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«Қазақстан Республикасы Ұлттық ғылым академиясының Хабарлары. Геология және техникалық ғылымдар сериясы» ғылыми журналы 2016 жылдан бастап халықаралық реферативтік және ғылыметриялық Scopus дерекқорында индекстеледі және тұрақты библиометриялық көрсеткіштерді көрсетіп келеді.

Сонымен қатар журнал Web of Science платформасының (Clarivate Analytics, 2018) халықаралық реферативтік және наукометриялық дерекқоры Emerging Sources Citation Index (ESCI) тізіміне енгізілген.

ESCI дерекқорында индекстелуі журналдың халықаралық ғылыми рецензиялау талаптары мен редакциялық этика стандарттарына сәйкестігін растайды, сондай-ақ Clarivate Analytics компаниясы тарапынан басылымды Science Citation Index Expanded (SCIE), Social Sciences Citation Index (SSCI) және Arts & Humanities Citation Index (AHCI) дерекқорларына енгізу қарастырылуда.

Scopus және Web of Science дерекқорларында индекстелуі жарияланымдардың халықаралық деңгейде жоғары сұранысқа ие болуын қамтамасыз етеді, олардың дәйексөз алу көрсеткіштерінің артуына ықпал етеді және редакциялық алқаның геология мен техникалық ғылымдар саласындағы өзекті, бірегей және ғылыми тұрғыдан маңызды зерттеулерді жариялауға ұмтылысын айқындайды.

Научный журнал «News of the National Academy of Sciences of the Republic of Kazakhstan, Series of Geology and Technical Sciences» с 2016 года индексируется в международной реферативной и наукометрической базе данных Scopus и демонстрирует стабильные библиометрические показатели.

Журнал также включён в международную реферативную и наукометрическую базу данных Emerging Sources Citation Index (ESCI) платформы Web of Science (Clarivate Analytics, 2018).

Индексирование в ESCI подтверждает соответствие журнала международным стандартам научного рецензирования и редакционной этики, а также рассматривается компанией Clarivate Analytics в рамках дальнейшего включения издания в Science Citation Index Expanded (SCIE), Social Sciences Citation Index (SSCI) и Arts & Humanities Citation Index (AHCI).

Индексирование в Scopus и Web of Science обеспечивает высокую международную востребованность публикаций, способствует росту цитируемости и подтверждает стремление редакционной коллегии публиковать актуальные, оригинальные и научно значимые исследования в области геологии и технических наук.

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MODELING OF TERRIGENOUS CRETACEOUS DEPOSITS OF THE GAZLI UPLIFT USING FILTRATION AND CAPACITY PROPERTIES OF ROCKS

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Abstract. *Introduction.* Terrigenous Cretaceous deposits of the Gazli uplift are key hydrocarbon reservoirs in the Bukhara–Khiva region, but geological heterogeneity complicates prediction of productive zones. *Methods*. Well logs, core analyses, 3D seismic data, sequential indicator simulation, sequential Gaussian simulation, and hydraulic flow unit analysis were used to construct a 3D geological model. *Results.* The model identified productive zones and showed more than 87% agreement with production history. Reservoirs with porosity >18% and permeability >150 mD were mainly located in the central and southeastern parts. *Conclusion.* The proposed workflow improves reservoir characterization and

supports more reliable planning of new production wells. *Methods.* The study is based on well logging data, laboratory core analysis results, and 3D seismic survey data. Modeling was performed using stochastic algorithms of sequential indicator simulation (for lithofacies) and sequential Gaussian simulation (for porosity and permeability). The correlation of "porosity-permeability" petrophysical relationships was carried out considering the identified hydraulic flow units (HU). *Results.* A highly detailed 3D geological and hydrodynamic model of the Cretaceous complex of the Gazli uplift was constructed. Regularities in the spatial distribution of sandy reservoirs and shale barriers were revealed. It was established that zones with improved reservoir properties (porosity > 18%, permeability > 150 mD) are confined to the central and southeastern parts of the structure, which are associated with paleochannel facies. *Conclusion.* Comparison of the obtained model with the production history confirmed its high convergence (over 87%) with actual well production rates. The modeling results prove that accounting for the micro-heterogeneity of reservoir properties allows for revising the boundaries of fluid contacts and minimizing risks when planning new production wells. This methodological approach can be scaled to adjacent fields of the Bukhara-Khiva oil and gas province.

Keywords: well, oil and gas potential, modeling, productivity, reservoir, filtration properties, interpretation

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ГАЗЛИН КӨТЕРІМДІГІНІҢ ТЕРРИГЕНДІ МОР КЕНІМДЕРІН ТЕКСЕРДІҢ СҮЗІЛУ ЖӘНЕ СЫЙЫМДЫЛЫҚ ҚАСИЕТТЕРІН ПАЙДАЛАНУ

