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Satbayev University

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CHARACTERISTICS OF THE STRUCTURAL UPLIFTS OF KURGANBAI AND BAYRAM-KYZYLADYR LOCATED WITHIN THE ZHAZGURLI DEPRESSION

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Abstract. In this article, the authors have done statistics on the parameters of 3D seismic field work using new methods of attribute analysis to extract structural features. Tectonically, the studied area is confined to the central part of the South Mangyshlak trough. The structures under consideration are Kurganbai and Bayram-Kyzyladyr, located within the Zhazgurli depression and the Great Mangyshlak flexure. Within the framework of the Kurganbai and Bayram - Kyzyladyr structures, previous 2D seismic surveys were mapped. The authors revised the geological structure of the area on the basis of 3D volumetric seismic survey materials, which allowed to obtain new data on the structure of the main structures. The main purpose of the authors works is to describe the structure of Kurganbai and Bayram-Kyzyladyr and to predict local objects promising for the search for oil and gas deposits. The authors present the current understanding of the geological structure of the sites under consideration, which is based on the materials of detailed 3D seismic surveys and drilling data. The raising of Kurganbai complicates the northeastern part of the Bayram - Kurganbai shaft, along the reflecting horizons V3 and V2II has a block structure. The Bayram – Kyzyladyr uplift along the V3 reflecting horizon is a brachianticlinal fold, which is divided by a series of tectonic disturbances into a number of blocks gradually sinking in a southeasterly direction. The uplift mainly consists of three half-arches adjacent to the transverse discontinuous faults.

Keywords: structure, middle triassic, uplift, seismic, vault, 3D seismic

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ЖАЗҒҰРЛЫ ОЙПАТЫ ШЕГІНДЕ ОРНАЛАСҚАН КУРГАНБАЙ ЖӘНЕ БАЙРАМ-КЫЗЫЛАДЫР ҚҰРЫЛЫМДЫҚ КӨТЕРІЛІМДЕРІНІҢ СИПАТТАМАСЫ

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Аннотация Бұл мақалада авторлар құрылымдық ерекшеліктерді алу үшін атрибутивті талдаудың жаңа әдістерін қолдана отырып, 3Д далалық сейсмикалық барлау параметрлері туралы статистиканы жинады. Тектоникалық зерттелген аудан Оңтүстік Маңғышлақ иілісінің орталық бөлігімен шектеседі. Қарастырылып отырған құрылымдар Жазғырлы ойпаты мен үлкен Маңғышлақ ойпаты шегінде орналасқан Қорғанбай мен Байрам-Қызыл-Адыр болып табылады. Қорғанбай мен Байрам-Қызыладыр құрылымдары аясында 2Д сейсмикалық барлау жұмыстары картаға түсірілді. Авторлар 3Д көлемді сейсмикалық барлау материалдары негізінде ауданның геологиялық құрылымын қайта қарады, бұл негізгі құрылымдардың құрылымы туралы жаңа мәліметтер алуға мүмкіндік берді. Авторлар жұмысының негізгі мақсаты Қорғанбай мен Байрам-Қызыладыр құрылысын сипаттау және мұнай мен газ кен орындарын іздеу үшін перспективалы жергілікті объектілерді болжау болып табылады. Авторлар 3Д егжей-тегжейлі сейсмикалық барлау жұмыстары мен бұрғылау деректерінің материалдарына негізделген қарастырылып отырған учаскелердің геологиялық құрылымы туралы заманауи түсінік береді. Қорғанбайдың көтерілуі блоктық құрылымы бар v3 және V2II шағылысатын көкжиектер бойындағы Байрам-Қорғанбай білігінің солтүстік-шығыс бөлігін қиындатады. V3 шағылысатын горизонт бойымен Байрам-Қызыладыр көтерілісі брахиантиклинальды қатпар болып табылады, ол бірқатар

тектоникалық бұзылулармен оңтүстік-шығыс бағытта біртіндеп төмендейтін блоктарға бөлінеді. Көтеру негізінен көлденең жарылғыш ақауларға іргелес үш жартылай доғадан тұрады.

Түйін сөздер: құрылым, орта триас, көтеру, сейсмика, қойма, 3Д сейсмикалық барлау

Қаржыландыру: Бұл зерттеуді Қазақстан Республикасы Ғылым және жоғары білім министрлігінің Ғылым комитеті қаржылай қолдады. (Грант № AP15473398) - Жазғұрлы ойпатындағы өнімді горизонттардың геологиялық құрылымын егжей-тегжейлі зерттеу және мұнай-газ перспективаларын іздеу.

Мүдделер қақтығысы: Авторлар осы мақалада мүдделер қақтығысы жоқ деп мәлімдемейді.

