant manifestations of volcanism in the lower parts of the Paleozoic rock assemblage. The study area covers the territory of Almaty and partly East Kazakhstan regions within 43˚-47˚N 74˚-82˚E. The studied geological complexes in the depressions are composed of volcanogenic-sedimentary Paleozoic rocks and terrigenous Meso-Cenozoic sedimentary deposits [3-4].

The thickness of the sedimentary cover in the Alakol depression reaches 4.0 km in its deep troughs, but there is no reliable information on the composition of the deposits. The thickness of Neogene sediments is estimated at 1.5 km. The immersion depths of the Meso-Cenozoic complex suggest that some of them are located in the main oil generation zone and even in the main gas generation zone (2-3 km) [5-6].

The tectonic structure of the depressions is analyzed on the basis of geological surveys, geophysical works, and data obtained from rare wells. The study considers a wide range of issues, namely, lithological and paleogeographic rock characteristics, sedimentation conditions, tectonics of the sedimentary cover, its structure and placement in the section of prospective oil and gas source strata for establishing favorable conditions for them. For a complete analysis, the issues of the geological structure and oil and gas content of the considered depressions are addressed [7-8].

Materials and research methods. The structural features of the Alakol depression are described in many sources. Although the basement surface and Paleozoic diagrams, based on a comprehensive interpretation of seismic and graviometric materials (*Figure 1*), are useful for analysis, seismic data are more reliably illuminated by the common depth point method (CDP), as applied by Remas Corporation LLP in 2007-2008.

Along the basement surface, the Alakol depression is an extensive asymmetric depression with a steep southwestern side at the regional fault (thrust) and a gentle northeastern side.

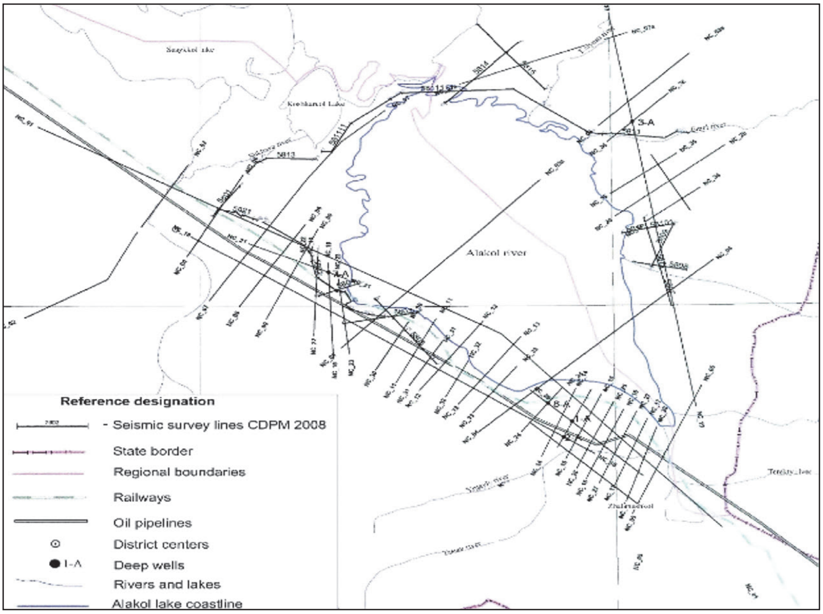

Figure 1 – **Seismic exploration scheme of the Alakol depression**

The greatest depths of the basement are located along its southwestern side at the Alakol-Dzungarian fault from the 200-m isohypse in the northwest to 4,200 m in the southern part of the depression near the state border with the People's Republic of China (PRC).

In the central part of the depression, in the area of islands with the outcrop of Devonian-Carboniferous sediments, there is a swell-like uplift of the northwest extension (saddle) dividing the depression into the South Alakol and East Alakol troughs. The depths to the basement in the East Alakol trough are outlined by the isohypse of up to -2,000 m. In the South Alakol trough, the most lowered section is located at a depth of 4,200 m. Their dimensions are 60x20 km and 100x30 km, respectively. The maximum depths of the basement surface for the entire depression are recorded within 2,300-4,200 m in the troughs. In the depression, in addition to the regional faults, namely North Dzungarian (aka Alakol-Dzungarian) and Chingiz-Alakol (in the east of the depression), there are a large number of smaller faults in the northeast, complicating the structure of the sedimentary complex. These faults create a system of large and small blocks in the basement and the inherited draping structures of complex composition in the overlying sediments.