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Аннотация. *Кіріспе.* Газли көтерілімінің терригенді бор шөгінділері Бұхара-Хива аймағындағы мұнай мен газ өндірудің негізгі нысандары болып табылады, бірақ жоғары геологиялық әртектілік пен тау жыныстарының коллекторлық қасиеттерінің (ТЖК) құбылмалылығы көмірсутектердің қалдық қорларының оқшауланuын болжауды қиындатады. Бұл жұмыстың мақсаты — ТЖК-ның өзекті деректерін біріктіретін үш өлшемді цифрлық геологиялық модельді құру негізінде өнімді белдемдерді болжау дәлдігін арттыру. *Материалдар мен әдістер.* Зерттеудің негізіне ұңғымаларды геофизикалық зерттеу (ҰГЗ) деректері, керн материалын зертханалық талдау нәтижелері және 3D сейсмикалық барлау материалдары алынды. Модельдеу жүйелі индикаторлық (литофациялар үшін) және жүйелі Гаусс симуляциялық модельдеудің (кеуектілік пен өткізгіштік үшін) стохастикалық алгоритмдерін қолдану арқылы орындалды. «Кеуектілік-өткізгіштік» петрофизикалық тәуелділіктерін үйлестіру бөлініп көрсетілген гидравликалық ағын бірліктерін (HU) ескере отырып жүзеге асырылды. *Нәтижелер.* Газли көтерілімінің бор кешенінің жоғары деталды үш өлшемді геологиялық-гидродинамикалық моделі құрылды. Құмды коллекторлар мен саздылық тосқауылдарының кеңістіктік таралу заңдылықтары анықталды. ТЖК жақсартылған белдемдер (кеуектілік > 18%, өткізгіштік > 150 мД) құрылымның палеоарналық фациялармен байланысты орталық және оңтүстік-шығыс бөліктеріне шоғырланғаны анықталды. *Қорытынды.* Алынған модельді игеру тарихымен салыстыру оның ұңғымалардың нақты дебиттерінің көрсеткіштерімен жоғары сәйкестігін (87%-дан астам) дәлелдеді. Модельдеу нәтижелері ТЖК микроәртектілігін есепке алу су-мұнай жапсарларының шекараларын қайта қарауға және жаңа пайдалану ұңғымаларын салу кезіндегі тәуекелдерді азайтуға мүмкіндік беретінін көрсетеді. Бұл әдістемелік тәсілді Бұхара-Хива мұнай-газлы облысының іргелес кен орындарына қолдануға болады.

Түйін сөздер: ұңғыма, мұнай және газ әлеуеті, модельдеу, өнімділік, коллектор, сүзу қасиеттері, түсіндіру

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МОДЕЛИРОВАНИЕ ТЕРРИГЕННЫХ МЕЛОВЫХ ОТЛОЖЕНИЙ ГАЗЛИНСКОГО ПОДНЯТИЯ С ИСПОЛЬЗОВАНИЕМ ФИЛЬТРАЦИОННО-ЕМКОСТНЫХ СВОЙСТВ ПОРОД

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Аннотация. *Актуальность.* Терригенные меловые отложения Газлинского поднятия являются важными объектами нефтегазодобычи в Бухаро-Хивинском нефтегазоносном регионе. Однако высокая геологическая неоднородность продуктивных пластов и пространственная изменчивость фильтрационно-ёмкостных свойств пород затрудняют прогнозирование локализации остаточных запасов углеводородов. Построение детализированных трёхмерных геологических моделей, интегрирующих данные геофизических исследований скважин, лабораторного изучения керна и сейсморазведки, позволяет повысить достоверность выделения перспективных коллекторов и снизить геологические риски при дальнейшем освоении месторождений. *Цель.* Повысить точность прогнозирования продуктивных зон терригенного мелового комплекса Газлинского поднятия на основе построения трёхмерной цифровой геологической модели, учитывающей пространственное распределение фильтрационно-ёмкостных свойств пород. *Материалы и методы.* Исследование основано на данных геофизических исследований скважин, результатах лабораторного анализа кернового материала и материалах трёхмерной сейсморазведки. Для моделирования литофациальной неоднородности применялся алгоритм

последовательной индикаторной симуляции, а для распределения пористости и проницаемости - алгоритм последовательной гауссовой симуляции. Петрофизическая зависимость «пористость - проницаемость» уточнялась с учётом выделенных гидравлических единиц потока (hydraulic units, HU). Построенная модель была сопоставлена с фактическими показателями разработки и дебитами скважин. *Результаты.* Построена детализированная трёхмерная геологическая модель мелового комплекса Газлинского поднятия. Выявлены закономерности пространственного распределения песчаных коллекторов и глинистых барьеров. Установлено, что зоны с улучшенными фильтрационно-ёмкостными свойствами, характеризующиеся пористостью более 18 % и проницаемостью более 150 мД, преимущественно приурочены к центральной и юго-восточной частям структуры и связаны с палеорусловыми фациями. Сопоставление результатов моделирования с историческими данными разработки показало соответствие более 87 % фактических показателей дебитов скважин. *Выводы.* Учёт микронеоднородности фильтрационно-ёмкостных свойств пород позволяет уточнить пространственное положение продуктивных зон, скорректировать границы флюидальных контактов и снизить риски при заложении новых эксплуатационных скважин. Предложенный методический подход может применяться для моделирования сходных терригенных резервуаров на смежных месторождениях Бухаро-Хивинской нефтегазоносной области.

Ключевые слова: скважина, нефтегазоносност, моделирование, продуктивность, пласт, фильтрационные свойства, интерпретация

Introduction. Filtration properties of rocks (or their permeability) are the most important parameter characterizing the conductivity of the reservoir, i.e. the ability of the formation rocks to pass oil and gas to the well bottoms. It depends on many factors: on the composition and size of the detrital material, on the degree of its sorting, on the amount, type and composition of cement, on the structure of the pore space and the porosity of the rock, on the nature of the manifestation of post-sedimentation processes, etc., as well as on the type of formation fluid and the nature of its movement.

The current level of scientific and technological development of the industry predetermines the need to improve the system of modeling underground reservoirs using high-tech programming in the creation of new and modernization of existing models. When modeling with the help of computers, it is possible to study the reservoir in more detail by dividing it into blocks (sometimes into several thousand) and applying the basic filtration equations to each of them.

The study of the filtration and capacity properties of rocks of terrigenous deposits of the Cretaceous and Jurassic in Uzbekistan was carried out by such scientists as Akramkhodjaev A.M., Abdullaev G.S., Akhmedov P.U., Evseeva G.B., Karshiev O.A., Muminov A.S., Safonova L.N., Ubaykhodjaeva Z.S. and others. Abroad, a special contribution to the study of the petrophysical properties of rocks was

made by such specialists as Abrosimov A.A., Avdeeva A.V., Avchyan G.M., Aziz Kh., Akselrod S.M., Ampilov Yu.P., Babushkin V.D., Bagrintseva K.I., Basin L.N., Bakirov A.A., Barkov A.Yu., Bitner A.K., Bembel S.R., Kitaeva I.A., Konyrbekov M., Kulyapin P.S., Maltseva A.K., Mezin A.A., Ovchinnikov M.N., Plotnikov I.I., Sokolova T.F., Settari E., Stefankevich Z.B., Yakovlev I.V. and others.