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ХАРАКТЕРИСТИКИ СТРУКТУРНЫХ ПОДНЯТИЙ КУРГАНБАЙ И БАЙРАМ-КЫЗЫЛАДЫР, РАСПОЛОЖЕННЫХ В ПРЕДЕЛАХ ЖАЗГУРЛИНСКОЙ ДЕПРЕССИИ

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Аннотация В данной статье авторами дана статистика параметров полевых сейсмических работ 3Д с применением новых методов атрибутного анализа для извлечения структурных особенностей. В тектоническом отношении исследуемый район приурочен к центральной части Южно-Мангышлакского прогиба. Рассматриваемые структуры Курганбай и Байрам-Кызыладыр, располагаются в пределах Жазгурлинской депрессии и Большой Мангышлакской флексуры. В пределах структуры Курганбай и Байрам-Кызыладыр были закартированы предыдущими сейсморазведочными работами 2Д. Авторами было пересмотрено геологическое строение площади на основании материалов объемной сейсморазведки 3Д, которые позволили получить новые данные, такие как о строении основных структур. Основной целью работ авторов является описание структуры Курганбай и Байрам-Кызыладыр и прогнозирование локальных объектов, перспективных для поиска залежей нефти и газа. Авторами представлено текущее представления о геологическом строении рассматриваемых

участков, которое базируется на материалах детальных сейсморазведочных работ МОГТ 3Д и данных бурения. Поднятие Курганбай осложняет северо-восточную часть Байрам-Курганбайского вала, по отражающим горизонтам V3 и V2II имеет блоковое строение. Поднятие Байрам-Кызыладыр по V3 отражающему горизонту представляет собой брахиантиклинальную складку, которая разбита серией тектонических нарушений на ряд блоков, ступенчато погружающихся в юго-восточном направлении. Поднятие в основном состоит из трех полусводов примыкающей к поперечным разрывным нарушениям.

Ключевые слова: структура, средний триас, поднятие, сейсморазведка, свод, сейсморазведка 3D

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Introduction

The area under consideration is tectonically confined to the central part of the South Mangyshlak trough and is located in the zone of articulation of various tectonic elements of the II order, as indicated in my previous work by Merekeeva E.K. and Kozhakhmet K.A. (Merekeyeva et al., 2023). In the northwest it borders with the Karagiinsky saddle, in the south — with the Aksu-Kendyrlinsky step, in the east with the Karynzharyk saddle, from the northwest to the northeast with the Zhetybai-Uzen and Kokumbai steps, in the southwest - with the Peschanomyssko-Shell zone.

On the Southern Mangyshlak (Krupin et al., 2012), three extended geoblocks are distinguished along the surface of the foundation: North-Mangyshlak, South-Mangyshlak and Karabogaz, having a west-northwest orientation. The Zhazgurli depression occupies the entire eastern part of the Southern — Mangyshlak geoblock and is one of the most important promising oil and gas-bearing areas of the eastern side of the Middle Caspian Depression (Hibasov, 2013).

The Zhazgurlinsky depression and the Large Mangyshlak flexure occupy the entire eastern part of the Southern — Mangyshlak geoblock, in the center of which the roof of the foundation is submerged up to 9.5 km. In the north-western part of the Zhazgurli depression, the Bayram mulda is isolated by an isohypse of -6500 m. The field work was carried out by Azimut Energy Services JSC in accordance with the geological and technical task, 3D seismic survey work was carried out (Zakrevsky et al., 2016).

Research materials and methods

Deep (Jun Qu et al., 2023) exploration wells have been drilled on the work area in different years (Wang H et al., 2023): Bayram-Kyzyladyr well 1, 2, 3, 10, 11 and Kurganbai 1, 3, 4, 6, 7.

The raising of Kurganbai complicates the northeastern part of the Bayram-Kurganbai shaft, along the reflecting horizons V3 and V2II has a block structure.

Along the reflecting horizon V3, this structure is a large brachianticlinal fold of the sublatitudinal strike complicated by a number of tectonic disturbances. By resetting the latitudinal orientation, the main area of the structure is divided into two extensive blocks. The southern, elevated block is divided by faults into four arches, of which two eastern ones are lowered, and the south-western and north-eastern ones are raised. The largest western arch in the contour of the isogypse — 5250 m has a size of 4.8 * 2.5 km, an amplitude of 60 m. The dimensions of the southern block with all small arches are 7.8 * 1.6 km.

The northern block has the shape of a semicircle, enclosed between the above discharge and the isohypse -5380m, bordering the rise from the north. Two arches are localized within the block, the dimensions of the western half-arch along the isohypse -3580m are 3.2 * 1.3 km, the amplitude is more than 20m, the eastern arch along the same isohypse has dimensions of 3.2 * 1.6km, the amplitude is 30 m.

Along the southern wing of the Kurganbai structure, an extended tectonic disturbance is confidently recorded, the origin of which is associated with the process of horizontal shift (Figure 1).

According to the V2–2 reflecting horizon, the Kurganbai uplift preserves the structural plan V3 of the reflecting horizon with all tectonic disturbances and structural features. The western arch in the southern raised block within the isohypse minus 5080 m is characterized by dimensions of 4.3 * 4.0 km, an amplitude of 100 m. The central block of isohypseminus-4980 m has a size of 2.2x1.5 km, an amplitude of 30 m. The eastern arch is closed with one isohypse complicated by a fault. The minimum absolute mark in its arches is minus 5000 m. The lifting contour is limited by an isohypse -5010 m. To the north of the main arch, there is also a zone of increased occurrence with two arches, along the isohypse minus 5130 m, characterized by dimensions of 5.0 * 1.8 km and an amplitude of 50 m. The total area of the Kurganbai structure along the reflecting horizon V2-2 is more than 30 sq km (Figure 2).

