Код МРНТИ 38.17.17:52.31.47

G. Tarassenko[1], Y. Muralev[1], Y. Demicheva[2], *Y. Bukayev[1]
[1]Yessenov University (Aktau, Kazakhstan),
[2]LLP Kazakhstan Agency for Applied Ecology (Aktau, Kazakhstan)

EXPLORING THE GEOLOGY AND TECTONICS OF THE MOYINKUM TROUGH FOR OIL AND GAS PROSPECTS

Abstract. The studied area, located in the surface region of the Republic of Kazakhstan and Uzbekistan, has become an object of increased interest in recent years. It is important to increase the share of the Ustyurt region in the total increase in natural gas reserves. However, the main problem faced by specialists is the need to study the location of clusters within the Moyinkum bend to determine the state of oil and gas operations. The purpose of our study is to study deeper stratigraphic complexes, including Lower-Middle Devonian and pre-Devonian fields, in order to increase the gas potential of the region. It is planned to lay an exploration well with a depth of 5,000 meters on the Jardai square. To achieve these goals, it is planned to reclaim three previously drilled wells and carry out a complex of geophysical works.
Key words: *field, oil and gas content, exploration, natural gas, seismic survey, geological section, sag, production, natural gas, well.*

Мұнай-газ перспективалы үшін мойынқұм ойпатының геологиясы мен тектоникасын зерттеу

Аңдатпа. Қазақстан мен Өзбекстан Республикаларының Үстірт аймағында орналасқан зерттелетін аумақ соңғы жылдары қызығушылықтың артуына айналды. Табиғи газ қорлары өсімінің жалпы көлеміндегі Үстірт өңірінің үлесін ұлғайту маңызды болып табылады. Алайда, мамандардың алдында тұрған басты мәселе мұнай-газ жұмыстарының жай-күйін анықтау үшін Мойынқұм иілісі шеңберінде кластерлердің орналасуын зерделеу қажеттілігі болып табылады. Біздің зерттеуіміздің мақсаты-аймақтың газ әлеуетін арттыру мақсатында төменгі орта девондық және девонға дейінгі шөгінділерді қоса алғанда, тереңірек стратиграфиялық кешендерді зерттеу. Жардай алаңында тереңдігі 5000 метр барлау ұңғымасын салу жоспарлануда. Алға қойылған мақсаттарға қол жеткізу үшін бұрын бұрғыланған үш ұңғыманы рекультивациялау және геофизикалық жұмыстар кешенін жүргізу көзделеді.
Түйінді сөздер: *кен орны, мұнай-газ, геологиялық барлау жұмыстары, табиғи газ, сейсмикалық барлау, геологиялық кесу, иілу, өндіру, табиғи газ, ұңғыма.*

Изучение геологии и тектоники мойынкумского прогиба на предмет перспектив добычи нефти и газа

Аннотация. Исследуемая территория, расположенная в поверхностном регионе республик Казахстан и Узбекистан, стала объектом повышенного интереса в последние годы. Важным является увеличение доли устюртского региона в общем объеме прироста запасов природного газа. Однако основной проблемой, с которой сталкиваются специалисты, является необходимость изучения расположения кластеров в рамках мойынкумского изгиба для определения состояния нефтегазовых работ. Целью нашего исследования является изучение более глубоких стратиграфических комплексов, включая нижне-средне-девонские и до-девонские отложения, с целью увеличения газового потенциала региона. Планируется заложить разведочную скважину глубиной 5000 метров на Жардайской площади. Для достижения поставленных целей предполагается провести рекультивацию трех ранее пробуренных скважин и провести комплекс геофизических работ.
Ключевые слова: *месторождение, нефтегазоносность, геологоразведочная работа, природный газ, сейсморазведка, геологический разрез, прогиб, добыча, природный газ, скважина.*

Introduction

The work area is tectonically located within the Moyinkum trough, which, in turn, is part of the Shu-Sarysu depression.

The latter is regionally extended by the Tastinsky uplift, located in the axial part and extending to the northwest, divided into two parts: eastern and western. Within the eastern wing, a number of troughs and uplifts are established, including the Moyinkum trough located in the southeastern sector of the Shu-Sarysu depression (Figure 1).

The Moyinkum Trough is composed of Middle and Upper Paleozoic sedimentary sequences overlain by Mesocainozoic sediments. The Upper Devonian, Carboniferous and Permian sediments were formed under platform conditions.

