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Satbayev University

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ИЗВЕСТИЯ

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РЕСПУБЛИКИ КАЗАХСТАН
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Taskinbayev K.M.[1*], Pankratov V.F.[2], Obryadchikov O.S.[1], Nyssanova A.S.[1]

[1]Atyrau Oil and Gas University named after S. Utebayev, Atyrau, Republic of Kazakhstan;
[2]JSC "Geophysical Support Services", Atyrau, Republic of Kazakhstan.
E-mail: taskinbayev6126@tanu.pro

UNCOMMON OIL FIELD AKZHAR VOSTOCHNY: ANOTHER VERSION OF THE STRUCTURE AND OIL AND GAS CONTENT

Abstract: the results of a comprehensive interpretation of 3D seismic and well data within the contract area of LLP "Aman Munai" at the AkzharVostochny field are presented. Based on the results of acoustic logging in wells and on the basis of the performed time-to-depth conversion of seismic data, a model for the distribution of velocity parameters of the subsalt section is constructed, and patterns of changes in the velocity model in the "dome-basin" sections are studied. According to borehole data, correlation of uniform age deposits was performed. The maps of isochron and structural maps of the main subsalt horizons (P1, P1a, P2, P3), maps of the distribution of average reservoir velocities P1a-P2, maps of isochores and thicknesses were constructed. Based on the compiled map of the distribution of the velocity parameter P1a-P2 and the results of field operations, correlation dependencies were found that made it possible to build forecast maps of maximum productivity for the main production horizons of the field. Recommendations are given in the direction of further research aimed at identifying and studying traps of this type, and specific areas for setting up deep exploration and production drilling on the studied territory are indicated.

Key words: seismology, drilling, manufacturing industry, oil source rock, post-salt terrigenous deposits.

Introduction. The Akzhar Vostochny subsalt oil field is located on the eastern edge of the Caspian Depression, to the east of the Akzhar post-salt field discovered back in 1962, confined to the salt dome of the same name. According to administrative organisation, the field is located in the Bayganin district of the Aktobe region of the Republic of Kazakhstan. The subsalt uplift of the Akzhar Vostochny was discovered in 1983 as a result of CDP seismic surveys by the Aktobe geophysical expedition. On the time sections, the area of the supposed subsalt uplift corresponded to the area of development of an extensive post-salt basin, under which an anomalous decrease in the reflection interval of the subsalt horizons P2 and P3 was noted [1-4]. On the basis of the seismic data obtained in 1985, the "Exploratory drilling project in the Akzhar Vostochny area" has been drawn up, according to the project, drilling of the exploratory well 1-AB began, and has been completed in 1988 with a bottomhole of 5200 m. The deposit was discovered in 1989, during cased hole testing of the well 1-AB on the section of 5049-5074 m, an oil flow to surface with a yield of 921.6 m^3/day was obtained.

Over the next years, about three dozen wells were drilled on the site, core material studies, well logging were carried out, 3D seismic studies were conducted, several reserves calculations were performed, however, the field is still at the stage of trial production with unclear prospects for its delineation and unclear distribution of the density of reserves over the area. Stable commercial production rates were obtained only in four wells on a small "patch" near the discovery well. Until now, there is no generally accepted view either on the nature of the genesis of trap reservoirs in the field, or on the search criteria for their identification, in particular, according to seismic data [5-12]. This situation is associated with a number of factors that do not allow a comparative analysis of the geological structure of the Akzhar Vostochny field with other identified and studied deposits within the Caspian basin [13].

These factors, first of all, include the following:

1. Fissured argillites, widely developed in the interbedded strata of terrigenous-carbonate

composition, act as a trap reservoir. After receiving commercial oil flow from them at Akzhar Vostochny, such rocks were called "akzharites" [14]. A distinctive feature of such traps can be considered the fact that clays act as a source rock, and cracks in argillites formed from these clays act as the main oil reservoir.

2. The majority of researchers, and this is confirmed by the results of drilling, recognise the non-structural nature of the traps. It is assumed that deposits of this type can be classified as lithologically screened. At the same time, the limitation criteria can hardly be unambiguously determined, since according to the survey results, the productive ranges were traced over the entire vast territory of the site, differing only in the yields (from units to hundreds of cubic meters per day). At the same time, the yields can significantly increase with the use of special methods of reservoir stimulation (for example, various types of acid treatment).