According to V2 (the sole of the Upper Triassic sediments), the reflecting horizon of the Kurganbai uplift, in comparison with the structural plan of the lower-Middle Triassic horizons, shifts in the north-easterly direction up to 2.5 km. The structure is elongated in a north-westerly direction, the arch is complicated with two peaks. Along the closing isohypse - 4740 m, the dimensions of the structure are 11 * 3.6 km, the amplitude is -110 m. In the southwestern part of the structure, a small vault with dimensions, along a closed isohypse - 4720m, 1.25 * 0.8 km, with an amplitude of more than 20 m is isolated.

According to the V reflecting horizon, the Kurganbai uplift has two arches differently oriented, the western arch, bounded by the isohypse - 4290m retains a latitudinal orientation, the eastern arch is elongated in the northern direction and is also outlined by the isohypse -4340 m. along the closing isohypse -4340 m have dimensions of 9.0 * 3.3 km, an amplitude of 75 m. Compared with the lower horizons, tectonic disturbance is recorded here with less intensity (Figure 3).

According to the reflecting horizons J2b, J2bt, J2k, III, there is a coincidence of structural plans, but the size of the upward elevation along the section increases slightly.

The arches, in comparison with the structural plan of the Middle Triassic horizons, also shifts eastward to 2.5–3.0 km. The regional structure of the Jurassic section preserves all the most characteristic features of the underlying Upper Triassic sediments, smoothing the morphology of structural elements and further expanding the area of the structure. The degree of activity of the tectonic regime in the Jurassic epoch is significantly reduced in comparison with the Triassic (Yang et al., 2019), for this reason, no disjunctive disturbances were detected on the intra-Jurassic surfaces.

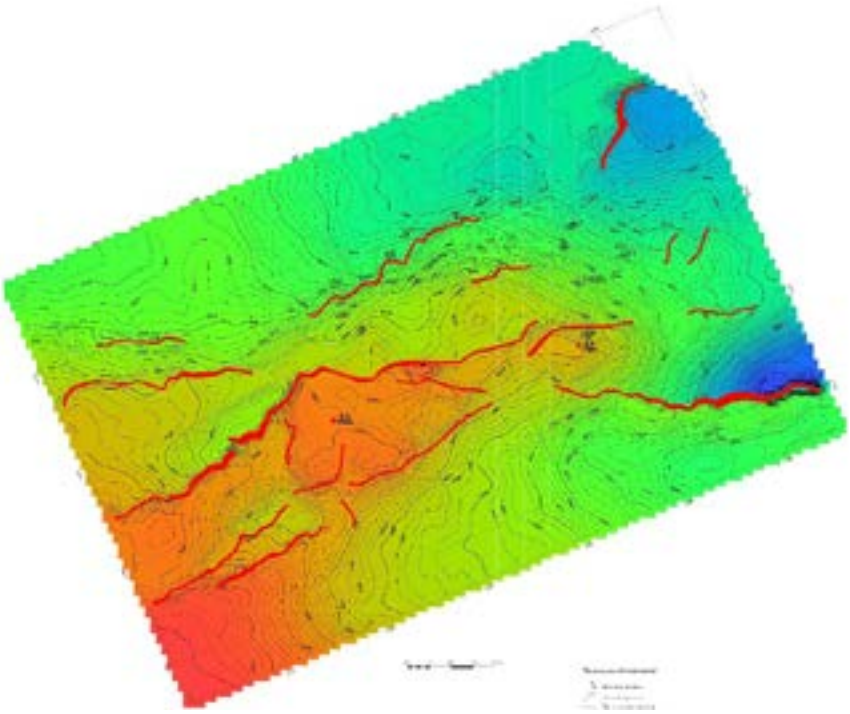

Fig. 1 – Kurganbai. Structural map of the reflecting horizon III.

By J2b, reflecting horizon (bayos sole) the vault is complicated with two vertices, along a closed isohypse of 3775 m has dimensions of 9.4 * 3.5 km, an amplitude of 75 m.

According to J2bt, the reflecting horizon along the outlining isogypse is -3375 m, the dimensions are 10 * 3.9 km, the amplitude is 85 m.

According to the J2k reflecting horizon, it has a clearly defined two-domed structure, separated with a slight deflection. For the first time, an additional low-amplitude elevation in the west of the main arch is recorded on the structural map along this horizon, which was not previously mapped according to 2D seismic survey data. The eastern, main arch along the closed isogypse of 3035 m has dimensions of 11.7 * 4.1 km, an amplitude of 90 m, the second, western arch along the circumference of the isogypse of 3010m has dimensions of 3.0 * 2.0 km, an amplitude of more than 10 m.

Along the III reflecting horizon, the Kurganbai uplift in the plan shifts even more

to the east, along a closed isohypse of 2510 m has dimensions of 10.3 * 3.0 km, an amplitude of 45 m.