They are separated from the sedimentary-volcanogenic formations by a regional fault of sedimentation, stratigraphic and angular unconformities caused by the change of the orogenic tectonic regime to the platform regime [1].

The accumulation of Middle-Upper Paleozoic sediments in the Moyinkum trough, as well as in the entire Shu-Sarysu Basin, occurred in the conditions of differentiated tectonic movements of separate blocks against the background of general subsidence of the entire territory.

As a result of uplift of the whole region at the end of the Paleozoic, denudation of sediments occurred within the Moyinkum trough until the Late Cretaceous. Only from the Late Cretaceous the accumulation of Mesocenozoic cover began.

Literature review and problem statement

The geological and tectonic structure of the trough, within which both uplifted and curved zones (moulds) are established, is complex, as evidenced by numerous variants of its tectonic zoning. The present report presents the scheme of tectonic zoning proposed by A. Bigarayev on the basis of the study of the tectonic zones (moulds) [2, 3]. Bigaraev based on the study and behavior of structural surfaces of the Paleozoic complex using data on the behavior of other geophysical fields. In particular, the character of the gravity field behavior (Figure 2) can serve as one of the confirmations of the presence of such a tectonic element as the Kayraktin and other waves [6-9].

Figure 1. Overview map of the work area.
Сурет 1. Жұмыс ауданының шолу картасы.
Рис. 1. Обзорная карта района работ.

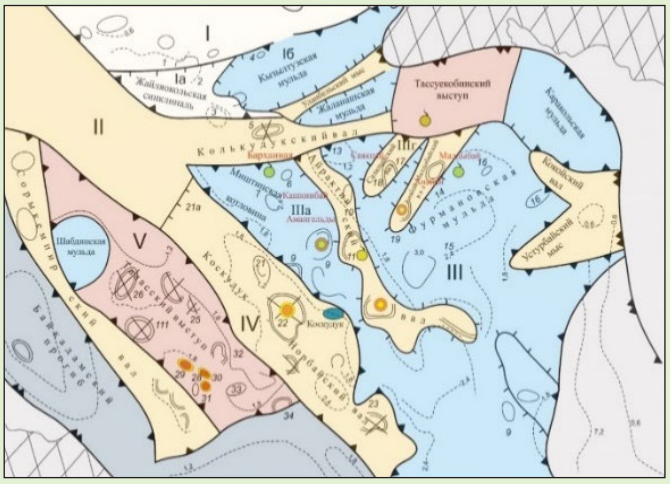

Figure 2. Moiynkum trough. Tectonic zoning scheme.
Сурет 2. Мойынқұм иілімі. Тектоникалық аймақтарға бөлу схемасы.
Рис. 2. Мойынкумский прогиб. Схема тектонического районирования.

Name of regional and local geostructural elements:

I – Nizhneshuyskaya block: 1 – Bestobe;

I – Zhailayakol syncline: 2 – Shuyskaya, 3 – South-Shuyskaya;

Ib – Kyzyltuz mulda: 4 – Andygul;

II – Tastinsky macrovalley (uplift):

IIa – Kolkudyk Shaft: 5 – Kolkudyk;

III – Moyinkum trough:

IIIa – Mishta basin: 6 – Barkhannaya, 7 – Bekmurat, 8 – Amangeldy, 9 – Orynbai, 9a – Amangeldy – 2, 9b – Karamatau;

IIIb – Ayrakty rampart: 10 – Kashymbai, 11 – Zharkum, 12 – Ayrakty;

IIIb – Furmanovskaya mulda: 13 – Sultankudyk, 14 – Kolgaly – 1, 15 – Kolgaly – 2, 16 – Kenes, 16a – Markesh;

IIIg – Sayakpai rampart: 17 – Sayakpai, 18 – Sayapai West;

IIId – Anabai-Maldybai rampart: 19 – Anabai, 20 – Maldybai;

IV – Koskudyk-Norbai rampart: 21 – Bestak, 21a – Mishty Western, 22 – Kumyrly, 23 – Akbai;

B – Talas bulge: 24 – Togusken Western, 25 – Togusken Eastern, 26 – Zailma, 27 – Ucharal Northern, 28 – Kempirtobe, 29 – Ucharal Western, 30 – Kyzylzhar, 31 – Ucharal, 32 – Togusken Southern, 33 – Kozhekudyk, 34 – Elemes.