All this, taken together, explains both the uniqueness and the complexity of the Akzhar Vostochny field, which differs from other well-studied subsalt deposits in the Caspian Depression. For a better understanding of the results of the work performed, it is necessary to turn to some historical aspects of the seismic study of the region. According to their findings, in different parts of the Caspian Depression, characterised by alternation of high-amplitude salt-dome structures and deep synclinal basins, a number of patterns were established in the behaviour of subsalt horizons, including:

– in the areas of dome folding, the quality of seismic subsalt reflections, as a rule, deteriorated significantly compared to the areas of basin development.

– some areas of most deep basins corresponded to areas of sharp positive time anomalies of the horizons P2 and P3 with a corresponding decrease in time thicknesses of P1-P2 and P1-P3.

Since reliable information on the nature of the velocity distribution in the subsalt section at that time was clearly insufficient, such data allowed many geologists and geophysicists to consider the established positive time anomalies of subsalt horizons as evidence of the actual existence of a multitude of positive structures reflecting the block structure of the base. The history of the study of the so-called "Guryev arch" is a striking example of the interest towards such phenomena. With the helping hand of the Saratov geologists and geophysicists (Saratovneftegeofizika group), who conducted extensive seismic surveys in the Atyrau (formerly Guryev) region in the 1970s-1980 s, the presence of an extensive gentle uplift along the P3 horizon was predicted here, complicated, in turn, by many "sub-basin" local uplifts along horizons P2 and P3. To study the prospects of the so-called "Guryev arch", a programme was drawn up for drilling three parametric wells in different sections of the "dome-basin" with a target depth of 7000 m. The drilling was carried out in the late 1980 s. As a result, the subsalt section was opened and studied only in one well, P3, drilled under the conditions of the Akatkol salt dome. The other two wells (P2 under the conditions of the Zharbasskaya basin and P1 under the conditions of the slope of the Botakhan salt dome) were stopped for technical reasons and the subsalt section was not uncovered. In all three wells, vertical seismic profiling (VSP) was performed to study the velocity characteristics of the exposed section. Despite the failure to achieve the set goals by drilling, the obtained data on velocities turned out to be largely unexpected and was of great value for geophysicists, first of all, in solving the problems of converting time imaging into depth imaging. Indeed, in the above-dome well P3 in the sections of exposed subsalt depths of 5995-6455 m, in a predominantly terrigenous section, the interval velocities turned out to be abnormally low for such depths, not exceeding 3400-3800 m/s.

On the other hand, in the Zharbaswell P2, under the conditions of a post-salt basin, in the bottom-hole part, at depths of only 4700-4830 m, the velocity of the exposed post-salt terrigenous sediments (siltstones) reached 5400 m/s. After receiving the VSP findings, already in those years, a number of specialists from the Embaneftegeofizika group, which carried out additional seismic studies in the Guryev arch, suggested that the positive time anomalies observed under the post-salt basins are due to a complex distribution of velocities in the subsalt, in general, subhorizontal section. In particular, when the average speed P1-P3 in the basin is assumed to be about 4800 m/s, the subsalt time anomaly along the P3 horizon is practically levelled, and the horizon in the structural plan becomes subhorizontal within the entire time section. Thus, even in those years, assumptions were made about the existence of special "salt-free windows" within the basin zones, after the formation of which further compaction of rocks took place.

With time, the presence of "salt-free windows" was recognised by most researchers, especially after the scientific substantiation of the theory of the pre-salt genesis of oils from post-salt deposits [15; 2]. But the assumption of the presence of additional compaction in the "sub-basin" zones and, as a consequence, an increase in speeds in such areas, has been successfully forgotten. Until now, when calculating velocity models of subsalt sections in

the "dome-basin" sections, geophysicists use constant reservoir velocities, as a result of which dubious subsalt structures remain during depth conversion, which makes it difficult to objectively assess the prospects of the subsalt section.