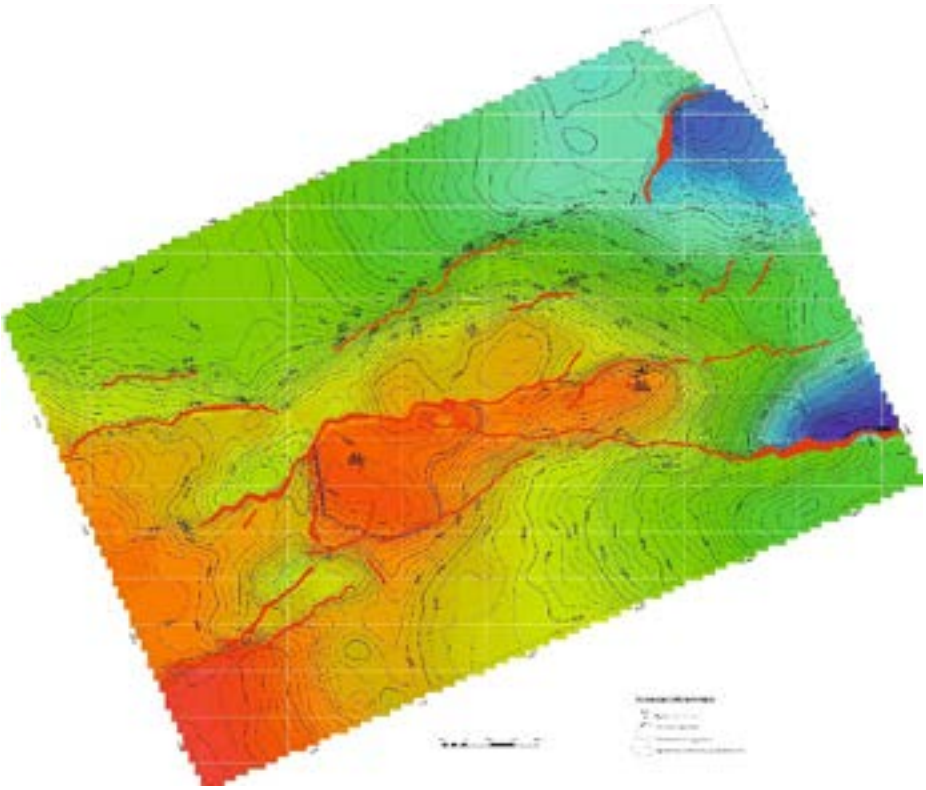

Fig. 2 - Kurganbai. Structural map of the reflecting horizon V2II. (the roof of carbonate deposits of the Middle Triassic)

Thus, it can be confidently stated that the structural plans of the Upper Triassic and Jurassic horizons coincide, and the arches of the Middle-Lower Triassic horizons are shifted to the west relative to the arches of the overlying horizons by 2.5–3.0 km.

Five wells have been drilled on Kurganbai Square (1, 3, 4, 6, 7).

Well 1 with a design depth of 4700 m, having opened the Bath deposits, was stopped by drilling at a depth of 3300 m due to a strong gas occurrence. The formation tests were not conducted during the drilling process. As a result of testing in a column from the deposits of Bath and Calloway, weak gas inflows and insignificant oil inflows were obtained. In well 3, the entire Middle Jurassic strata has been opened up to a depth of 4200 m. As a result of testing in a column from the deposits of Kimerridge and aalen, weak gas inflows were obtained. Well 4 also uncovered the entire Middle Jurassic strata with a depth of up to 4200 m. As a result of testing in the column, a weak inflow of gas and water was obtained from the aalen deposits, and an influx of oil was obtained from the Kimeridge deposits. In well 6, sediments of the bayos were uncovered to a depth of 3590 m. A weak inflow of filtrate with dissolved gas was obtained during the formation

testing in the Kelloway-Bath sediments. As a result of testing, a weak gas release was noted in the column from the bath deposits, and a weak oil inflow was obtained from the Kimeridge deposits. In well 7, deposits of aalen were uncovered to a depth of 3935 m.