The boundaries of the trough run along the Zhalair-Naiman anticlinoric system in the northeast (Shu-Ili Mountains) and related buried tectonic elements: the Tassukobinsky ledge, Karakolsky Muldinsky, Kokoysky and related Usturbaysky ledges, which border the trough in a semicircle in the east. From the north, the Moyinkum trough is bounded by the Kolkudyk rampart, which in turn is a branch of the Tast uplift. In the southwest, the boundary of the Moyinkum trough is defined by the vast Koscudyk-Norabai rampart, while the southern boundary of the trough is the folded formations of the Karatau megaval and the adjacent relatively submerged Talas uplift.

Within the trough, in turn, there is a number of extended ramparts: the Airaktin rampart starting from the Kolkudyk rampart in the north and extending in the southeastern direction, the Sayakpai and Anabai-Moldabai ramparts starting from the western slope of the Tassuekobi escarpment extending in the east and having a southwestern strike, i.e., the strike is orthogonal to the strike of the Airaktin and Koskudyk-Norbai ramparts. In the space between the above-mentioned ramparts and the three uplifts, the Myshtinskaya and Furmanovskaya soaps and the Airaktinskaya mulda of the same name, located to the south of the Airaktinskaya rampart, are distinguished.

The Airaktin (Moyinkum) rampart of northwestern strike, separating the Airaktin and Furmanov fields, unites local structures of Kashkinbai, Airakta, Eastern Airakta, Zhuala and Zharkum.

Two structures are associated with the Sayakpai Shaft: Sayakpai and Sayakpai West. On the continuation of the Sayakpai arm in the southwestern direction, gravity data also suggest a more submerged system of shafts. Local structures are developed within them: Amangeldy, Bosoba and Sulushoky.

According to geophysical surveys, local structures such as Barkhany, Sayakpai, Koskudyk, Anabai, Moldybay, Kolgaly, etc. are also identified within the muld. As a rule, local structures are confined to roll-shaped protrusions adjacent to faults.

At present, a number of structures and fields have been identified within the Moyinkum trough in the Amangeldygaz activity zone. Information on the structure of these structures is given below.

Materials and methods

The Amangeldy structure is a brachianticline fold of asymmetric shape with a gentle dip of the northwest wing and bounded from the southeast by a discontinuous upward-type disturbance, in the northern part closely adjoining the lower wing. Analyzing the wave field, it is possible to note an increase in the thickness of Lower Carboniferous sediments in the northeastern direction, which indicates the paleo-reconstruction existing at that time in the southwestern part of the monument and, as a consequence, the existence of more favorable conditions for the fieldion of more sandy rock gradients.

At the roof of the lower vise on the trailing isohypsis is 1950 m, the amplitude of the structure is more than 150 m. The dimensions of the structure are significant 10.0x4.5 km, and Amangeldy is the largest structure within the Moyinkum trough. For all other structural surfaces there is a complete correspondence with the structural plans.

The Anabai structure is located at the southwestern end of the Anabai-Maldybai escarpment complicating the northwestern slope of the Furman-Muldy. The geological structure of the structure is being clarified using 3D. According to the performed constructions, the Anabai structure is an anticline elongated in the northeastern direction and associated with a tectonic disturbance, west of which the surface of the Visayan-Turnean complex experiences a dip with the formation of a deep depression. According to the reflecting horizon, the structure is closed along the isohypsis – 2200 m, has dimensions of 6.0 x 2.0 km, amplitude of 50 m.

The Airakta structure is a brachianticline fold of submeridional strike. The Airakta uplift is separated from the Koskudyk

section by a low-amplitude deflection of 50 m amplitude. The northern part of the structure is complicated by tectonic faults.

The considered sedimentary strata are widespread in the study area, and the plan position and configuration of the reflecting horizons are preserved. The structural plans of this area are characterized by an isometric dome-shaped fold with an amplitude of 100 m.

Productivity of the Airaktinskaya structure is established in the Upper Turonian, Lower Visean coal-terrigenous and Lower Permian sediments.

During well testing a commercial gas flow was obtained in 3 wells (Nos. 1, 6, 11) with a flow rate of 9-27 thousand m^3/day in the Nizhneviseyskaya field.

On the structural map of the Devonian sediments roof (OG IV) absolute surface elevations vary from 2500 m to 2900 m.

In the most elevated part of the Ayrakta structure there is an isometric elevation oriented submeridionally and having a mark in the vault of 2500 m.

In general, the structural plan of the IV horizon is characterized by a uniform monoclinal dip in the northwestern direction.

The structural plan of the Turnean (OG C1t), Lower Visean (OG III), Middle Visean (OG IIId) and Serpukhov (OG IIIk) sediments is largely inherited, preserving the plan position and configuration of the main elements.