The proposed concept of interpretation in the "dome-basin" areas, which focuses on the study of the velocity parameters of the environment, casts doubt on another important tectonic factor that geologists-tectonists use in their conversions – the presence of numerous faults in the structure of subsalt deposits, especially along the line conjugation of the dome and basin. With regard to the proposed method of interpretation, the presence of faults is not disputed, however, their genesis may be associated not so much with deep dislocations of the basement, but with a difference in the reduction of volumes of rocks of different lithological composition at the compaction stage. For example, it is known that argillitic varieties in the process of diagenesis can be significantly reduced in volume compared to carbonate deposits, including being exposed to greater fissuring. At the same time, the presence of thin interbedding of such rocks can lead to an additional increase in fissuring, both subvertical and subhorizontal, complexly distributed in space. Admittedly, the catagenetic transformations that take place can lead to a certain healing of cracks and a change in the filtration-capacitive properties of the host sediments, therefore, the issue of studying the effect of fracturing requires more subtle and combined methods than the standard interpretation of CDP materials.

The discovery of the Akzhar Vostochny field took place in approximately the same historical geological setting in the 1980s. It seems that the presence of positive time anomalies of the P2 subsalt horizons made it possible to substantiate the existence of an extensive positive structure and the need for deep drilling in the area under consideration. But almost every newly drilled well in the field "did not fit" into the predicted structural model of the trap.

Materials and methods. The Akzhar Vostochny field is located in a zone of relatively shallow, in terms of the Caspian Depression, basement depth, the surface of which is traced by seismic exploration at depths of about 7.0 km. It has not been uncovered by drilling. In the contract area, the deepest well, AkzharVostochny 5-AB, has a bottomhole of 5843 m, located in the Devonian sediments. Taking into account the presence of salt-bearing deposits in the section, the entire section of the sedimentary cover is divided into subsalt, salt-bearing and post-salt sections. As a result of drilling operations, it was found that the section of the sedimentary cover in the contract area has at least two differences from the sections of the more eastern parts of the depression.

The subsalt sections along the Carboniferous and Early Permian do not contain well-studied carbonate strata in the eastern part of the depression, but belong to the type of uncompensated and composed mainly of terrigenous deposits (Fig. 1). The sections are characterised by increased carbonate and bituminous content. Such sections of Carboniferous and Early Permian rocks are also known in other regions of the Caspian Depression. They formed immediately behind the zone of carbonate sedimentological scarps and occupy the overwhelming part of the Caspian Depression. After obtaining from them industrial flows of oil and gas, these rocks were called "akzharites" [14; 2]. The main production horizons are confined to the Sakmar-Asselian deposits, within the range of P1a-P2 horizons, where in the lower zone, in the interbedded terrigenous-carbonate strata, highly radioactive (15 μR/h and more) fissured argillites appear. At the same time, the fissuring of such argillite bench is so great that it cannot be studied in laboratory conditions, since the core crumbles into small pieces on the surface.

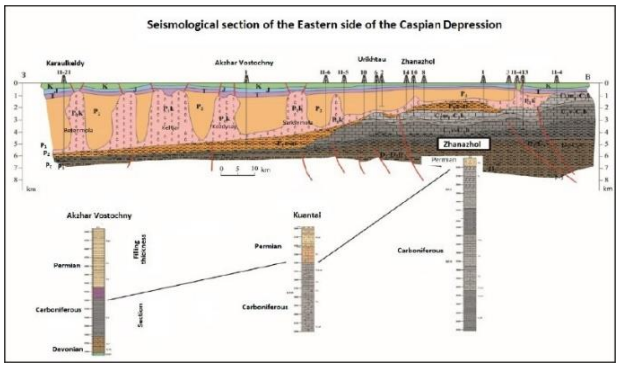

Fig. 1. Principal geological section across the eastern margin of the Caspian Depression

An important feature of the time sections is the sharp changes in time thickness between the subsalt horizons. Sections 3-7 and maps provide a visual representation of such changes. Local changes in temporal thickness, as established by the results of dynamic correlation of well data (acoustic logging), are mainly associated with local changes in average interval velocities between the subsalt horizons. Therefore, the main goal of time-to-depth conversion was to solve the inverse problem: identifying velocity changes in seismic data and comparing it with acoustic logging data, in order to more reliably display such changes in the survey area.

The studies conducted are based, first of all, on the results of physical measurement of the velocities of subsalt deposits by the acoustic sounding log

(ASL) in more than twenty wells, covering the areas of the salt dome and, in fact, the East Akzhar basin. The main goal was to compare the identified velocity patterns with the structural features and changes in the thickness of the coeval sediment complexes. For the purpose of a more detailed display of the structural plan, all surveyed wells were combined into three groups (lines) by the areal characteristics, according to which correlation schemes were drawn up with the identification of coeval complexes. In the process, the following boundaries were established, correlated and applied in the calculations of velocity characteristics:

VI – the surface of the Kungurian salt deposits.