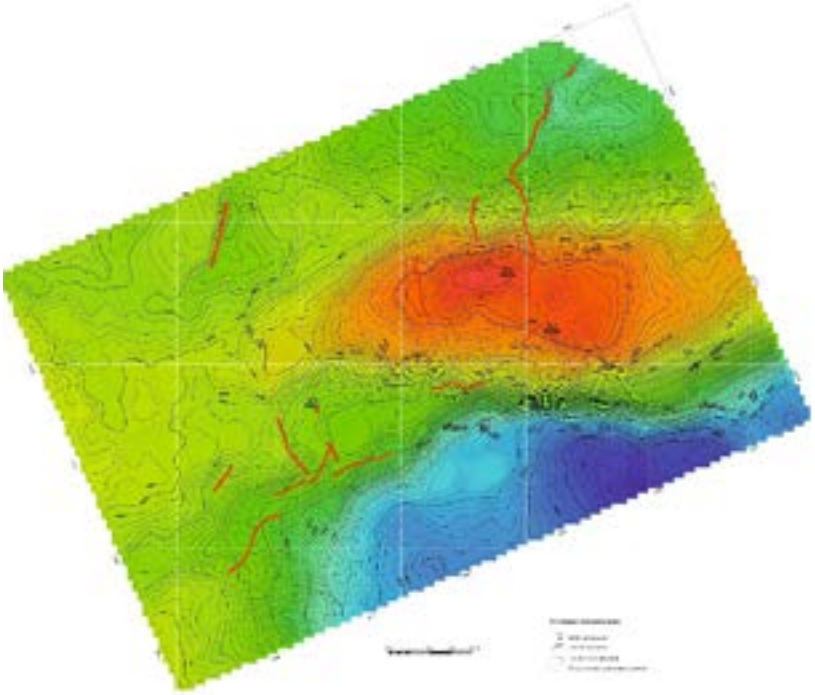

Fig.3 - Kurganbai. Structural map along the reflecting horizon V (Lower Jurassic sole)

During testing in the column, a weak inflow of water and gas was obtained from the aalen deposits. According to the results of drilling these wells in the Kurganbai area, the presence of an anticline structure (Ramirez-Perez et al., 2023) was confirmed for Upper Jurassic sediments with dimensions of 9.5x3.5 km and an amplitude of up to 70 m along a closed isohypse -2920 m.

Weak gas inflows obtained in wells from Jurassic sediments are associated with low reservoir properties of rocks and calming of the bottom-hole zone of wells.

The Bayram-Kyzyladyr uplift is located in the central part of the Zhazgurli depression. Tectonically, the studied area is confined to the central part of the South Mangyshlak trough (Kozhagulova et al., 2023). On structural maps along the reflecting horizons V3, V2–2 represents a large shaft (Bayram-Kyzyladyr), which plunges from the southwest to the northeast. The structure throughout its entire length is complicated by a large number of tectonic disturbances of various lengths, orientations and amplitudes.

The Bayram-Kyzyladyr uplift along the V3 reflecting horizon is a brachianticlinal fold, which is divided by a series of tectonic disturbances into a number of blocks gradually sinking in a southeasterly direction. The uplift mainly consists of three half-arches adjacent to the transverse discontinuous faults. The western raised half-arch of the

uplift has dimensions of 10.5 * 4.5 km, an amplitude of 70 m along the isohypse -5320 m, the central half-arch is complicated by a transverse fault, along the closing isohypse -5350 m, the dimensions are 3.3 * 2.9 km, an amplitude of 40 m. The eastern half-arch is divided by a narrow deflection from the central arch, elongated in sublatitudinal directions, complicated with three peaks, along the closing isohypse of 5350 m has dimensions of 6.7 * 2.1 km and an amplitude of 40 m (Figure 5).

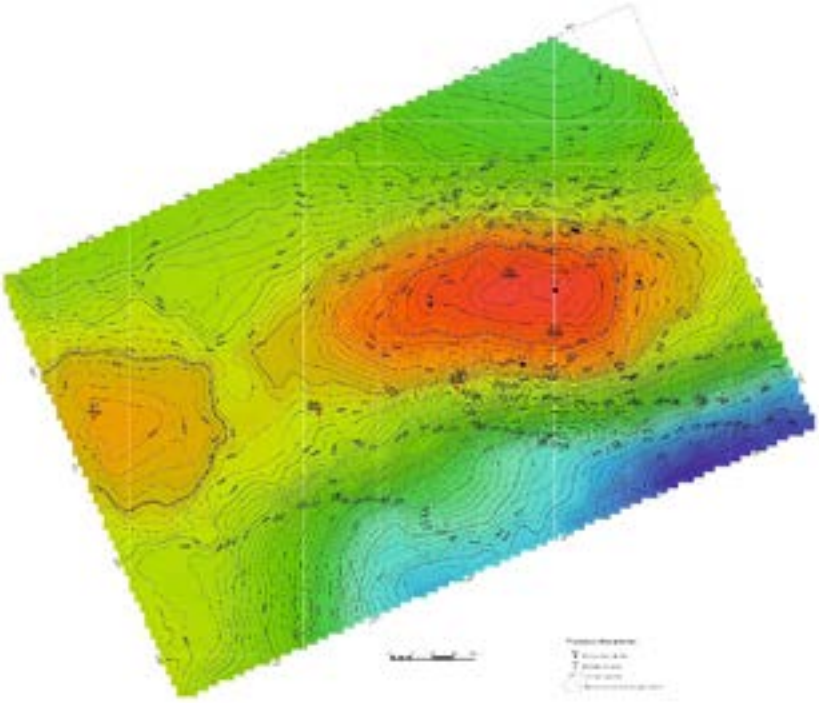

Fig.4 - Kurganbai. Structural map on the reflecting horizon J2k

VII-2 to the reflecting horizon, the uplift retains the structural shape of the lower horizon, also represents a brachianticlinal fold of three half-arches, separated by a series of tectonic faults, gradually sinking in a south-easterly direction. The western raised semicircle has dimensions of 10.8 * 6.5 km, an amplitude of 80 m along the isohypse minus 5130 m, the central semicircle along the closing isohypse - 5140 m - dimensions of 3.3 * 2.9 km and an amplitude of 20 m. The eastern arch is elongated in a north-easterly direction, complicated by four small peaks within the boundaries of the isohypse minus 5170 m dimensions – 5.5 * 1.75 km with an amplitude of 50 m (Figure 6).