Materials and Methods. An analysis of the available measurements of the petrophysical properties of the core by comparison showed that obtaining individual core dependencies for each layer is not optimal due to the small number of core measurements for some layers, as well as due to the similarity of the properties of individual layers with each other. As part of the study on the Gazli, Mullakhol and Tashkuduk fields, the authors compared the filtration-capacity properties (FPP) of the core both for the layers as a whole and separately. Figure 1 shows a set of problems solved in geomodeling of the petrophysical properties of terrigenous Cretaceous deposits (Ratov et al., 2023; Hayitov et al., 2020).

The next stage of the study includes the distribution of petrophysical properties of terrigenous Cretaceous sediments by depth and area. Based on the available data on the petrophysical properties of the core, it was decided to combine the measurements to build a more extensive database, which will facilitate the creation of a digital geological model.

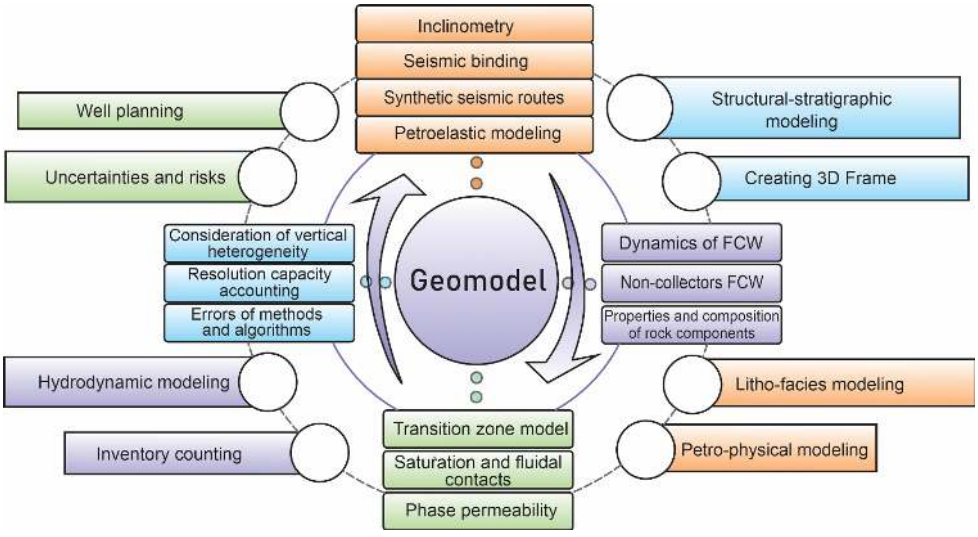

Figure 1. A set of tasks solved in geomodeling.

The tasks solved in geomodeling of petrophysical properties of terrigenous Cretaceous deposits include: stratigraphic binding of geophysical data; creation of a database for constructing a digital geological model; construction of a structural model and 3D grid; averaging of well data; modeling of a cube of lithology, porosity, residual water saturation; forecast of oil and gas saturation and phase

composition of formation fluids based on production geophysical data. When solving the problems, the following was carried out:

– comparison of available petrophysical properties of core samples from different layers and areas;

– based on the analysis of the data, make a decision on combining measurements, both for the layers as a whole and for individual layers, in order to increase the statistical base and improve its representativeness;

– creation of a structured database combining core measurements, interpolated values and geographic coordinates;

– implementation of distribution of the studied properties by depth and area based on statistical analysis and geostatistical interpolation methods;

– construction of a structural model and 3D grid displaying geological structures;

– construction of a lithology and porosity cube model over the entire area and depth, which serve as the basis for assessing oil and gas saturation and composition of formation fluids.

– implementation of forecasting the distribution of oil and gas saturation, phase composition and estimated gas reserves based on production geophysical data.

Stratigraphic referencing of geophysical data. In the course of further work on obtaining petrophysical dependencies, it was decided to combine core measurements by layers into groups with similar petrophysical properties. The most optimal division turned out to be into three groups based on age:

1) formations IX-XI;

2) formations XI-A, XII and XIII-A; 3) formations XIII-B and XIII-E.

These groups differ from each other in typical well logging characteristics, as eloquently demonstrated by the shape of the PS curve. However, the differences in the core porosity and permeability are less obvious. The similarity of the logging properties of these groups of formations was also established in previous works, including studies on calculating the reserves of the field.

The above-mentioned groups of layers differ from each other in typical well logging characteristics, the most obvious example being the shape of the PS (spontaneous polarization potential) curve, while the differences in the filtration-capacitive properties (FEP) of the core are less obvious. The similarity of the logging properties of these groups of layers has been established in previous works, in particular, in the work on calculating the reserves of the field.

Creation of a database for building a digital geological model. The following information was used as initial data for the purpose of creating a 3D geological model for productive horizons IX, X, XI, XI-A, XII, XIII-A, XIII-B, XIII-V, XIII-G, XIII-D, XIII-E of the Gazli field: coordinates and altitudes of wells, inclinometry data, stratigraphic breakdown by wells, well logs, results of well geophysical research interpretation (RIGIS), results of effective thickness identification, structural maps, maps of effective thicknesses and porosity coefficients by productive horizons. All the initial data necessary for constructing a 3D geological

model are entered into the project created in the tNavigator software (Rock Flow Dynamics) (Bochkarev, 2010; Ratov et al., 2023).

Construction of a structural model and 3D grid. To create a structural model of the Gazli, Mullakhol, Tashkuduk, Dzhakasan, Takyrkuduk, Tungiz, Shorkul and Tuztepa fields, stratigraphic breakdowns were used based on the calculation of reserves and correlation of well logging data from previous years (Fig. 2).