VII – the surface of the Filippovian deposits in the lower part of the salt-bearing section. It is quite confidently distinguished by the features of the seismic record only in the areas of basin development, where it coincides with the position of VI horizon. This section (according to the regional studies) is represented by sulphate-carbonate-terrigenous sediments overlying the Upper Paleozoic subsalt sediments. Unfortunately, on the available logging materials, deposits of the Filippovian horizon are represented only in few wells.

P1 – surface of subsalt deposits. The horizon is traced as the first negative phase of the uppermost reflection in a train of consonant subsalt reflections. On the log data, the P1 boundary is displayed by a sharp negative jump in acoustic stiffness associated with a sharp transition from anhydrites or limestones to predominantly terrigenous Artinskian deposits.

P1a – the boundary closest to P1 in the upper part of the subsalt section, identified at the stage of drawing up correlation schemes. In the wave field, it corresponds to the negative phase of a dynamically expressed two-three-phase pulse. According to the accepted regional classification, the Artinskian age of the border is assumed. According to the geophysical characteristic, the boundary is associated with a sharp negative jump in the acoustic stiffness, as evidenced by the curves of ASL and NGR, as well as with an increase in the GR values.

VIIIp – the base of the highly radioactive argillite bench VIII, the higher level of the most production horizons. According to the classification of the 2016 reserve estimate report, the surface belongs to the roofing part of the P1a-I stratum. The boundary is associated with the transition from the highly radioactive bench to the carbonate-terrigenous section that composes the VIIIp-P2 stratum, which is also the most productive. On well logging materials, the boundary is distinguished, first of all, by a sharp increase in the acoustic stiffness parameter.

P2 – the surface of the Lower Carboniferous deposits. It is rather confidently distinguished as the second dynamically expressed negative phase of the interference three-phase reflection in the middle section of the subsalt reflections. On well logs, the boundary is distinguished by a sharp negative jump in acoustic stiffness.

P3 – presumably the surface of pre-Middle Devonian sediments. The horizon is tied according to the results of drilling well 5 and traced by the upper positive phase of the lowest powerful subsalt two-phase reflection.

Results of dynamic correlation, time-to-depth conversion, and structural imaging. Based on the dynamic correlation carried out in accordance to the ASL data, it was established:

– there is a significant difference in velocity parameters for wells drilled in the Akzhar salt dome (wells 6, 11), and wells drilled in the Eastern basin. If, for example, the average reservoir velocities P1a-P2 in wells 6 and 11 are 3446 and 3413 m/s, then in the basin they are much higher, varying from 3721 (well 12) to 4471 m/s (well 9).

– within the East Akzhar basin, the highest values of the P1a-P2 velocity are confined to the areas ofthe supposed “salt-free windows”. There are four such areas in total. The first area corresponds to the location of the most productive wells (206, 205, 208, 200), where the average reservoir velocities reach 4352 m/s (well 208). The second, southern area is Kursaysky, where the speeds are also high and amount to 4353 m/s (well 1). The third area is near the wells 203 and 2, where the velocities (according to the data of acoustic logging in well 2) are 4252 m/s.

There is one more underexplored area along the eastern boundary (area of drilling of well 9), where the velocities are the highest (4471 m/s).Based on the results of time-to-depth conversions and structural imaging, the following has been established:

– structural plans of the subsalt horizons are basically represented by monoclines with superimposed discordant basins at the level of the upper subsalt horizons P1 and P1a;

– the surface of the P3 boundary with a certain (small) error can be approximated by a pitching monocline of the south-eastern dip with depths of 5400-5600m;

– the surface of the pre-salt horizon P2, in general, is a monocline rising in the east-southeast direction, from elevations -5100m to -4850m. At the level just above the P2 horizon, the attenuation of the tectonic disturbance, which complicates the surface of the P3 horizon, is assumed;

– the surface of the P1a subsalt horizon is more dislocated. Against the background of regional uplift from elevations -4470 m to -4250 m in the east-southeast direction, there are areas of local subsidence, corresponding to the areas of "salt-free windows" and formed, apparently, as a result of bulging-in due to additional compaction of the subsalt area. The amplitude of the formed synclinal structure at the drilling site of the Akzhar Vostochny well 1, is about 100 m, at the drilling site of the Kursaysky well 1about 60 m;

– the surface of the P1 subsalt horizon repeats the features of the P1a horizon.