Along the V2 reflecting horizon (the sole of the upper Triassic) retains the structural shape of the underlying volcanogenic-carbonate complex (Brandano et al., 2021), is elongated in the sublatitudinal direction, consists of two parts, the elevated western part of the structure, along a closed isohypse of -4650 m has dimensions of 5.2 * 4.5 km, amplitude -160 m. The eastern lowered part has the shape of a semicircle, along the adjacent isohypse – 4750 m, dimensions - 3.4 * 3.2 km, amplitude -50 m.

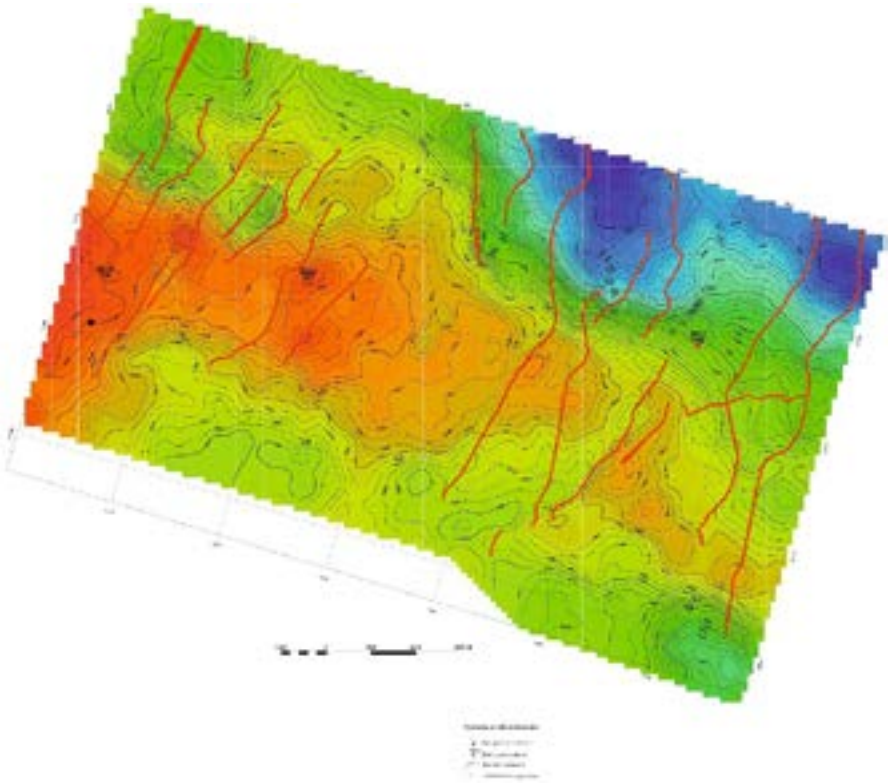

Fig. 5 - Bayram-Kyzyladyr. Structural map along the reflecting horizon V3. (Middle Triassic sole)

Bayram-Kyzyladyr V uplifts to the reflecting gorizont (soles of the Lower Jurassic) the structural plan is mainly preserved, two objects are fixed, separated by a narrow deflection. The western raised one is a half-arch adjacent to the tectonic disturbance, along the closing isohypse of 4300 m it has a square shape, with submeridional faults it is divided into four blocks, which are gradually sinking in a south-easterly direction. Dimensions 4.5 * 4.3 km, amplitude – 110m. The eastern omitted part of the structure also consists of four blocks separated by transverse faults, adjacent to the fault along the isohypse -4400 m dimensions - 3.75 * 2.5 km, amplitude -40 m.

According to the intra-Jurassic reflecting horizons J2B, J2bt, the structural plan of the Triassic complex is not reflected and represents a structural nose elongated in latitudinal directions, opening in a westerly direction (Figure 7).

According to the III reflecting horizon, the Bayram-Kyzyladyr uplift is a gentle structural nose opening in a westerly direction, tectonic disturbances traced in the Triassic complex are also not manifested here. Traps of a structural type are not distinguished along the Jurassic-Cretaceous horizons.

4 wells № 1, 2, 3 and 6 were drilled on Bayram-Kyzyladyr Square with the intended purpose of opening a productive Jurassic-Cretaceous complex.

Well № 1, having opened the Bath deposits, was liquidated for technical reasons due to an accident.

Well № 2, having opened the Aalen deposits, was also liquidated for technical reasons.

Wells № 3, having opened 60 m of Lower Jurassic deposits, was liquidated for geological reasons, since, according to well logging data (Wood, 2020), there were no productive layers in the opened Jurassic-Cretaceous section.