The structural map of the Lower Permian terrigenous sediments (OG II) generally preserves the spatial position of the structural forms of the underlying horizons and has a northwestern strike.

Thus, the Airacts are studied in detail in the Lower Carboniferous sediments (reflecting horizon III on the roof of the Tournaisian Stage and the base of the Lower Visean gas-bearing horizon) and in the subsalt sediments of the Permian (reflecting horizon II).

Along the reflecting horizon III, the structure has the shape of a triangle of northwest direction, with dimensions of 17x11 km and amplitude of 260 meters.

The structure plan has been updated based on drilling data and the thickness of sediments on the vault of the lower vise is constant.

The structural plan of Permian sediments from seismic data generally coincides with that of the Lower Carboniferous and has been studied by drilling structural wells.

According to the drilling data, it differs somewhat from the Lower Carboniferous plan, which is due to the increase in the thickness of the Lower and, especially, Middle-Upper Carboniferous to the north. This is reflected in a significant elongation of the structure vault to the north, along the long axis of the structure.

The size of the structure along the isohypsis is 600 m, its area is 16 x 4 km, and its area is about 60 square kilometers.

The Maldybai structure in the contract area, according to the results of previous works, is a series of parallel shaft-shaped uplifts complicated by tectonic faults, extending in the northeastern direction: Sayakpai and Maldybai.

The main faults of the regional trace are the faults passing through the southeastern wing of Sayakpai rampart and Zharkum structure, on the northwestern slope of Maldybai rampart. Unfortunately, the density of the profile network does not allow to identify and trace the main elements of regional significance everywhere.

The surfaces along the stratigraphic boundaries of the Maldybai section are constructed on the basis of a single northeastern orientation of seismic profile 209061, so they should be accepted as schematic. The Maldybay structure is a brachyanticlinal fold of northeastern strike. The northeastern closure of the structure extends beyond the working area.

On the structural map of the Devonian sediments roof (OG IV) absolute elevations vary from 2200 m to 3200 m. In the most elevated part there is an elevation in the form of a narrow brachyanticlinal fold oriented submeridionally and having a mark in the vault – 2200m.

The structural maps of the surface of the Tournaisian sediments (OG C1t), the roof of the terrigenous Lower Visean layer (OG III), the roof of the Middle Visean sediments (OG IIId), the roof of the Serpukhov limestone layer (OG IIIk) are inherited, preserving the planned position and configuration of the main elements. Absolute elevations in the most elevated part of the study area are – 1050 m, and in the most submerged zone – 2000 m. The Maldybay structure within the study area is delineated by the isohypsis – 1050 m. Absolute levels of OH III in the study area vary from 1700 to 2300 m. The contour of the structure within the area of works is outlined by isohypsis – 1800 m, with the amplitude of elevations of 100 m.

There are no Lower Permian fields in the area of the Maldybay structure.

7 wells were drilled in the Maldybay area. Gas content was established at Nizhneserpukhovskaya and Nizhnevisey fields, and a gas fountain was obtained in well No.1. The Maldybay structure is of interest from the point of view of gas content and requires further study.

The Barkhan structure is located in the western part of the square and has the form of a brachyanticlinal fold of northwestern strike. In the temporal section, the Barkhan structure is a small arch complicated by a linear series of faults, on which well #1 was drilled and the East Barkhan uplift is observed through a deflection bounded by a tectonic disturbance. The indefinite contour of the structure on the structural maps is probably due to the sparse network of profiles, which does not take into account the small size of the selected structures. The presence of faults in the vault is probably explained by their formation during the growth stage of the structure, i.e., during the period of vault stretching.

Structurally, the Devonian sediments roof (OG IV) in the area of Barkhannaya well No. 1 shows a small arc-shaped uplift with an amplitude of 50 m and a closing isohypse of 2800 m, and the East Barkhannaya tributary structure is outlined through a small deflection at the same absolute level.

On the surface of the Tournaisian sediments (OG C1t), the Barkhannaya structure is a very gentle brachyanticlinal fold of sublatitudinal strike. It has a small amplitude (about 50 m) and indistinct contours. Absolute elevations vary within the area from 2300 m to 2400 m.

In the southwestern part of the study area, the roof of the terrigenous Lower Visean Stage (OG III) is distinguished by a low-amplitude dome in the Barkhannaya area, the circumference of the isohypsis of which is 2200 m. This structure is separated from the rift structure by a shallow trough. The eastern Barkhana within the work area is associated with a tectonic disturbance and is also delineated by an isohypsis of 2200 meters.