The amplitudes of local synclinal structures increase, up to 130 m in the drilling area of well 208 and up to 100 m in the Kursaysky area.

Zoning of the research area according to the parameter of the predicted maximum productivity of subsalt horizons. The map of the distribution of the average layer velocity between the horizons P1a and P2 obtained from the temporal and deep plotting reflects the velocity changes established from the acoustic logging in the wells of the East Akzhar basin.

The highest velocities here are associated with a localised isometric section within the drilling outline of wells 1, 205, 206, 208, where the maximum values reach 4370 m/s. This outline, in fact, defines the modern boundaries of the Akzhar Vostochny field. The second, following the velocity parameter, distinguishes an area of well 9 drilling. At the same time, this area, being on the border of seismic data, should be considered insufficiently studied, therefore, it requires additional seismic study. The next section, where the velocities reach 4250 m/s, is the southern, Kursaysky area, which has a more complex, than isometric, areal configuration of its distribution. The fourth area is located in the section within the drilling outline of wells 203, 2, 101. Here the maximum speeds reach values of 4050-4120 m/s.

The most important result of velocity model building is the identification of a vast zone of distribution of the "salt-free window" within the Akzhar Zapadny basin. The zone of high velocities (up to 4800 m/s) highlighted here has a submeridional distribution with a length of about 15 km with four local areas of extreme values and, undoubtedly, is of particular interest for further study. The calculated velocity characteristic of the average reservoir velocity P1a-P2 for the East Akzhar basin, in the first approximation, through mathematical relations, displays the link between the velocity and the maximum flow rates of the wells, which, in turn, may have a direct relationship with the fracture intensity of the subsalt section. The simplest, linear form of such a relationship is noted for the Sakmara production horizon P1s, tested, first of all, in old wells dating back to the Soviet period of study. Analysis of the flow rates obtained in wells during testing of the P1s horizon, in comparison with the P1a-P2 velocity map, makes it possible to establish the sizes of the areas where, according to the findings, any significant inflows of hydrocarbons were obtained or can be obtained. These areas can be limited by the velocity isoline with a value of 3900 m/s. Simple mathematical analysis makes it possible to relate oil yields to rates according to the formula of linear dependence (Eq. 1):

$$Pr= (V-3900)/6 \quad (1)$$

where: Pr – predicted maximum productivity of the Sakmara production horizon R1s, m^3/day; V – the value of the average reservoir velocity between the horizons P1a-P2, m/s.

According to the map of estimated maximum productivity, the most significant deviation is observed for well 9, where the maximum oil yield during testing was 2 m^3/day with a predicted value of 55 m^3/day (on the presented maps, actual yields in wells are rounded to units).

The analysis of the distribution of maximum yields for the most productive horizons R1a-I and R1a-II shows an increase in the area of productivity, limited by the 3800 m/s velocity contour, and a much more complex nature of the relationship. To estimate the maximum productivity, in the first approximation, a quadratic dependence was chosen according to (Eq. 2):

$$Pr=((V-3800)/20)^2 \quad (2)$$

There is a relationship between the position of the areas of "salt-free windows" and areas of decreasing temporal thickness between horizons VII and P1. This may indicate the ability of the Filippovian deposits to increase the insulating properties and complicate the process of compaction of the subsalt deposits.

The estimated maximum production rates shown on the map have not been confirmed, mainly in well 9, where the maximum production rate of 0.5 m^3/day was obtained during joint testing of the R1a-I and R1a-II horizons with an estimated value of 500 m^3/day. This fact requires additional study of the drilling site for this well, which is located on the eastern boundary of the conditioned seismic data. There is also a significant excess of real production rates over the predicted ones in the Akzhar Vostochny well 1, where the maximum yield is 1440 with the predicted value of 100 m^3/day. However, the test table for this well also provides data on lower production rates in this well under

other test modes, starting from 630 m^3/day and up to 1440 m^3/day.

The analysis of dependences of the maximum yields on the average velocity characteristic allows to assume that finely dispersed highly radioactive argillites, alternating with carbonaceous deposits, which compose part of the productive horizons R1a-I and Ra1-II, and which are not present in the depth interval of the productive horizon P1s, have the maximum ability to fissure. Despite the existing deviations of actual flow rates from the estimated ones, the constructed forecast maps reliably reflect changes in productivity, which makes possible to perform zoning of the East Akzhar basin in the most promising areas and recommend additional study.