The structure of the cover is formed by the Jurassic coal-bearing terrigenous (500–700 m) structural stage, which is not developed everywhere, and the Neogene-Quaternary (up to 1,000 m) structural stage. The maximum thickness of the sedimentary cover is 1,600 m, located near the Alakol-Dzungarian fault. In the axial part of the depression, the Sasykkol-Alakol uplift is situated, the roof of which is expressed by Paleozoic outcrops on the islands of Lake Alakol and the coast of Lake Sasykkol. To the north and south of the uplift, the Paleozoic surface subsides. In the area of the Dzungarian Gate, the depression narrows to 1-1.2 km and closes. The northwestern closure of the depression occurs through a smooth lift of the Paleozoic surface towards the Bakanas synclinorium [2].

The structure of the Alakol depression was formed as a result of active postcollisional Paleozoic, riftogenic and platform Mesozoic-Cenozoic events. Since the Miocene, this territory of Central Eurasia has been involved in active epiplatform mountain-building processes associated with the collision of the Eurasian and Hindustan plates. It is in the Mesozoic-Cenozoic that these areas were formed, and since the Miocene, they have been actively developing as submontane and intermontane depressions (*Figure 2*).

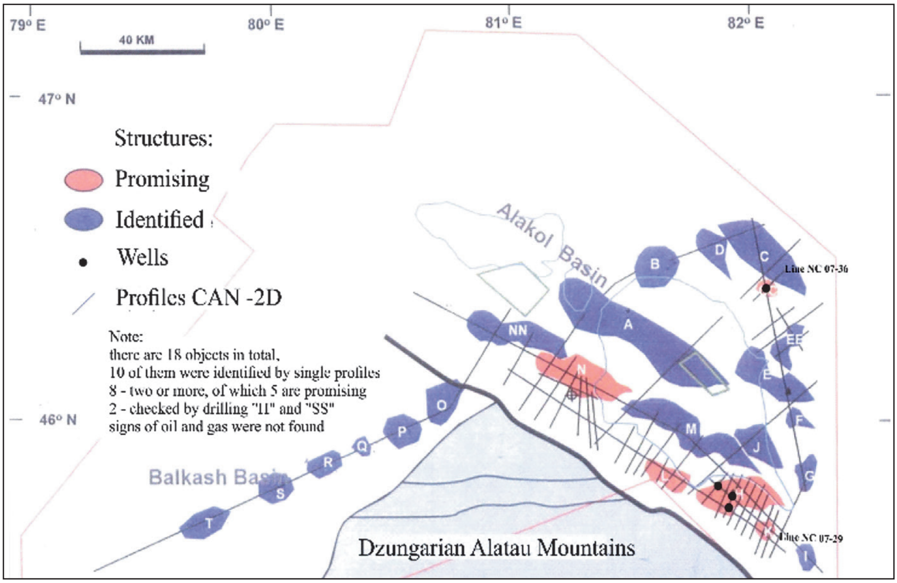

Figure 2 – **Location map of the Alakol depression structures**

The modern tectonic structures of the Alakol region and the adjacent territory of the PRC were strongly affected by the Alpine orogeny (Pliocene-Anthropogen). Its characteristic feature is the activation of faults in the Paleozoic substratum with a sharp dominance of vertical movements both in the substratum itself and in the Meso-Cenozoic cover. The extensive southern part of the Alakol Meso-Cenozoic depression experienced uplift and transformation into a continuous system of grabens and horsts. As noted above, along the basement surface, the Alakol depression is an extensive asymmetric depression.

The tectonic structure of the Alakol depression is characterized on the basis of a Paleozoic surface map, compiled from seismic data. The southwestern side is steep and bounded by the Zhetysu fault. The northeastern side is gentler. Along the axial lines of Lake Alakol and Lake Sasykkol, there is a swell-like uplift of the Paleozoic surface, which divides the depression into two parts – shallow gentle northeastern and deep southwestern [2].