Structural surfaces on the roofs of horizons were constructed using the method of convergence from the roof of horizon IX due to the conformal bedding of the layers and were adjusted according to the available stratigraphic markers. In total, 27 zones were identified vertically in the geological model, taking into account the clayey barriers between the productive horizons. According to geophysical materials, clayey barriers were identified between the horizons, and also, according to a number of wells in these barriers, collectors of insignificant thickness were identified. Due to the presence of an insignificant volume of collectors, when constructing the model, all intervals between the horizons were taken as non-reservoirs.

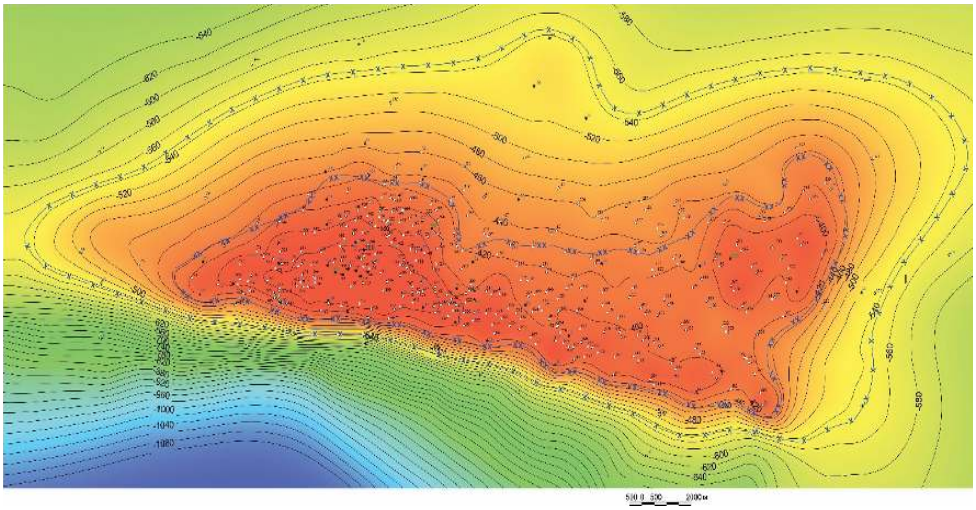

Figure 2. Structural map of the roof of the IX horizon, Gazli deposit. 2024.

Structural surfaces were considered along the roofs of all productive horizons IX–XIII, indicating the external contours of gas and oil content. A different approach was chosen to construct structural surfaces along the bases of horizons IX–XII. To correctly display the base in the geological model and to control the absence of zero thicknesses, maps of the thicknesses of clayey barriers were constructed. Using the thickness maps constructed using the thickness attributes, the bases of the horizons were constructed (Kholismatov et al., 2022; Ratov et al., 2023).

For the group of horizons XIII-A – XIII-E, the thicknesses of the bridges were

set by constants due to significant discrepancies in the thicknesses in the wells in order to maintain the conformity of the roof and base of the horizons, since their thickness is not great (Table 1).

Table 1. Average thicknesses of bridges between layers of horizon XIII.

Interval	Average thickness of the lintel, m
XIII-A and XIII-B	2.0
XIII-B and XIII-V	3.1
XIII-V and XIII-G	4.3
XIII-G and XIII-D	2.9
XIII-D and XIII-E	2.8

After completion of the construction of the structural framework, the geological grid was constructed (Table 2). The polygon for constructing the 3D geological model was determined by the outer contour of the gas-bearing horizon IX, since it is the largest in area of all the other horizons. The horizontal grid step was chosen equal to 100 x 100 m based on the average distance between wells in the existing well stock (Ratov et al., 2023). Due to the conformal bedding of the layers, a proportional type of breakdown was chosen. The number of layers for each horizon was chosen with the aim of optimal remapping of the lithology curve onto the geological grid.

Table 2. Geological model grid parameters.

Parameters	**Value**
Horizontal cell size	100 x 100
Vertical cell size	Proportional
Number of vertical layers	508
Total number of cells	36 301 680
Grid dimensions	397 x 180 x 508
Average cell thickness, m	1.652

Averaging of well data. At this stage, well data are averaged, which contain stratigraphic markings and geophysical survey interpretation results, including lithology parameters (e.g. reservoir or non-reservoir type) and porosity values.

To prepare the data for modeling, the GIS data is scaled onto a three-dimensional grid (3D grid), which ensures their integration into a single geological model. After this, the obtained hypsometric data are compared with the original values, using statistical evaluation methods - histograms and spatial distributions, which allows checking their compliance and consistency (Khalismatov et al., 2023 a; Mukhutdinov et al., 2021; Garba et al., 2024).

The main task of this stage is the correct transfer of the initial data from the RIGIS GIS (this is a regular GeoGlobe table) to a three-dimensional geological grid using the UpScaling method. It is important to ensure the preservation of key statistical characteristics: average value, minimum, maximum and other statistical

parameters, which ensures the accuracy and reliability of subsequent modeling and analysis (Ratov et al., 2023).

Results and Discussion. *Modeling the lithology cube.* The initial data for constructing the lithology model were the reservoir-non-reservoir curves for 50 wells. The construction of the discrete lithology parameter model was implemented using the stochastic SIS (Sequential Indicator Sumulation) method. The variogram ranks for constructing the lithology of productive horizons IX–XIII were adopted based on the variogram analysis.

For each horizon, a geological-statistical section (GSS) was created (Fig. 3), which was used as a vertical trend to reproduce the distribution of reservoirs along the section (Abbasova, 2019). Based on the obtained distribution of reservoirs, taking into account the specified fluid contacts, maps of gas- and oil-saturated thicknesses were constructed (Fig. 4).

The constructed lithology cube corresponded to the trends of preserving the proportion of the reservoir code by the vertical (RCV). As a result of modeling, clay layers extended along the entire model, the reason for which is unrepresentative statistics. When constructing models, the assignment of the vertical curve of the RRV, also takes into account the regional geological structure and sedimentation features of the sections of neighboring fields when developing trends in the lateral distribution of reservoirs. In order to create a correct geological model, it is necessary to carefully approach the selection of sedimentation models, which in turn serve as a justification for geostatistical distributions in facies and petrophysical modeling of reservoir properties.