The dune structure on the roof of the Middle Aegean sediments (OG IIId) and the roof of the Serpukhov Stage (OG IIIk) has significantly increased in size, the amplitude of uplift is 50 meters. The structure is oriented sublatitudinally. It is separated by a low-amplitude sag from the near-fault structure of the Barkhanskaya area, practically uniting into a single structure.

The structural map of the Lower Permian terrigenous sediments (OG II) is almost completely flattened, with only the tear fault structure bounded by the disturbance, the amplitude of uplift is 50 m, and the isohypsis contour is 750 m.

Wells #1 and #3 Barkhannaya were drilled on the proposed western dome, and well #4 was drilled on the low-amplitude sag between the East Barkhannaya structure. During open hole testing in well No. 1 Barkhannaya from the Lower Visean sediments, a gas fountain with a visual flow rate of up to 100 thousand m^3/day was detected when sampling the interval during drilling at absolute levels – 2143-2272 m. Optimal location of well No.1 Barkhannaya drilled according to seismic data at a high level and the presence of tectonic disturbance at the base suggests that the positive result was obtained for the Lower Visean horizon. Well No. 2 was drilled at the base of a tectonic fault behind the contour of isohypses of the eastern slope, sampling and testing of which did not give positive results, the object turned out to be dry.

In this area, according to the results of the present study of the Lower Paleozoic, Zhardayskaya structure is distinguished, the main productive horizons are located at depths of 4-5 km.

The territory of the Moyinkum trough is characterized by poorly studied, practically no regular network of seismic profiles allowing to establish with a high degree of reliability the morphological features of the structure of the selected prospective structures. Besides, as it follows from the data of the works performed, the productive horizons are characterized by sharp changes in reservoir properties, which, given the limited gas resources at each site, determines a high degree of project risk. Therefore, along with mapping and preparation of designs, justification of the degree of productivity of the studied objects before drilling operations is one of the main tasks.

The study of cause-and-effect relations of gas content with the peculiarities of tectonic structure of local structures and second-order tectonic elements (shafts, uplifts) within the Moyinkum trough allowed us to conclude that tectonic disturbances affect the degree of preservation of gas fields. However, it is not possible to study the extent of this impact and other geologic factors that determined the productivity of individual structures due to insufficient data. In this regard, it is planned to additionally cover the Barkhannaya, Sultankudyk, Kashkinbai and Maldybai structures using the CDP method. To increase the efficiency of geological exploration works along with seismic survey it is planned to carry out a wide range of works using other geophysical methods.

Metal-telluric sounding method, as the experience of their implementation in the South Torgai basin shows, allows not only to divide the section into geoelectric boundaries, but also to identify productive hydrocarbon areas within the studied area. Gravimetric methods in combination with seismic methods allow to substantiate the structure of structures and variations in the gravity field, which allows to identify relatively unconsolidated zones, which may be due to the development of weathering crust or zones of intense fracturing.

Geochemical methods, which include helium surveying, can identify areas of maximum concentration of hydrocarbon fluids, but without a specific reference to depth. The problem of depth relation of gas anomalies should be solved by studying electrical and seismic wave fields. A total of 4500 measurements are planned on a 300x300m grid.

Thus, before the start of deep drilling it is planned to justify their prospectivity for hydrocarbon gases and to justify the location of prospecting wells along with the preparation of structures.

The specific location of exploration work at the sites and the scope of this work is summarized below. In accordance with the program it is planned to conduct additional studies of explored gas fields Kumyrly-Koskudyk, Barkhannaya-Sultankudyk (Kashkinbai), Anabai-Maldybai, Airakty. It is planned to study these objects on Lower Carboniferous sediments. In the course of the works, the structural features of the structure will be clarified and the main promising complexes, including Devonian and pre-Devonian, will be identified [4].