In the modern structural plan, the Alakol depression is represented by the North Alakol and South Alakol grabens separated by the Sasykkol-Alakol horst (*Figure 3*). Before the neotectonic transformation, this structure extended far to the southwest (the Biyen-Aksu interfluve) and to the south, at least to the Tastau River valley. The northern boundary is less clearly expressed and represented by a system of small step faults separating Meso-Cenozoic strata from Carboniferous-Permian volcanic rocks. The maximum thickness of the platform cover overlying the Paleozoic basement is characteristic of the southern graben. Based on the geophysical data of vertical electrical sounding (VES), the thickness of unlithified strata in the Paleozoic exceeds 2,100 m.

The Paleozoic substratum is most submerged in the northwestern direction, about 55 km long along the southwestern coast of Lake Alakol. This fault-line graben enters the Zhetysu "gate" in the southeast and can be traced to the Ayaguz River in the northwest. Its total length exceeds 250 km with a width of 20-25 km. To the west of the Tentek River, Miocene-Oligocene sediments are penetrated by drilled wells at depths of 200-600 m. Jurassic and Triassic sediments come to the surface in thrown tectonic blocks in the far northwest (the Aktogay region) and the far southeast (the Katu Mountains) [2].

The Sasykkol-Alakol horst is outlined according to geophysical data and Paleozoic outcrops on the islands of Lake Alakol and the coast of Lake Sasykkol. Since even Tertiary sediments are absent in these places, it can be assumed that in the Pliocene and the early Anthropocene, the horst area was very intensively eroded. The northern graben is situated between the Paleozoic Tarbagatay massif and the Sasykkol-Alakol horst. On the eastern flank, the northern graben passes into the Emel graben, which connects the Alakol depression with the Pre-Tarbagatay part of the Paleozoic.

On the northern and southern grabens of the Alakol depression, there may be poorly dislocated continental Permian sediments, presumably attributed to the transitional or quasi-platform structural stage. The Urzhar monocline is located in the extreme peripheral part of the depression with a "gradual" uplift of the basement surface towards the Tarbagatay ridge. The monocline occupies the territory north of the Sasykkol-Alakol horst and the North Alakol graben-syncline. In the eastern part of the depression bordering the PRC, between the Arkarly and Arasantau mountains, there is the Emel graben-syncline stretching further to the east in the PRC. The Usharal horst is a fault-line structure paragenetically related to the South Alakol fault-line graben. The horst can be traced along the Alakol-Zhetysu fault zone from the Arganaty Mountains to the Tastau River valley.

To the east, from the Tentek River valley to the bottom of the Arganaty Mountains, there is a fault-flexural zone, where Paleozoic strata come to the day surface in tectonic blocks. They are overlain by a cover complex of mottled clays, dated mainly to the Paleocene. The structure of the Shilikti and Tonkuruz grabens adjoins the considered zone directly from the south. Paleogene-Neogene red and mottled sediments in the area of the grabens are penetrated by wells at depths of 200-500 m. The northwestern and southeastern boundaries of the grabens are complicated by uplifts and thrusts with a fault plane tilting to the southeast.

In the cover complex of the grabens, surface-gravitational folding is widespread. This folding is found in the Tushangzi oil field. This field is located on the western flank of the Urumchi piedmont trough. Fault-line anticlines are also widespread in the Alakol, Shilikti, Sarkand, Kolpakovsky and Borotalinsky grabens. The appearance of anticlines in small grabens, such as Terekti, Konstantinovsky, and Tonkoruzsky, is not excluded. The widespread occurrence of mud volcanic breccia and mud volcanoes in the Pliocene indicates their possible connection with oil deposits, which suggests the likely impact of the Alpine orogeny on the formation of oil-bearing deposits in this region [3].

Mud volcanoes are another important feature of the structure of the Alakol depression. Mud volcanoes observed on the day surface are formations of modern active tectonics. In the Kolpakovskaya depression, there are faults associated with mud volcanism, along which there is a displacement of areas composed of mound clays.