It seems that the findings will initiate a revitalisation of the discussion in geological circles on the formation and travel of oil in relation to the Caspian basin, which may lead to the discovery of new oil and gas deposits in the region, similar to the Akzhar Vostochny field. According to one of the authors of the paper, the findings suggest other, possibly no less promising, areas of geological exploration in the conditions of the salt-dome tectonics of the Caspian Basin. In particular, this is indicated by the discovery of oil deposits in the Upper Permian red-coloured sandstones occurring at more accessible depths. It seems expedient to study in more detail the structure of post-salt deposits, where salt-dome tectonics create many favourable structural forms. For example, the formation of an oil reservoir in the Karatyube Yuzhnoye area can be considered a result of the over flow from the oil accumulation in the VIII Akzhar Vostochny reservoir (or similar) along the vertical fracture system.

Prospects of the search for new deposits of the Akzhar V. type are predicted in the east of the Caspian Depression and in its other regions on the slopes of carboniferous platforms and massives [13; 18]. The stratigraphic confinement of productive strata of the Akzhar V. field requires further clarification. Possibly, they are deep-sea analogues of the KT-I and KT-II carbonaceous complexes located to the east, as well as the inter-carbonaceous terrigenous strata separating them.

Conclusions. Based on the results of the studies carried out, recommendations were developed for setting up exploratory drilling in the contract area. Undoubtedly, the most promising area for solving the problem of increasing the production capacity is the production area of the Akzhar Vostochny field. Here, in the area of maximum estimated productivity, it is recommended to drill a production well R-1 to an absolute depth of -5100 m with the penetration of all productive horizons in this area. It is also proposed to conduct exploratory drilling in the southern, Kursaysky area (well R-2) with a depth of -5100 m in the area between the wells Kur-1 and 211, where it is also expected to obtain yields of production scale.

It is recommended to lay exploratory well R-3 at the Western basin within one of four extrema of the calculated reservoir velocities. The hole target (-5600m) will allow to penetrate the sediments below the P3 horizon and examine the entire subsalt section up to this boundary in order to establish the scale of oil and gas content in this completely new area. The well is located in close proximity to well 302, which was recommended for drilling according to the reported data. It is also recommended to conduct an additional seismic study on the available materials to the east and south of the current study area, where there may be promising objects similar to those studied, for example, the drilling site of well 9.

The main geological result of the study can be considered the conclusion that subsalt sediments of the same composition and properties, passing through different stages of diagenesis in the “dome-basin” sections (undergoing additional compaction under the conditions of the “salt-free window”), can significantly change their physical properties with the formation of a fissured reservoir, which allows a new look at the prospects of non-anticlinal traps in the subsalt terrigenous section on the scale of the entire Caspian oil and gas basin. Indeed, under the conditions of the developed salt-dome tectonics of the Caspian Depression, hundreds of salt domes and basin zones associated with them have been identified, which include areas with weakened screening properties – “salt-free windows”. This a priori assumes the presence of many objects with improved reservoir properties, primarily due to an increase in the fissuring of subsalt deposits in such areas.

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Таскинбаев К.М.[1*], Панкратов В.Ф.[2], Обрядчиков О.С.[1], Нысанова А.С.[1]

[1]Өтебаев атындағы Атырау мұнай және газ университеті, Атырау, Қазақстан;
[2]ТОО "Геофизикал Саппорт Сервисез", Атырау, Казахстан.
E-mail: taskinbayev6126@tanu.pro