Exploration of Devonian and pre-Devonian sediments is one of the main tasks and one of the areas for their development in conditions of relatively high hypsometric position is the Airakta Shaft. The shaft, as noted in the Tectonics section, is located between two relatively large Paleozoic troughs, which in turn are composed of Lower Middle Devonian and Predevonian sediments. The rock and material composition of these fields has been studied on the sides of the depression, where metamorphic rocks predominate in the section. However, according to seismic data within the Mishta and Furman depressions of the Barkhannaya-Sultankudyk (Zhardai) section, they may be represented by clayey rocks or clayey shales, as well as occur on the vault of the Airakta Shaft. The thickness of these sediments within the basins may exceed 5000 m. The nature of occurrence, thickness of rocks of the Lower-Middle Devonian and Predevonian complexes, possible types of reservoirs and reservoirs on the ramparts have not been studied. The most elevated position within this rampart is occupied by the conventionally identified Zhardayskaya structure, which is essentially located within the Barkhannaya-Sultankudyk (Kashkinbay) section and is associated with the pre-Devonian sedimentary complex. The probability of the presence of reservoirs associated with disintegrated rocks of the Dodevonian complex is confirmed, as noted in the previous sections, by the presence of a gas field at the Ortalyk field in rocks represented by clay shales [5, 6].

Results

To increase gas production potential, it is necessary to study deep stratigraphic complexes, including Neoglacial and pre-Devonian fields. As part of this, an exploration well with a depth of 5,000 meters is planned to be drilled in the Zhardai area. The purpose of the well is to search for gas fields in Lower Devonian sediments and to study the structure, lithology, reservoir-filtration and geochemical characteristics of the Devonian layer. Based on the drilling results, it is planned to determine the prospects of gas supply in the Moyinkum depression. In addition, it is planned to drill well 1C at the West Sultankuduk structure.

Further exploration of the deep complexes is suggested, which may lead to an increase in gas potential. Various research objectives such as studying the structure, lithology, reservoir-fil-

tration and geochemical characteristics of the Devonian layer are indicated.

Discussion of the results

Plans to drill a 5,000-meter-deep exploration well at the Zhardai field and conduct studies of neoglacial and pre-Devonian sediments indicate a desire to increase gas production potential.

The study of deep stratigraphic complexes, including Devonian sediments, is essential for determining gas and oil prospects in the region. Planned study of the structure, lithology, reservoir-filtration and geochemical characteristics of the Devonian reservoir for the purpose of field prospecting makes it possible to estimate potential resources and develop effective strategies for further development.

The installation of well 1C at the West Sultankuduk structure is also an important step and opens up new prospects for studying the deep complexes and searching for gas fields in this zone.

Studies aimed at studying various characteristics of the Devonian layer, such as structure, lithology and geochemistry, will help to better define the field potential and develop optimal production strategies.

Conclusion

Drilling a research well at the Zhardai prospect and well 1C at the West Sultankuduk structure, as well as rehabilitation of three previously drilled wells (Barkhannaya #1, Maldybay #1, #4) will allow for a detailed study of the productivity of Permian, Carboniferous and Upper Devonian sediments using survey techniques. This could lead to the identification of gas prospects in the Moyinkum Basin and increase the potential for gas production.

REFERENCES

1. *Tarassenko G.V. Effect of the Earth and the Formation of Oil. «Where Geoscience Meets the Silk Road», Almaty: EAGE, KazGeo, 2010. P. 121-124 (in English)*
2. *Tarassenko G.V., Tuzelbayeva A.K., Demicheva Y.V., Bukayev Y.Z. Conditions of formation and chemical composition of Mangyshlak globular nodules in the western part of Kazakhstan. // International Scientific and Practical Conference «WORLD SCIENCE: PROBLEMS AND INNOVATIONS», Penza: ICNS «Science and Enlightenment». 2021. – P. 192-194 (in English)*
3. *Tarassenko G.V. Formation of oil-based cold fusion and electricity in the earth's crust. // «International Geological Congress 34th IGC», Brisbane: Australia, 2012. – P. 175-177 (in English)*
4. *Instrukcija po oformleniju otchetov o geologicheskom izuchenii nedr Respubliki Kazahstan. «IAC», 2004. – 113 s [Instructions for the preparation of reports on the geological study of the subsoil of the Republic of Kazakhstan. «IAC», 2004. – 113 p.] (in Russian)*
5. *Instrukcija po otboru, dokumentacii, obrabotke, hraneniju, sokrashheniju i likvidacii kerna skvazhin kolonkovogo i razvedochnogo burenija. Moskva. «Geoinformmark», 1994. – 32 s. [Instructions for the selection, documentation, processing, storage, reduction and elimination of core wells for core and exploratory drilling. Moscow. Geoinformmark, 1994. – 32 p.] (in Russian)*
6. *Porjadok otbora, privjazki, hranenija, dvizhenija i kompleksnogo issledovanija kerna, i gruntov neftegazovyh skvazhin. Rukovodjashhij dokument. 39-0147716-505-85-RD. AO NPF «Geofizika», Moskva, 1985. – 3 s. [The procedure for the selection, binding, storage, movement and comprehensive study of core and soils of oil and gas wells. The guidance document. 39-0147716-505-85-RD. JSC NPF Geophysics, Moscow, 1985. – 3 p.] (in Russian)*
7. *Yong-Fei Zheng. Plate tectonics in the twenty-first century. // Science China Earth Sciences. 2022. Vol. 66. P. 1-40 (in English)*
8. *Zhen-Jie Zhang et al. Lithospheric thickness records tectonic evolution by controlling metamorphic conditions. // Science Advances. 2023. Vol. 9. P. 9-12 (in English)*
9. *Guoxiong Chen et al. Hadean tectonics: Insights from machine learning. // Geology. 2023. Vol. 51. P. 718-722 (in English)*
10. *Li J. et al. Anisotropic zoning in the upper crust of the Tianshan Tectonic Belt. // Science China Earth Sciences. 2021. Vol. 64. P. 651-666 (in English)*