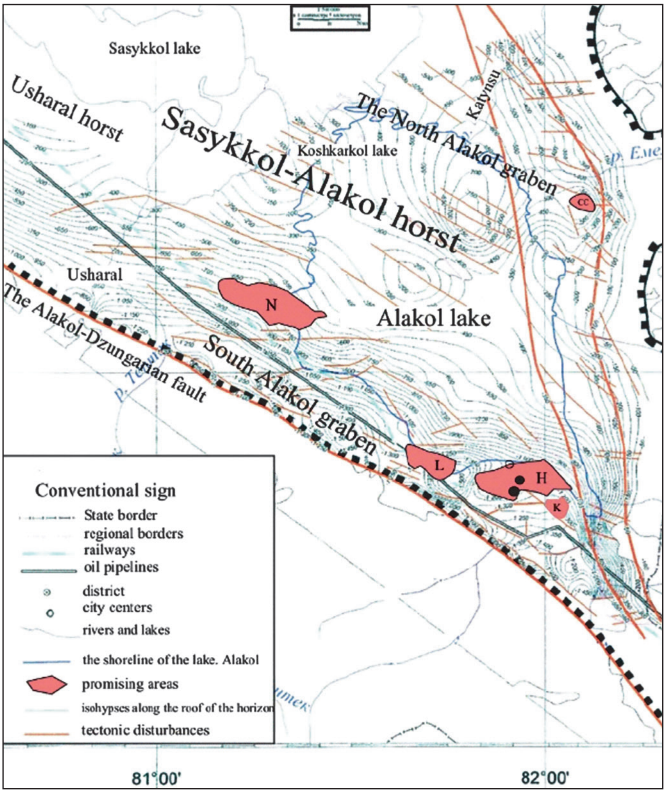

Figure 3 – **Map of tectonic zoning of promising areas of the Alakol basin**

Various domed uplifts, small horsts and grabens are widespread in the Alakol depression. In geomorphological terms, there are landslides as well as steeply-sloping ridge-shaped, crescent-ridge-shaped, and crescent-ridge-shaped landslide topographic forms. All these structures and topographic forms may have resulted from mud volcanoes [3].

V.L. Gulnitskiy carried out electrical measurements in the eastern and northeastern parts of the Alakol depression (1957) and applied the VES method to reinterpret the geoelectrical data. Based on the results, the depth of the Paleozoic basement was established at 3,600 m. It was revealed that the basement was complicated by a system of deep faults. In the subsurface section, Cenozoic and Jurassic-Paleogene sediments up to 2,000 m thick were identified [4].

In 1958, Yu.N. Akopov and L.A. Pevzner carried out seismic surveys using the reflection method and the correlation refraction method in the area of Lake Alakol for the first time. Their surveys had an experimental and methodological nature. A marking boundary was established (V_g = 5,400 m/s), developed throughout the entire survey area and lying at a depth of 1,200-1,300 m. The section of the pre-Paleozoic complex of the Alakol depression was not identified [5].

Results and discussion. The structural features of the sedimentary complexes of the Alakol depression can be analyzed by the basement surface and Paleozoic schemes, compiled based on a comprehensive interpretation of seismic and gravimetric data [2].

The IV reflecting horizon, confined to the top of Paleozoic sediments, is characterized by the highest dynamic expressiveness and extended tracking. In most of the depression, the top of Paleozoic sediments lies at depths from tens to a few hundred meters, as a result of which seismograms usually have none or one or two reflections with a significant background of multiple waves. In the gravitational field, an extensive minimum corresponding to the Alakol depression and an intense gravity step tracing the deep fault in the southwest of the depression are clearly distinguished.

Along the basement surface, the Alakol depression is a vast asymmetric depression with steep southwestern and gentle northeastern sides. The greatest depths of the basement are observed along its southern and southwestern boundaries, where along the North Dzungarian high-amplitude fault it borders the outcrop of Paleozoic rocks on the day surface. Near the North Dzungarian fault, the South Alakol and South Sasykkol troughs are recorded with dimensions of 100 x 35 km and 60 x 20 km, respectively. The maximum depths of the basement surface for the entire depression are recorded in the range of 2-3 km to 4 km in the South Alakol trough.

To the northeast of the fault-line zone, the basement top rises at an angle of 10° towards the Tokrau-Bakanas zone. At a distance of 40-50 km from the North Dzungarian fault, the depth of the basement decreases to a few hundred meters. In the eastern part of the depression, the East Alakol trough is outlined against the background of a monocline. The structure of the top of Paleozoic sediments almost completely inherits the structural features of the basement surface [5].