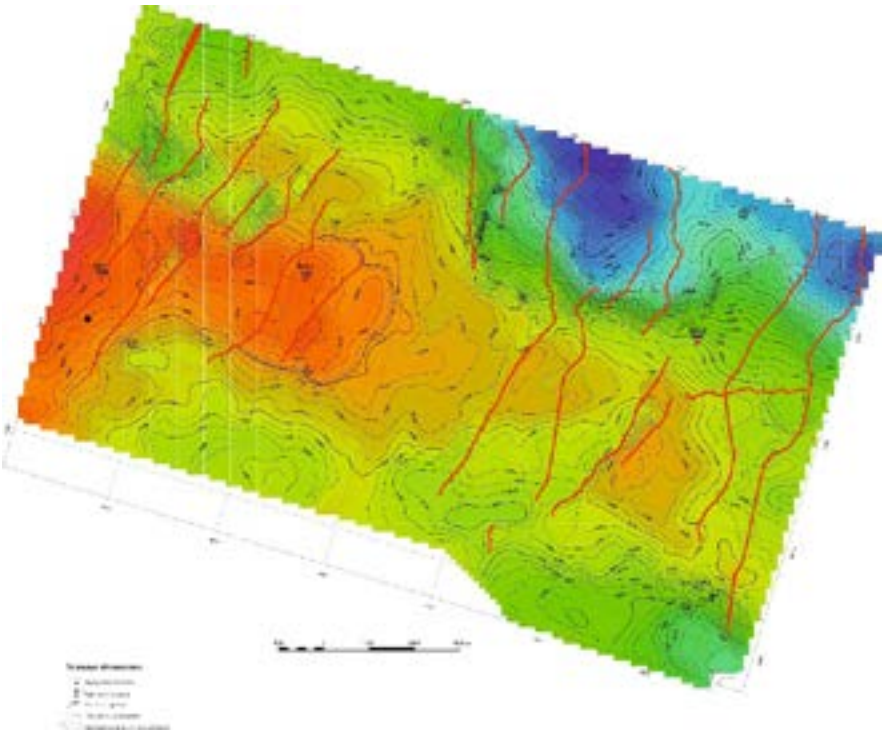

Fig. 6 - Bayram-Kyzyladyr. Structural map of the reflecting horizon V2.II (roof of carbonate deposits of the Middle Triassic of the Middle Triassic)

Well № 6, having opened the Aalen deposits, was liquidated for technical reasons.

In all wells, drilling through Jurassic-Cretaceous sediments was carried out with core sampling. According to the macro description, the core is represented by terrigenous rocks, without signs of UV. According to the well logging data set, there were no productive reservoirs in all wells in the opened section, and only in one well No. 6 in the depth range of 2720–3547 m (middle Jurassic) increased readings for gas logging were noted.

In order to assess the oil and gas potential (Tlepieva et al., 2021) of the Triassic deposits of the arched part of the eastern block (half-water) of the Bayram-Kyzyladyr uplift, a search well 11 was drilled, and a search well 10 was drilled in the central part of the area. The design depth of both wells is 4900 m, the design horizon is the middle Triassic. Upon reaching depths of 3850 m, the wells were stopped by drilling in the lower part of the Lower Jurassic sediments and mothballed due to the lack of chemicals, weighting and casing pipes.

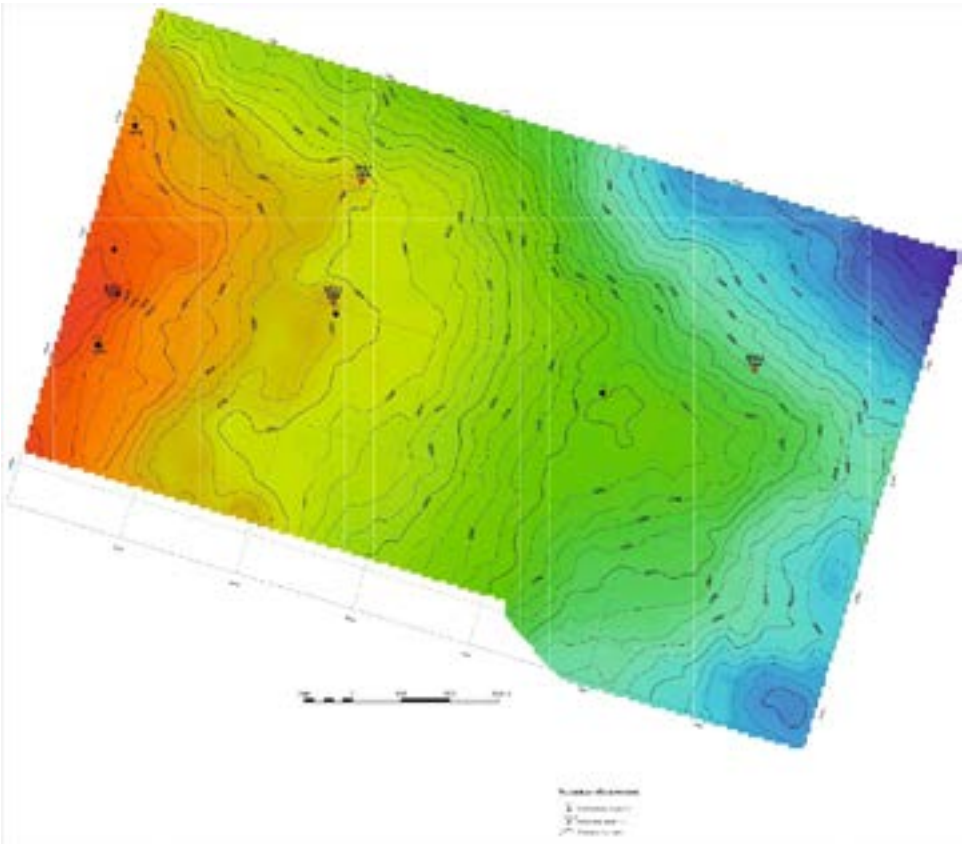

Fig. 7 - Bayram-Kyzyladyr. Structural map along the bottom of the J2bt horizon

Discussion

Based on the analysis and discussion of the results obtained, the raising of the Kurganbai complicates the northeastern part of the Bayram - Kurganbai shaft, along the reflecting horizons V3 and V2II has a block structure.