ПАЙДАЛАНЫЛҒАН ӘДЕБИЕТТЕР ТІЗІМІ

1. *Tarassenko G.V. Жердің әсері және мұнайдың түзілуі. «Жер туралы геоғылымдар Жібек жолымен кездесетін жерде»: Алматы: EAGE, KazGeo, 2010. Б. 121-124 (ағылшын тілінде)*
2. *Tarassenko G.V., Tuzelbayeva A.K., Demicheva Y.V., Bukayev Y.Z. Қазақстанның батыс бөлігіндегі Маңғышлақ сфералық конкрецияларының түзілу шарттары мен химиялық құрамы. // «ӘЛЕМДІК ҒЫЛЫМ: ПРОБЛЕМАЛАР МЕН ИННОВАЦИЯЛАР» халықаралық ғылыми-практикалық конференциясы, Пенза: «Ғылым және білім» ХҒС, 2021. – Б. 192-194 (ағылшын тілінде)*
3. *Tarassenko G.V. Жер қыртысында мұнай мен электр энергиясына негізделген суық термоядролық синтездің қалыптасуы. // 34-ші Халықаралық Геологиялық конгресс «IGC 5-10», Брисбен: Австралия, 2012. – Б. 175-177 (ағылшын тілінде)*
4. *Қазақстан Республикасының жер қойнауын геологиялық зерттеу туралы есептерді ресімдеу жөніндегі Нұсқаулық. «АТО», 2004. –113 б. (орыс тілінде)*
5. *Бағаналы және барлау бұрғылау ұңғымаларының өзегін іріктеу, құжаттау, өңдеу, сақтау, қысқарту және жою жөніндегі нұсқаулық. Мәскеу. «Геоақпарат», 1994. – 32 б. (орыс тілінде)*
6. *Өзекті және мұнай-газ ұңғымаларының топырақтарын іріктеу, байлау, сақтау, қозғалу және кешенді зерттеу тәртібі. Басқару құжаты. 39-0147716-505-85-БҚ. «Геофизика» АҚ ҒӨФ, Мәскеу, 1985. – 3 б. (орыс тілінде)*

7. *Yong-Fei Zheng. XXI ғасырдағы плиталар тектоникасы. // Ғылым Қытай Жер туралы ғылым. 2022. Т. 66. Б. 1-40 (ағылшын тілінде)*
8. *Zhen-Jie Zhang et al. Литосфераның қалыңдығы метаморфтық жағдайларды бақылау арқылы тектоникалық эволюцияны көрсетеді. // Ғылым жетістіктері. 2023. Т. 9. Б. 9-12 (ағылшын тілінде)*
9. *Guoxiong Chen et al. Хадей тектоникасы: Машиналық оқыту нәтижелері. // Геология. 2023. Т. 51. Б. 718-722 (ағылшын тілінде)*
10. *Li J. et al. Тяньшань тектоникалық белдеуінің жер қыртысының жоғарғы бөлігіндегі анизотропты зоналылық. // Ғылым Қытай Жер туралы ғылым. 2021. Т. 64. Б. 651-666 (ағылшын тілінде)*