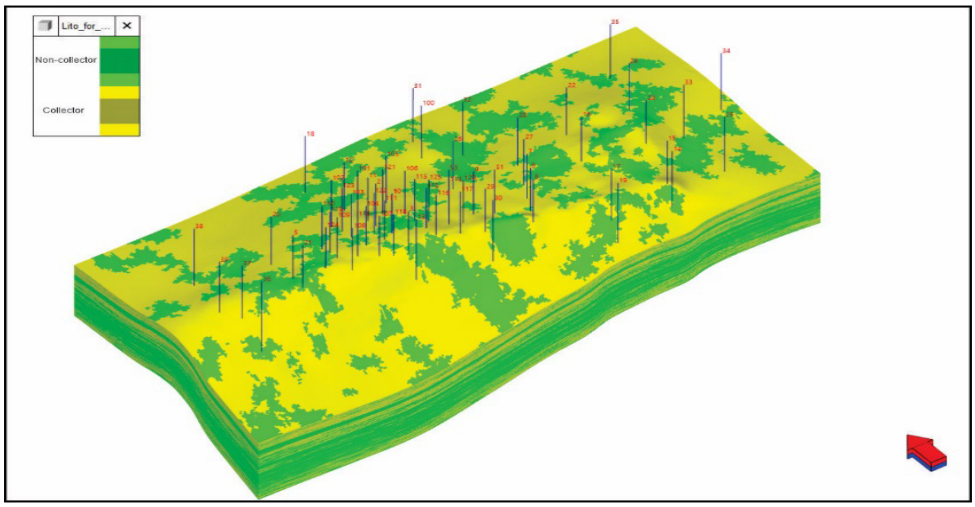

Figure 3. Three-dimensional section of the lithology cube of the productive horizons of the Gazli field, 2024.

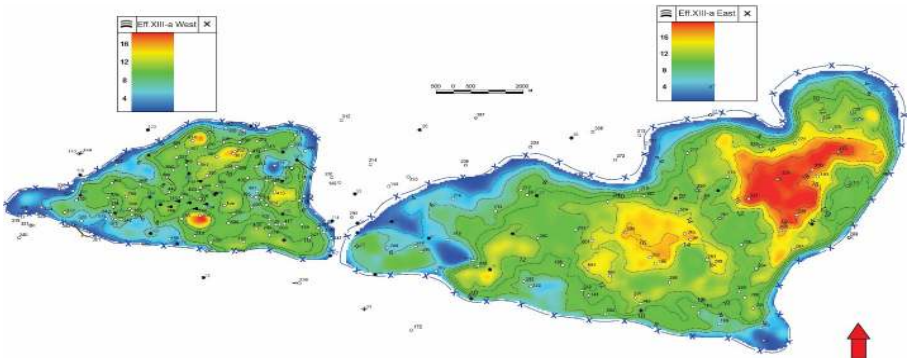

Figure 4. Map of effective gas-saturated thicknesses of the XIII-A horizon of the Gazli field, 2024.

Porosity cube modeling. To construct the porosity cube of horizons IX – XIII, RIGIS data were used for exploration wells of the old fund and new wells No. 1001, 1002 and 1003. The porosity parameter was modeled using the stochastic interpolation method Sequential Gaussian Simulation (SGS) with an exponential type of variogram for reservoir cells. In non-reservoirs, the porosity coefficient was not modeled and was assumed to be zero by default (Fig. 5). Variogram ranks for constructing porosity were adopted based on variogram analysis.

Typically, the resulting porosity volume is used to estimate reserves and as a basis for calculating permeability (Ratov et al., 2023). Quality control was performed by comparing the histograms of the distribution over squares, the RIGIS (Results of Interpretation of Geological Surveys of Wells) data and the curves after merging the RIGIS data on a grid, i.e. the degree of preservation of the distribution density function was assessed.

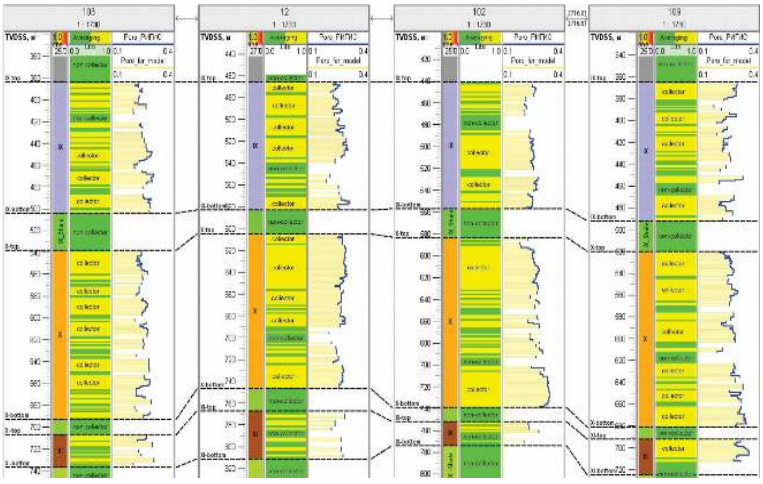

Figure 5. Quality control of the porosity coefficient for productive formations of the Gazli field. 2024.

The accuracy of averaging the main porosity curve per 3D grid cell is given in Table 3.

Table 3. Results of averaging porosity on cells of 3D grid of geological model of Gazli deposit.