A comparison of the structural diagrams of the folded basement surface and the top of Paleozoic sediments shows that there is an intermediate structural stage in the composition of Paleozoic sediments in the deepest troughs. It is characterized by lower densities in comparison with the basement and, apparently, less dislocation. The thickness of this stage reaches 0.7 km in the South Alakol trough and up to 1.2 km in the East Alakol trough. Based on geophysical data, it can be assumed that the intermediate stage is represented by terrigenous rocks.

Thus, the Alakol depression, formed as a result of the subsidence of the crustal block along the North Dzungarian fault, is characterized by a relatively weak structural differentiation with a shallow bedding of the basement surface. The deepest South Alakol and East Alakol troughs are presumably filled with relatively weakly dislocated Upper Paleozoic terrigenous sediments that are part of the intermediate structural stage.

For a complete assessment, geochemical studies were not carried out to predict the oil and gas content of the depression, with the exception of single drilling cutting analyses. The outcrops of rocks studied in the margin of the depression show that they have industrial coal-bearing properties within the Alakol coal field and are generally enriched by dispersed forms of organic matter. These sediments are developed mainly in the trough zones and can be considered as potential oil and gas source. However, even in these zones, their immersion depths do not exceed 1.5-1.8 km, making it impossible for them to reach the maturity level of active hydrocarbon generation. In this case, the magnitude of the generation potential could not be significant since the bulk of organic remains is represented by remains of higher vegetation.

Due to the poor knowledge of the oil and gas content of the sedimentary complexes of the Alakol depression, one can estimate their oil and gas prospects very roughly. The high intensity of the tectonic regime influenced the structural-formational complexes associated with horsts and grabens, which affected the lithological-paleogeographic conditions of rock formation (*Figure 4*). The most favorable conditions for hydrocarbon generation are Mesozoic and Cenozoic formation strata, represented by Triassic-Jurassic and Paleogene-Neogene sediments. This rock assemblage is identified as potentially promising oil and gas bearing [6].

The depth of oil and gas generating rocks in favorable catagenetic gradations also allows us to identify the Mesozoic-Cenozoic complex as promising for oil and gas exploration. The degree of catagenesis corresponds to the upper half of the main oil generation phase.

To assess the oil and gas potential of the depression, the study used data on gray-colored complexes of Paleozoic and Mesozoic sediments as well as mud volcanoes in the margin of the depression.

According to the data of Remas Corporation LLP, C_{org} in the outcrops of Jurassic sediments constitutes an average of 2.7% in the inter-coal intervals at the Alakol brown coal field.

Only one oil show is identified – an oil film on water from the hydrogeological well No. 20 at the Tasta River mouth at its confluence with the lake. Hydrogeological parameters in the side sections of the depression are also unfavorable. Aquifers contain fresh infiltration water, but mineralization increases with increasing depths. Permian, Triassic, and Jurassic coal-bearing sediments in the inner parts of the depression can be considered as oil and gas source. However, in most of the depression, their immersion depths do not exceed 2.0 km. Therefore, they cannot reach the maturity level of the main oil generation zone of 2.8-3.0 km for intermontane depressions.

The magnitude of the generation potential, in this case, could not be significant also because the bulk of organic sediments is represented by remains of higher vegetation. This means that the nature of dispersed organic matter is predominantly humus, while for the active generation of liquid hydrocarbons they need to submerge to depths corresponding to temperatures from 80-90°C to 150-170°C at the catagenesis stages of dispersed organic matter, mesocatagenesis (MC_1, — MC_2) [7].

The temperature regime of the sedimentary complex is determined by the magnitude of the geothermal gradient, about which there is no specific information in the deep wells of the Alakol depression. Therefore, one can use similar data for the nearest Ile and Zaisan depressions. In the Ile depression, in eight deep wells of the Zharkent trough, an average geothermal gradient was 2.7°C per 100 m of the section. According to these averaged data, a depth of 2 km should correspond to a temperature of 54°C, 3 km – 81°C, and 4 km – 108°C. Although this is an approximate estimate, it testifies to the low-temperature regime of the depression, which is typical for intermontane alpine basins [8].

Lithological-paleogeographic conditions and the tectonic regime influenced the general rock composition scheme in the stratigraphic section of the Paleozoic complex. The widespread development of coarse clastic rocks and coarse-grained sandstones accumulated during the rare penetration of the sea, as well as the manifestation of volcanism clearly demonstrate the synchrony of tectonic movements covering the vast territory of the Asian continent.