АҚЖАР ШЫҒЫС КЕН ОРНЫ: ҚҰРЫЛЫМЫ МЕН МҰНАЙ-ГАЗДЫЛЫҒЫНЫҢ ТАҒЫ БІР НҰСҚАСЫ

Аннотация: Ақжар Шығыс кен орнындағы «Аман Мұнай» ЖШС келісімшарттық аумағы шегінде сейсмикалық 3Д және ұңғымалық деректерді кешенді қайта түсіндіру нәтижелері ұсынылған. Ұңғымалардағы акустикалық каротаж нәтижелері бойынша және сейсмикалық деректердің уақытша-тереңдік өзгерістері негізінде тұз астындағы тіліктің жылдамдық параметрлерін бөлу моделі құрылды, "күмбез-мульда" учаскелеріндегі жылдамдық моделінің өзгеру заңдылықтары зерттелді. Ұңғымалық деректер бойынша шөгінділердің бір жастағы қалыңдығының корреляциясы орындалды. Изохрон карталары және негізгі тұзасты горизонттар бойынша құрылымдық карталар (П1, П1а, П2, П3), П1а-П2 орташа қабатты жылдамдықтарды бөлу карталары, изохор және қалыңдық карталары салынды. П1а-П2 жылдамдық параметрін бөлудің жасалған картасы және кәсіпшілік жұмыстардың нәтижелері негізінде корреляциялық тәуелділіктер табылды, бұл кен орнының негізгі өнімді горизонттары бойынша максималды өнімділіктің болжамды карталарын жасауға мүмкіндік берді. Осы түрдегі тұзақтарды анықтауға және зерттеуге бағытталған әрі қарайғы зерттеулер бағыты бойынша ұсыныстар берілді, сондай-ақ жүргізілген зерттеулер аумағында терең барлау-іздестіру және пайдалану бұрғылауын қою үшін нақты учаскелер көрсетілген.

Түйін сөздер: сейсмология, бұрғылау, өнеркәсіптік индустрия, мұнай материалы, тұз үстіндегі терригендік шөгінділер.

Таскинбаев К.М.[1*], Панкратов В.Ф.[2], Обрядчиков О.С.[1], Нысанова А.С.[1]

[1]Атырауский университет нефти и газа имени С. Утебаева, Атырау, Казахстан;
[2]ТОО "Геофизикал Саппорт Сервисез", Атырау, Казахстан.
E-mail: taskinbayev6126@tanu.pro

НЕОБЫЧНОЕ МЕСТОРОЖДЕНИЕ АКЖАР ВОСТОЧНЫЙ: ЕЩЁ ОДНА ВЕРСИЯ СТРОЕНИЯ И НЕФТЕГАЗОНОСНОСТИ

Аннотация: представлены результаты комплексной переинтерпретации сейсмических 3Д и скважинных данных в пределах контрактной территории ТОО «Аман Мунай» на месторождении Акжар Восточный. По результатам акустического каротажа в скважинах и на основе выполненных временно-глубинных преобразований сейсмических данных построена модель распределения скоростных параметров подсолевого разреза, изучены закономерности изменений скоростной модели на участках «купол-мульда». По скважинным данным выполнена корреляция одновозрастных толщ отложений. Построены карты изохрон и структурные карты по основным подсолевым горизонтам (П1, П1а, П2, П3), карты распределения среднепластовых скоростей П1а-П2, карты изохор и толщин. На основании составленной карты распределения скоростного параметра П1а-П2 и результатов промысловых работ найдены корреляционные зависимости, позволившие построить прогнозные карты максимальной продуктивности по основным продуктивным горизонтам месторождения. Даны рекомендации по направлению дальнейших исследований, направленных на выявление и изучение ловушек подобного типа, а также указаны конкретные участки для постановки глубокого разведочно-поискового и эксплуатационного бурения на территории проведенных исследований.

Ключевые слова: сейсмология, бурение, промышленная индустрия, нефтематеринская порода, надсолевые терригенные отложения.

Information about authors:

Kossan M. Taskinbayev – PhD in Geology,Oil and Gas Faculty,Atyrau Oil and Gas University named after S. Utebayev, Atyrau, Republic of Kazakhstan; taskinbayev6126@tanu.pro*;* https://orcid.org/0000-0002-6475-6486;

Vladimir F. Pankratov – Project Manager, JSC "Geophysical Support Services", Atyrau, Republic of Kazakhstan; vlad1950@nuos.pro; https://orcid.org/0000-0001-6526-4320;

Oleg S. Obryadchikov – PhD in Geology, Leading Scientific Cooperator, Oil and Gas Faculty, Atyrau Oil and Gas University named after S. Utebayev, Atyrau, Republic of Kazakhstan; *osobr19@ust-hk.com*. cn;https://orcid.org/0000-0002-8999-400X;

Aigul S. Nyssanova – Senior Scientific Cooperator, Oil and Gas Faculty, Atyrau Oil and Gas University named after S. Utebayev, Atyrau, Republic of Kazakhstan; aigul_nsanova@tanu.pro*;* https://orcid.org/0000-0001-6074-3963.