Zone	Name	Min, unit length	Max, unit length	Sample size	Average length of unit	Coefficient of variation
IX	Upscaled cells	0,16	0,38	2664	0,25	0,0012
	RIGIS	0,16	0,38	5328	0,25	0,0011
X	Upscaled cells	0,14	0,37	3241	0,25	0,0012
	RIGIS	0,14	0,37	6482	0,25	0,0012
XI	Upscaled cells	0,157	0,354	451	0,255	0,0013
	RIGIS	0,157	0,354	902	0,255	0,0013
XI-A	Upscaled cells	0,152	0,28	179	0,22	0,0007
	RIGIS	0,152	0,28	358	0,22	0,0007
XII	Upscaled cells	0,144	0,33	1218	0,234	0,0090
	RIGIS	0,144	0,33	2402	0,234	0,0009
XIII	Upscaled cells	0,131	0,307	3353	0,22	0,0009
	RIGIS	0,131	0,307	6706	0,22	0,0009

The following values are adopted for the discrete collector curve:

0 – non-reservoirs (cells correspond to zero porosity values);

1 – collectors (reservoir cells have porosity).

An important point when performing the lithology curve averaging stage is to control the complete transfer of permeable interlayers to the 3D grid within the wells (Ratov et al., 2023).

The residual water saturation cube is calculated using the petophysical dependence $K_{wo}=f(K_p)$. The graphs of petrophysical dependences of the residual water saturation coefficient on the open porosity coefficient are compiled using core samples from new wells IX–XIII of productive horizons (see Fig. 6, 7). To construct a map of average oil saturation from a volumetric cube, it is necessary to use weighting by the parameters of cell volume, its porosity and Net to Gross (NTG) (Ratov et al., 2023; Zhienbayev et al., 2025).

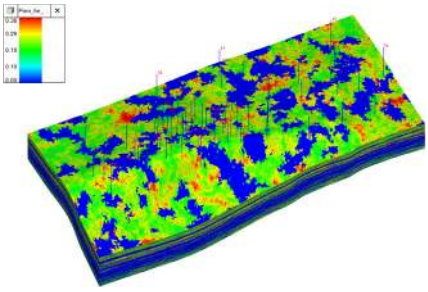

Figure 6. Three-dimensional section of the porosity cube of the Gazli deposit, 2023.

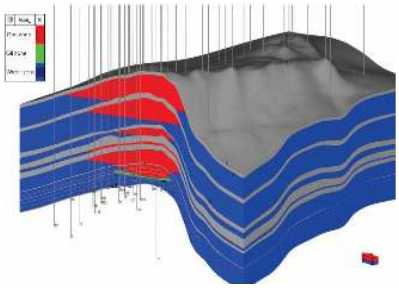

Figure 7. Three-dimensional section of the residual water saturation cube of the Gazli field, 2023.

Forecast of oil and gas saturation and phase composition of reservoir fluids based on production geophysical data. Most of the Gazlinskoye uplift fields are characterized by deposits with small heights and extended transition zones. Thus, in particular, the transition zone of the analyzed field is 10-15 m. It is not easy to develop reserves of formations with a significant content of mobile water. In such a situation, it is important to find methodical approaches to calculate the flow rate of wells put into operation using well logging curves (geophysical well logging), the degree of their water cut, to forecast oil and gas flow rates by area when designing new wells and to optimize geological exploration work. Such measures make it possible to significantly reduce the water content in the product and increase production growth (Gabrielyants, 1975).

In order for the hydrodynamic model to accurately reflect the processes of reservoir development and be as informative as possible, it is necessary to obtain the values of relative phase permeabilities in each cell of the 3D model. Therefore, their calculation was carried out as a function of $K_{p\ eff}$ and K_{ng} according to previously substantiated algorithms.

Also considered are various options for developing oil rims of the Gazli field, providing for the development of hydrocarbon reserves of productive deposits (horizons XIII-E, XIII-D, XIII-G, XIII-V) both by the existing well stock and by drilling new production wells, sidetracking and carrying out well workovers (WWO). The forecast of technological development indicators is made on the basis of a three-dimensional geological and hydrodynamic model using the tNavigator software package from Rock Flow Dynamics (Khalismatov et al., 2024 b; Orinbaev et al., 2025).

The optimal depression mode for producing wells (2.0 MPa – average depression based on the technological operating modes of oil producing wells at the Gazli field) was selected as the control parameter in the forecast period of development for oil facilities. For all producing wells, restrictions were applied on the maximum (limit) water cut of well production (99%) and/or reduction of well flow rate for oil below 0.1 t/day. The calculated forecast period is limited to a period of 102 years (until 2123). To increase annual oil production to 30 thousand tons and maintain it until 2027 by carrying out geological and technical measures, as well as drilling the 1st horizontal and 1st directional production wells. All project wells are dependent. In order to reduce geological risks and assess the feasibility of drilling, it is recommended to conduct a preliminary GIS complex (GK, 2NNKt, EDK, AKTs) in the wells of the existing fund, opening the target production facility in the area of the project wells.

The layout of the design wells for this option is shown in Fig. 8. When implementing this option, the accumulated oil production at the end of development will be 3,495 thousand tons, and the final oil recovery factor (ORF) will be 0.150 long units.