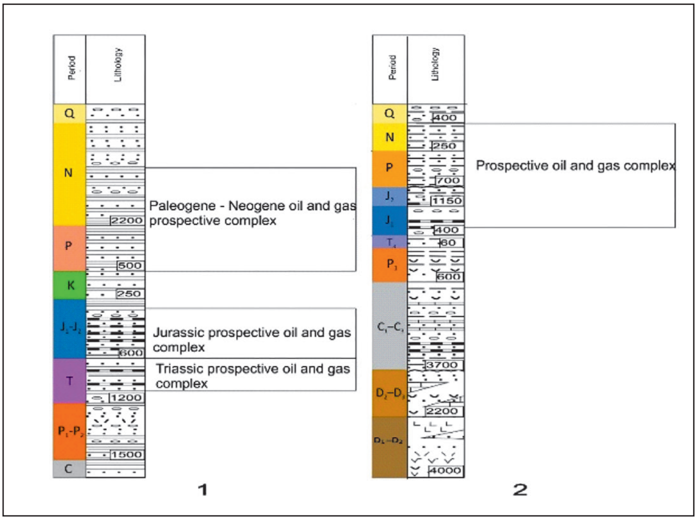

Figure 4 – **Scheme of prospective oil and gas bearing complexes: East Ile (1) and Alakol (2) depressions**

In our opinion, the Permian and Jurassic were the main formation periods of oil and gas source strata within the original Alakol depression, which exceeded the modern one by 2-3 times. The narrowing of the Alakol depression along the surface is associated with the overlap of its southern half by powerful thrusts that are an integral part of the deep structures of the modern mountains of Northern Dzungaria. Materials on the western part of the Alakol depression near Lake Balkhash indicate that the Carboniferous and Permian marine sediments form an underthrust plate submerging to the north under the volcanic belt of Carboniferous-Permian age. The underthrust seam runs from the southern side of the islands on Alakol to the southern edge of Lake Sasykkol [9].

Conclusions. The analysis of geophysical and geological data showed that the tectonic activity of this region manifested itself in two stages. The most active fault tectonics fell on the Cimmerian epoch, which left blind faults in the sedimentary cover body. The decline in their activity was observed in the Jurassic and Lower Cretaceous period. The second epoch was marked by the newest cross faults, which could be traced to the day surface of the depression cover.

The manifested tectonic movements suggest that the formation features of local structures in the zone of regional faults are mainly subject to their orientation [10]. An important and decisive role in the formation of the Alakol depression is assigned to the stages of tectonic movements, which are associated with the Caledonian and Hercynian folding cycles, as well as the processes of intrusive magmatism. The first Caledonian orogenic cycle of the formation of the depression structure manifested itself in the development of large linearly elongated folds in the southwestern extension. The structures were characterized by the steep incidence angles of the wings (60-700) and the irregular bedding of Silurian and Devonian strata on Ordovician and Silurian formations.

The second stage of tectonic movements, the Hercynian orogenic cycle, manifested itself in the development of gentle (25-300) brachyanticlinal folds mainly in the northwestern extension.

Subsequent powerful orogenic phases were accompanied by the intrusion of large felsic and intermediate bodies. At that time, due to the formed and rather rigid Caledonian substratum, the main disjunctive faults were manifested, which predetermined the modern contours of the Alakol depression and its individual tectonic blocks.

Within the boundaries of the modern Alakol depression, Permian and Jurassic oil and gas source rocks are overlain by a two-kilometer stratum of Cenozoic loose sediments formed in the Cenozoic young graben. The thrust sole is considered as a fluid seal. Presumably, in the northern part of the Dzungarian ridge, its depth is 1–2 km, submerged under the main ridge to the south-southwest [11].

The Paleozoic rock assemblage cannot be ruled out as a source of hydrocarbon generation. Devonian-Carboniferous sediments and terrigenous-siliceous-carbonaceous rocks of a rather significant thickness up to 10 km can be considered as oil and gas source strata. Particularly promising are the sediments located under the thrust base, where the preservation of hydrocarbons is guaranteed by a powerful fluid seal. The results of the preliminary research work carried out and the analysis of available data revealed the presence of up to 5 km of sedimentary and volcanogenic-sedimentary deposits of Paleozoic, Mesozoic, and Cenozoic age.