On the Kurganbai structure, wave field analysis was applied for signs of fracturing. This information should be taken into account when choosing a drilling point, however, at this stage, reliable well data with a modern well logging complex should be obtained. Only after the availability of modern well logging data, the Upper Jurassic carbonates complex can be studied by the wave features of seismic exploration. A possible tool for studying fracturing from seismic data will be the study of anisotropy from azimuthal data, which was not implemented within the framework of this work, since such an analysis is a completely different branch of the use of seismic data. In any case, the first step is to obtain up-to-date well logging data.

The oil and gas complex of the Lower Jurassic period was uncovered at several sites, the uncovered complex could potentially be a complex of embedded valleys that could exist on the wings or arches of existing structures. Anomalies have also been identified in the Lower Jurassic complex, which are recommended for drilling.

The risks of the Triassic oil and gas complex are associated with the central part of the Mangyshlak basin as a whole, i.e. with the structures we are studying, since the northern and southern areas have deposits that are under development in the interval of the Triassic period. The qualitative characteristic of the reservoir is the main risk of the oil and gas complex in the studied part of the basin. The expected roof of the Triassic period is at a depth of 4000 m or more. Carbonates required karst to develop porosity, which is the result of erosion.

According to the results of the Bayram-Kyzyladyr uplift study, according to regional data, before the availability of 3D data, the structure was an extensive anticline fold, mainly of sublatitudinal strike, along the axial line, which is divided into a number of local arches and semi-arches.

According to 3D data, at the level of Jurassic-Cretaceous sediments, an uplift is recorded in the area of the Kyzyladyr wells, which goes west beyond the 3D cube, i.e. it is not possible to trace the closure.

According to the Triassic, based on 3D data, many faults are recorded, which creates a series of tectonically shielded structures within the 3D cube.

Possible productive horizons are expected in Upper and Middle Triassic sediments, where carbonate and terrigenous sand-siltstone rocks can be reservoirs. The reservoirs of the Jurassic perspective strata are represented by sandstones and siltstones. According to the available borehole data, some pros

Conclusions

The use of modern technologies for in-depth analysis of seismic attributes has made it possible to obtain detailed data on the structure of productive horizons, which is an important factor in planning exploration drilling.

On Kurganbai Square, the Collectors of the Middle Jurassic (Calloway, Bath, Bayoss, Aalen) are interesting from the position of non-anticline traps. The search for oil and gas with an assessment of the probable oil and gas potential of non-anticlinal traps in basins with a high degree of study is quite a promising direction. For the Mangyshlak basin, the implementation of this direction is most appropriate for the carbonate Kimeridzh-Titons and terrigenous Bayos complexes. Within the framework of this work, objects located in the deposits of the Calloway, Bath, Bayoss, and Lower Jurassic were identified and described in detail.

Deposits of the Upper Jurassic, in the carbonate part, by analogy with the Kurganbai site, should also be of search interest. However, dynamic analysis in this interval did not reveal significant anomalies.

In the northwestern part of the Bayram-Kyzyladyr cube, an anomaly is recorded in the Middle Jurassic deposits. In this case, the possibility of stratigraphic traps should be considered, since no anticline is fixed at this point along the reference horizons. The negative results of drilling on Jurassic-Cretaceous deposits in this area are explained by the lack of a reliable high-amplitude trap capable of retaining hydrocarbons, as well as low reservoir properties of rocks of Jurassic-Cretaceous deposits.

The negative results of drilling the Bayram-Kyzyladyr uplift on Jurassic-Cretaceous sediments in this area are explained by the lack of a reliable high-amplitude trap capable

of retaining hydrocarbons, as well as low reservoir properties of rocks of Jurassic-Cretaceous sediments.

According to the deposits of the Lower Jurassic, the structure is characterized by the presence of a ridge of anticlines, which are possibly tectonically shielded. Within the closed anticlines, favorable values of elastic properties are noted in the sediments of the Lower Jurassic.

Since the wells have not uncovered Triassic deposits, which can be considered a priority, in order to clarify the oil and gas potential of Jurassic-Triassic deposits, reservoir properties, study the geological structure, and ensure reliable stratification of reflecting horizons, it is recommended to study the Triassic interval by drilling. In the east of the studied cube, tectonically shielded traps with a reduced value of the longitudinal impedance are recorded, both in the Upper Triassic sediments (southeast of the cube) and in the Middle Triassic sediments (northeast). The superpositions of the two regions do not coincide.

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