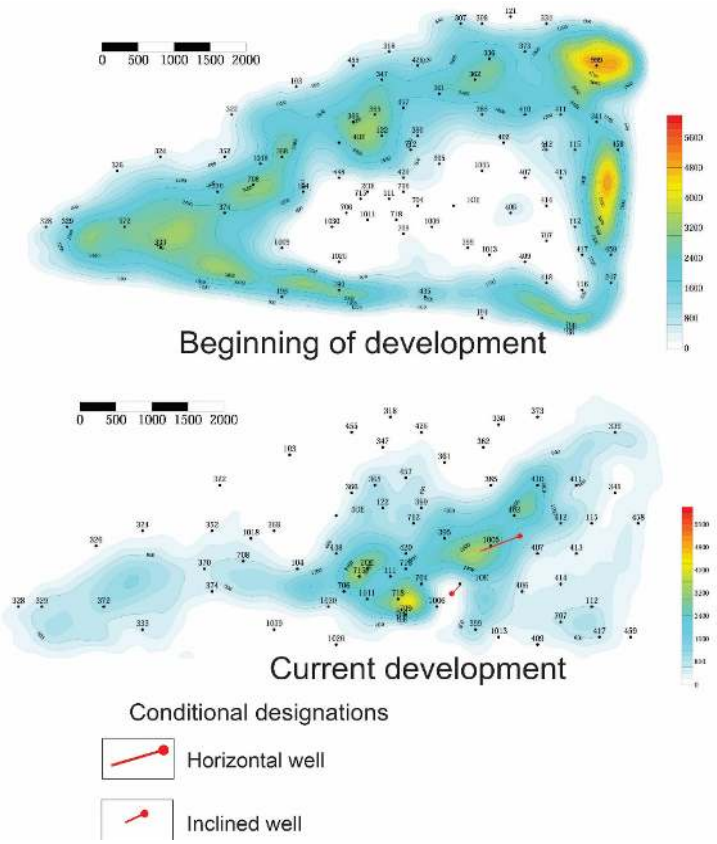

Figure 8. Map of mobile oil reserves.

Conclusion. Based on the results of the work performed, the following conclusions were formulated:

1. The created algorithm of petrophysical and geological modeling allows solving such important problems as: increasing the reliability of identifying complex-structured reservoirs, assessing the dynamic properties of formations taking into account the data of industrial geophysics and core studies (composition of the rock matrix and cement filling the pore space), monitoring the filtration heterogeneity of the reservoirs that make them up during the development of deposits.

2. By determining the dynamic characteristics and other petrophysical parameters, the zones of concentration of residual geological reserves of Cretaceous terrigenous reservoirs at the Gazli, Mullakhol and Tashkuduk fields were outlined and the possibility of resuming production at the mothballed fields was substantiated.

3. It is recommended to apply methods for assessing the value of primary water cut ($f_{initial}$) and productivity (correlation links between the specific productivity

of each exploitation object and the value of the effective porosity coefficient (Ω $_{specific}$)) ∗ the i-th object = f ($K_{p\ eff}$,) in the space between wells, distributions of phase permeabilities in it, using the results of hydrodynamic studies of wells.

Recommendations for further direction of geological exploration work with the aim of increasing hydrocarbon reserves. The 3D model of the Gazli field obtained on the basis of calculations of the dynamic properties of productive layers is a tool for optimizing solutions for its further operation. Based on the obtained calculation cubes and maps for such parameters as the coefficient of effective porosity, oil and gas saturation, phase permeability and specific productivity, recommendations are provided on the optimal directions of further work at the fields (Deshenenkov et al., 2013).

1. Recommendation for commissioning new wells: commission new wells first, since the distribution of specific productivity values obtained in the 3D model revealed a zone of increased oil productivity, in which the share of oil in the inflow decreases slightly over time, while the water cut remains the same during development (Mukhutdinov et al., 2021).

2. Recommendations of the methodological direction: assessment of dynamic characteristics of productive formations based on borehole logging data, including coefficients of effective porosity, oil and gas saturation, effective and phase permeabilities, capillary pressures (P_{cap}), specific oil productivity and water cut;

– creation of relevant geological and hydrodynamic models of target objects with a forecast of dynamic parameters of productive formations;

– ranking of wells by the date of their commissioning, based on data on the dynamic properties of productive objects.

Based on the results of clarifying the geological structure, productive and energy potential of the field, based on the operating experience and dynamics of the properties of productive formations, the main conclusions for further development of the field were formed (Mukhutdinov et al., 2021). The need to use small depressions in natural conditions entails the relevance of the technology of drilling horizontally-flat wells, increasing the coverage of formations with small oil-saturated capacities (Sudakov et al., 2018).

For the best development of oil reserves at the late stage of operation, it is advisable to drill side wellbores in places of maximum concentration of mobile residual reserves: the space between wells and marginal areas where small effective oil thicknesses ($O_{eff.\ oil}$) are determined, since drilling operational design wells there is ineffective. The commissioning of all wells is ranked from the dome of the deposit to the periphery; from large effective oil-saturated capacities ($O_{eff.\ oil}$) to smaller ones (Mukhutdinov et al., 2021).

To improve the quality of modeling oil and gas saturated reservoirs with intergranular void space, it is recommended to: study the dynamic properties of productive reservoir rocks by combining GIS (geographical information systems) data (modern modifications of instruments and processing technologies) and special laboratory studies of core samples.

References

Abbasova S.A. (2019) Modelirovanie geologicheskogo stroeniya slozhnykh uglevodorodnykh lovushek yurskikh otlozheniy severo-zapadnoy chasti Bukharo-Khivinskogo regiona [Modeling of the geological structure of complex hydrocarbon traps of the Jurassic deposits of the northwestern part of the Bukhara–Khiva region]. Abstract of the dissertation for the degree of Doctor of Philosophy in Geological and Mineralogical Sciences. – Tashkent. – 32 p. (In Russ.).

Aziz H., Settari E. (2004) Mathematical Modeling of Reservoir Systems. Translated from English by A.V. Korolev and V.P. Kestner; edited by M.M. Maksimov. 2nd ed. Moscow; Izhevsk: Institute of Computer Research. (In Russ.).

Bochkarev V.A. (2010) Modelirovanie neftegazovykh ob"ektov [Modeling of Oil and Gas Objects]. – Moscow: VNIIOENG. – 268 p. (In Russ.).

Deshenenkov I.S. (2013) Povyshenie informativnosti modelirovaniya neftyanykh zalezhey na osnove dinamicheskikh svoystv kollektorov (na primere neokomskikh otlozheniy Zapadnoy Sibiri) [Increasing the information content of oil deposit modeling based on the dynamic properties of reservoirs]. Candidate of Technical Sciences Dissertation. – Moscow. – 156 p. (In Russ.).

Hayitov O.G., Yusupkhodzhaeva E.N., Abdurakhmanova S.P., & Holmatova N.G. (2020) On the state of hydrocarbon resource base in the Beshkent Trough. Journal of Advanced Research in Dynamical and Control Systems. – Vol. 12(7). Special Issue). – P. 2327-2332. DOI: https://doi.org/10.5373/JARDCS/V12SP7/20202360. (in Eng.).