REFERENCES

[1] Oreshkin I.V., Postnova E.V., Shestakova T.D. (1991). Conditions for the formation of hydrocarbon deposits and a local forecast of oil and gas content of subsalt deposits in the eastern part of the Caspian basin. Volga and Pricaspian Region Resources, 1, 33-39.

[2] Obryadchikov O.S., Taskinbaev K.M. (2012). South and North Emba: the main features of the structure, oil and gas content and prospects for oil and gas exploration. In: Caspian Basin: Actual Problems of Geology and Oil and Gas Potential, volume 1, (pp. 153-163). Atyrau: ObshchestvoNeftyanikov-GeologovKazakhstana.

[3] Shestoperova L.V., Yergaliev B., Seytkalieva G. (2012). Oil source deposits in the subsalt complex of the Caspian basin. In: Caspian Basin: Actual Problems of Geology and Oil and Gas Potential, volume 1 (pp. 117-122). Atyrau: ObshchestvoNeftyanikov-GeologovKazakhstana.

[4] Konyukhov A.I., Baimagambetov B.K., Kan A.I. (2006). Eastern side zone of the Pre-Caspian depression: sedimentary complexes and sedimentation environments of the Early-Middle Carboniferous time. Lithology and Mineral Resources, 41(6), 530-546. https://doi.org/10.1134/S0024490206060034.

[5] Kan V.P., Baimagambetov B.K., Lee V.Ch. (2008). Deep geological structure of the Western Primugodzharye according to the results of seismic studies of CDP. Earth Sciences in Kazakhstan, 12, 59-65.

[6] Krylov N.A., Aksenov A.A., Avrov V.P. (1992). Forecast of oil and gas content of the subsalt Paleozoic in the east and southeast of the Caspian Sea. Moscow: Nauka.

[7] Obryadchikov O.S., Liu Z.H., Zheng K., Han X. (2013). Features of the geological structure and history of the formation of the structure of subsalt sediments in the east of the Caspian basin. In: "Fundamental basis of innovative technologies for prospecting, exploration and development of oil and gas fields and priority directions of development of the resource base of the Russian fuel and energy complex" (pp. 86-87). Moscow: Gubkin University.

[8] Zholtaev G.Zh., Bulekbaev Z.E. (1975). Tectonics and oil and gas content of the side zones of the Caspian syneclise. Almaty: Kazakhstan.

[9] Zamarenov A.K. (1970). Middle and Upper Paleozoic of the eastern and southeastern framing of the Caspian Basin. Leningrad: Nedra.

[10] Savvin V.A. (1995). Features of identifying effective thicknesses and ways to optimize core information for productive carbonate reservoirs. Volga and Pricaspian Region Resources, 9, 20-26.

[11] Postnova E.V. (1992). Geofluidodynamic aspect of oil and gas content of subsalt sediments in the eastern regions of the Caspian basin. Volga and Pricaspian Region Resources, 3, 21-25.

[12] Zamarenov A.K. (1995). Tectonic nature of the Aktobe Ural region, the main features of its structure and oil and gas potential. Volga and Pricaspian Region Resources, 25, 15-20.

[13] Zholtaev G.Zh., Kulumbetova G.E. (2019). Characteristics of carbonate and terrigenous subsalt sediments in the east of the Caspian depression. Volga and Pricaspian Region Resources, 98, 65-77. https://doi.org/10.24411/1997-8316-2019-19805.

[14] Sherman G.Kh., Slukin A.V., Nikishov V.V. (1993). "Akzharit" – A new type of reservoirs forming oil and gas reservoirs in the Caspian Sea region? Volga and Pricaspian Region Resources, 5, 27-35.

[15] Taskinbaev K.M. (2011). Post-salt oil from the south of the Caspian region: how much is it and where is it from? (New life of an old idea). Oil and Gas, 4, 19-27.

[16] Yatskevich S.V. (1993). Lithological and stratigraphic characteristics of the rocks of the productive strata of the East Akzhar area and the conditions of sedimentation. Volga and Pricaspian Region Resources, 5, 35-40.

[17] Obryadchikov O.S., Taskinbayev K.M. (2019). Oil-bearing capacity of the great depths of the east of the Caspian depression and the conditions for the formation of oil and gas accumulations. Journal of Computational and Theoretical Nanoscience, 16, 1–11. https://doi.org/10.1166/jctn.2019.8342.

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