СПИСОК ИСПОЛЬЗОВАННЫХ ИСТОЧНИКОВ

1. *Tarassenko G.V. Эффект Земли и формации Нефти. «Где Геонауки о Земле встречаются с шелковым путем»: Алматы: EAGE, KazGeo, 2010, С. 121-124 (на английском языке)*
2. *Tarassenko G.V., Tuzelbayeva A.K., Demicheva Y.V., Bukayev Y.Z. Условия образования и химический состав шаровидных конкреций Мангышлака в западной части Казахстана. // Международная научно-практическая конференция «МИРОВАЯ НАУКА: ПРОБЛЕМЫ И ИННОВАЦИИ», Пенза: МЦНС «Наука и Просвещение», 2021. – С. 192-194 (на английском языке)*
3. *Tarassenko G.V. Формирование холодного термоядерного синтеза на основе нефти и электричества в земной коре. // 34-й Международный геологический конгресс «IGC 5-10», Брисбен: Австралия, 2012. – С. 175-177 (на английском языке)*
4. *Инструкция по оформлению отчетов о геологическом изучении недр Республики Казахстан. «ИАЦ», 2004. – 113 с. (на русском языке);*
5. *Инструкция по отбору, документации, обработке, хранению, сокращению и ликвидации керна скважин колонкового и разведочного бурения. Москва. «Геоинформмарк», 1994. – 32 с. (на русском языке)*
6. *Порядок отбора, привязки, хранения, движения и комплексного исследования керна, и грунтов нефтегазовых скважин. Руководящий документ. 39-0147716-505-85-РД. АО НПФ «Геофизика», Москва, 1985. – 3 с. (на русском языке)*
7. *Yong-Fei Zheng. Тектоника плит в XXI веке. // Наука Китай Науки о земле. 2022. Т. 66. С. 1-40 (на английском языке)*
8. *Zhen-Jie Zhang et al. Толщина литосферы отражает тектоническую эволюцию, контролируя метаморфические условия. // Достижения науки. 2023. Т. 9. С. 9-12 (на английском языке)*
9. *Guoxiong Chen et al. Тектоника Хадея: результаты машинного обучения. // Геология. 2023. Т. 51. С. 718-722 (на английском языке)*
10. *Li J. et al. Анизотропная зональность в верхней части земной коры тектонического пояса Тяньшань. // Наука Китай Науки о земле. 2021. Т. 64. С. 651-666 (на английском языке)*

Information about the authors:

Tarasenko G.V., Candidate of Geological Sciences, Professor of the Department of Ecology and Geology at Yessenov University (Aktau, Kazakhstan), *gennadiy.tarassenko@yu.edu.kz;* https://orcid.org/0000-0003-3278-3903

Muralev Y.D., PhD, Associate Professor, Head of the Institute for Sustainable Development of Arid Territories of Yessenov University (Aktau, Kazakhstan), *yevgeniy.muralev@yu.edu.kz;* https://orcid.org/0009-0006-6041-6341

Demicheva Y.A., Master of Engineering and Technology, Data Manager of LLP Kazakhstan Agency of Applied Ecology (Aktau, Kazakhstan), *helenka-56@mail.ru;* https://orcid.org/0009-0007-1289-4944

Bukayev Y.Z., Master of Natural Sciences, Researcher at the Institute for Sustainable Development of Arid Territories of Yessenov University (Aktau, Kazakhstan), *eldar_2306@mail.ru;* https://orcid.org/0000-0001-5993-3719

Авторлар туралы мәліметтер:

Тарасенко Г.В., т.ғ.к., Yessenov University «Экология және геология» кафедрасының профессоры (Ақтау қ., Қазақстан)

Муралев Е.Д., т.ғ.к., қауымдастырылған профессор, Yessenov University Құрғақ аумақтарды тұрақты дамыту институтының жетекшісі (Ақтау қ., Қазақстан)

Демичева Е.А., техника және технологиялар магистрі, ЖШС «Қазақстан Қолданбалы Экология Агенттігі» деректер менеджері (Ақтау қ., Қазақстан)

Букаев Е.З., жаратылыстану ғылымдарының магистрі, Yessenov University Құрғақ аумақтарды орнықты дамыту институтының ғылыми қызметкері (Ақтау қ., Қазақстан)

Сведения об авторах:

Тарасенко Г.В., к.г-м.н., профессор кафедры «Экология и геология» Yessenov University (г. Актау, Казахстан)

Муралев Е.Д., к.т.н., ассоциированный профессор, руководитель Института устойчивого развития аридных территорий Yessenov University (г. Актау, Казахстан)

Демичева Е.А., магистр техники и технологий, менеджер данных ТОО «Казахстанское Агентство Прикладной Экологии» (г. Актау, Казахстан)

Букаев Е.З., магистр естественных наук, научный сотрудник Института устойчивого развития аридных территорий Yessenov University (г. Актау, Казахстан)