Khalismatov I., Zakirov R., Shomurodov S., Isanova R., Joraev F., & Ergashev Y. (2024) Correlation analysis of geological factors with the coefficient of gas transfer of organizations. In E3S Web of Conferences. – Vol. 497. – P. 01018. DOI: https://doi.org/10.1051/e3sconf/202449701018. (in Eng.).

Khalismatov I., Zokirov R., Zakirov A., Abdurakhmanov B., Botirova N., & Akhmedova N. (2023) Main types of reservoirs of pre-jurassic deposits in the Ustyurt region. In E3S Web of Conferences. – Vol. 434. – P. 02024. DOI: https://doi.org/10.1051/e3sconf/202343402024. (in Eng.).

Kholismatov I.K., Tursunova T.M., Zokirov R.T., & Hayitov O.G. (2022). Prospects of oil and gas-bearing capacity of middle lower Jurassic terrigenous sediments of the Baysun trough. In AIP Conference Proceedings. – Vol. 2432. – No. 1. DOI: https://doi.org/10.1063/5.0090927. (in Eng.).

Konyrbekov, M. Z. (2015). Studying the features of livestock sector growth in Kazakhstan within market environment. Actual Problems of Economics, 169(7), 79–87. RL: http://nbuv.gov.ua/UJRN/ ape_2015_7_12

Kovalenko K.V., Kozhevnikov D.A., Martynov V.G. (2012) Ispol'zovanie petrofizicheskoy modeli effektivnoy poristosti pri geomodelirovanii [Using a petrophysical model of effective porosity in geomodeling]. Proceedings of Gubkin Russian State University of Oil and Gas. – No. 2. – P. 24-28. (In Russ.).

Mukhutdinov N., Khalismatov I., Akramova N., Zakirov R., Zakirov A., & Allayarov B. (2021). Geochemistry of natural gases from sediments of terrigenous and carbonate formations of the Bukhara-Khiva oil and gas region of Uzbekistan. In IOP Conference Series: Earth and Environmental Science. – Vol. 937. – No. 4. – P. 042085. DOI: https://doi.org/10.1088/1755-1315/937/4/042085. (in Eng.).

Nazarov K.B., Abdurakhmanov B.A., Ziyoev T.R. (2017) Issledovanie seysmorazvedochnykh rabot i ikh vliyanie na okruzhayushchuyu sredu [The study of seismic exploration and its impact on the environment]. Proceedings of the Republican Scientific and Practical Conference "Modern Technologies in the Commissioning and Operation of Oil and Gas Fields". – Karshi. – P. 47-49. (In Russ.).

Nazarov K.B., Amilov A.A., Sagdullaev I.A. (2017) Detal'nye seysmorazvedochnye raboty OGT-3D na ploshchadi Varyk-1 (yuzhnyy bort Ferganskoy vpadiny) [Detailed OGT-3D seismic exploration in the Varyk-1 area (southern side of the Fergana Depression)]. Proceedings of the Republican Scientific and Practical Conference "Modern Technologies in the Commissioning and Operation of Oil and Gas Fields". – Karshi. – P. 11-12. (In Russ.).

Orinbaev B., Ratov B., Khomenko V., Tileuberdi N., Khayitov O., Umirzokov A., ... &

Zahrytsenko A. (2025) Comprehensive Use of Electrical Inverse Lateral and Radioactive Logging for Strata Properties Investigation in Cased Wells. ES Materials & Manufacturing. – No. 27. – P. 1417. DOI: https://doi.org/10.30919/mm1417. (in Eng.).

Ratov B., Borash A., Biletskiy M., Khomenko V., Koroviaka Y., Gusmanova A., ... & Matyash O. (2023) Identifying the operating features of a device for creating implosion impact on the water bearing formation. Eastern-European Journal of Enterprise Technologies. – Vol. 5(1). – P. 125. DOI: https://doi.org/10.15587/1729-4061.2023.287447. (in Eng.).

Ratov B., Rucki M., Fedorov B., Hevorkian E., Siemiatkowski Z., Muratova S., ... & Bondarenko N. (2023) Calculations on enhancement of polycrystalline diamond bits through addition of superhard diamond-reinforced elements. – Machines. – No. 11(4). – P. 453. DOI: https://doi.org/10.3390/machines11040453. (in Eng.).

Ratov B.T., Fedorov B.V., Kuttybaev A.E., Sarbopeeva M.D., & Borash B.R. (2022) Drilling tools with compound cutting structure for hydrological and geotechnical drilling. MIAB. Mining Inf. Anal. Bull. – No. 9. – P. 42-59. DOI: https://doi.org/10.25018/0236_1493_2022_9_0_42. (in Eng.).

Ratov B.T., Mechnik V.A., Rucki M., Gevorkyan E.S., Bondarenko N.A., Kolodnitskyi V.M., ... & Korostyshevskyi D. L. (2023). Cdiamond–(WC–Co)–ZrO2 composite materials with improved mechanical and adhesive properties. Journal of Superhard Materials. – No. 45(2). – P. 103-117. DOI: https://doi.org/10.3103/S1063457623020107. (in Eng.).

Sudakov A., Dreus A., Ratov B., & Delikesheva D. (2018) Theoretical bases of isolation technology for swallowing horizons using thermoplastic materials. News of the National Academy of Sciences of the Republic of Kazakhstan. Series of Geology and Technical Sciences. – No. 2. – P. 72-80. (in Eng.).

Zhienbayev A., Takhanov D., Zharaspaev M., Kuttybayev A., Rakhmetov B., & Ivadilinova D. (2025) Identifying rational locations for field mine workings in the zone influenced by minedout space during repeated mining of pillars. Mining of Mineral Deposits. – No. 19 (1). – P. 1-12. DOI: https://doi.org/10.33271/mining19.01.001. (in Eng.).