Paleozoic rocks are not excluded as prospective for oil and gas content, since in many countries of the world, there are fields with significant oil and gas reserves in reservoirs formed under the impact of volcanism on sedimentary deposits.

When assessing the oil and gas content of the sedimentary cover of the Alakol basin, one should take into account the presence of coal-bearing horizons in the section (the Alakol field) and numerous manifestations of mud volcanism, which generally indicates a positive "hydrocarbon background" characteristic of the considered area.

As the practice of oil and gas exploration in various oil and gas provinces of the world shows, these are the accompanying factors in the identification of large oil and gas fields. In general, in the Alakol basin, one can hope, with a certain degree of confidence, for oil and gas prospects and field discoveries [12].

REFERENCES

1 Zholtaev G.Zh., Ozdoev S.M. Prospects for the oil and gas potential of the Alakol sedimentary basin // Proceedings of the National Academy of Sciences of the Republic of Kazakhstan, Geological Series, Almaty. - 2010. - No. 3.- P. 122-127.

2 Ozdoev S.M., Popov V.A., Tleuberdi N. Geology and prospects for the oil and gas potential of the eastern and southeastern depressions of Kazakhstan // K.I. Satpayev Institute of Geological Sciences, Almaty, Kazakhstan. - 2020.

3 Abilkhasimov K.B. Report on the results of exploration work performed in the areas of the reclaimed (vacated) contract territory of REMAS Corporation LLP and North Caspian Petroleum Limited in the East Kazakhstan and Almaty regions. – Almaty - 2010. - p. 45.

4 Atlas of Lithologo-Paleogeographic, Structural, Palinspastic and Geoenvironmental Maps of Central Eurasia. YuGGEO Research Institute of Natural Resources, Almaty. – 2002.

5 Koshkin V.Ya. On the oil and gas potential of the Alakol depression // Proceedings of the 1st International Conference “Oil and Gas Potential of Kazakhstan”, Almaty-Atyrau. - 2001. - P. 66-68.

6 Nazarbayev B.A., Uzhkenov B.S., Ostapenko R.N. Prospects for oil and gas potential of the Alakol intermontane depression // Petroleum, Almaty. - 2001. - No. 5. - P. 66-68.

7 Ozdoyev S.M., Abduev N.S., Popov V.A., Tileuberdi N., Dong M.H. Common and differing Geological features of the Alakol and Chinese Dzungarian troughs in view of their oil and gas prospects // News of the Academy of Sciences of the Republic of Kazakhstan // Series of Geology and Technical Sciences, Almaty, Kazakhstan. - 2019. - No. 436. - P. 6 - 11. https://doi.org/10.32014/2019.2518-170X.92.

8 Zhang L., Sidnev A.V. Geological structure and oil content of the sedimentary complex of the Dzungaria basin (China) // Interuniversity STC of students, postgraduates and young scientists: materials of the interuniversity STC. Publishing House of USPTU, Ufa. - 2009. – 145. P. (44-46).

9 Min G., Sidnev A.V. Oil and gas fields in Zhungeer basin and the problems of their exploration in the northwest of China // Electronic scientific journal "Oil and Gas Business". - 2015. - No.3. - P. 20-30. http://dx.doi.org/10.17122/ogbus-2015-3-20-30

10 Votsalevsky E.S., Daukeev S.Zh., Kolomiets V.P., Komarov V.P., Paragulgov H.H., Pilifosov V.M., Shlygin D.A. Deep structure and mineral resources of Kazakhstan // Oil and gas, Volume I // National Academy of Sciences of the Republic of Kazakhstan, Almaty. - 2002. - P. 248.

11 Bykadorov V.A., Fedorenko O.A. Report "Geodynamic model and assessment of the oil and gas potential of sedimentary basins in Kazakhstan" // YuGGEO Research Institute of Natural Resources, Almaty. - 2001. - P. 1-12.

12 Kulanchieva A.A., Bayandin S.N. Report "Seismic surveys by CDP of "Yerkin Oil", Almaty. - 2008.

13 Sanatbekov M.E., Zholtaev G., Sknarina N.A. Lithological and paleogeographic conditions of rock formation associated with the prediction of hydrocarbon deposits in the Alakol depression // «Mining Journal of Kazakhstan» scientific, technical and production journal, Almaty. - (2021). - №2. - P. 35-41.