FEATURES OF WELL CONSTRUCTION IN ANOMALOUS CONDITIONS AT THE FIELDS OF THE REPUBLIC OF UZBEKISTAN

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Study Object Of Research: productivity parameters Research devoted to assessing the productivity of gas condensate wells, the dynamics of their operation and factors influencing production efficiency.

This article examines the key issues of well drilling in complex geological conditions and presents the results of a geological study of the Mustakillikning 25-yilligi (here in after M-25) field. Based on well drilling data, the lithological composition of the rocks has been studied, and the geological conditions for deep well drilling at the M-25 field are highly complex, which impacts design decisions and construction.

Information is provided on the main complications encountered during well drilling at the Mustakillikning 25 Yilligi (25 Years of Independence) field. The main complications encountered during well construction at the M-25 field are highlighted.

This article considers the main issues of drilling wells in complex geological conditions and presents the results of studying the geological structure of the 25th Anniversary of Independence field. Based on the drilling data, the lithological composition of the rocks has been studied (is being studied), and the mining and geological conditions for drilling deep wells in the M-25 field are very complex, which is reflected in the design solutions and well construction.

Detailed information is provided on the main problems encountered in the well drilling process at the "25th Anniversary of Independence" field. The main difficulties encountered in the construction of wells at the M-25 field are considered.

The article discusses the main issues of drilling wells in complex geological conditions and presents the results of studying the geological structure of the Mustakillikning 25-yilligi field. Based on well drilling data, the lithological composition of rocks has been studied and the mining and geological conditions of drilling deep wells at the M-25 field are highly complex, which is reflected in design solutions and construction. Information is provided on the main complications during well drilling at the Mustakillikning 25 Yilligi (25 Years of Independence) field. The main complications encountered during well construction at the M-25 field are highlighted.

Key words: deposits, well, pressure, formation, well construction in complex mining and geological conditions, well design, drilling complications, absorption, manifestations, collapses, rockfalls, drilling accidents, well casing.

A natural gas field is a collection of natural gas and gas condensate deposits within a specific area. Typically, it occupies several hundred

Kilometers, gas wells are used for extraction. The gas-bearing horizon is usually located above the oil horizon. Rational development of gas fields is based on the scientific theory of gas movement in porous media.

The oil and gas industry covers the entire chain of oil and gas operations, from geological exploration (seismic exploration, well logging, geological survey, well development), drilling, oil and gas field development, hydrocarbon production and processing, production of petroleum products, oil and gas and chemical equipment, and provision of consumers with petroleum products.

A number of industrial enterprises operate in the oil and gas industry, producing such products as gasoline, diesel fuel, jet fuel, various types of oils, fuel oil, bitumen, various grades of polyethylene, commercial natural and liquefied gas, oil and gas chemical equipment, gas cylinder equipment, etc.

The investment policy of the oil and gas industry is primarily aimed at attracting high-tech foreign investment in order to diversify the industry and ensure advanced processing of oil and gas resources.

Today, the Republic of Uzbekistan has 5 oil and gas regions (Ustyurt, Bukhara-Khiva, Gissar, Surkhandarya and Fergana) and 4 promising oil and gas regions (Khorezm, Middle Syr Darya, Central Kyzylkum and Zarafshan Depression), in which more than 270 oil and gas fields have been discovered, which annually leads to the growth of hydrocarbon raw materials.

The geographical and administrative position of the M-25 field is part of the Baysun district of the Surkhandarya region of the Republic of Uzbekistan and is located 20 km southeast of the regional center of Baysun.

There are no settlements within the study area. The nearest settlements are Kafrun, Bashli-Bulak, Rabot, and Dashtgaz. The Gumbulak, Adamtash, Amu Darya, Khaudag, and Mirshody oil and gas fields are located in close proximity to the study area. The main occupations of the population in the study area are livestock breeding and agriculture. Agriculture (cotton growing) and the oil and gas industry are increasingly important in the region's economy. In addition to oil and gas, mineral resources include building stone, sand, and clay, which are used in the construction of industrial and residential buildings.

Boysun is a city and the administrative center of the Boysun District in the Surkhandarya Region of Uzbekistan. Trade caravans passed through the Steel Gate in a narrow mountain gorge for thousands of years. The armies of Alexander the Great, Genghis Khan, and Tamerlane passed through this area.

Teshik-Tash Cave, where Neanderthal remains were found, is world-famous. Wall paintings depicting a "magical bull hunt" from the Mesolithic era can be seen nearby in the Kugitang Mountains. It has been a town since 1975 (previously a village).

The surrounding area of the city of Baysun is proposed for inclusion in the UNESCO World Heritage List.

The natural and climatic conditions of the region and the deposit are sharply continental, typical of intermontane basins. The fauna is sparse and typical of the semidesert areas of Central Asia. Orographically, the deposit area is characterized by piedmont-adyr relief, in the structure of which the lithological composition of the Neogene deposits plays a significant role. Part of the work area is located in valley, in a relatively calm area, within which the installation of wells is difficult due to the presence of arable land, shallow ravines, and a system of canals.

In addition, the area contains springs and wells with fresh water suitable for drinking. There are also irrigation structures, canals, and adyrs. The water from the collectors is unsuitable for drinking due to its salinity and severe pollution.

The field is one of the largest gas fields in Uzbekistan. It is located in a challenging geological position, at an altitude of 1,000 meters above sea level.

Lithological and stratigraphic characteristics of the well

Stratigraphic Unit	**Depth (m) From**	**Depth (m) To**	**Dip (°)**	**Azimuth (°)**	**Cavernosity Coef.**	**Lithological Description**
Quaternary	0	15	–	–	–	Loess, loams, sands, gravels
Neogene	15	420	8–10	210	1.2	Clays, siltstones, sandstones; yellow-gray, reddish-brown
Paleogene	420	740	8–10	210	1.2	Friable clays with marl interbeds; calcareous sandstones; limestones
Senonian	740	1270	8–10	210	1.2	Gray to dark-gray clays; fine-grained sandstones
Turonian	1270	1620	8–10	210	1.2	Friable clays, strong marls, dense limestones
Cenomanian	1620	1880	8–10	210	1.2	Calcareous sandstones, shelly limestones, gypsum
Albian	1880	2220	8–10	210	1.2	Thin-bedded clays, limestones, medium-grained sandstones
Aptian	2220	2280	8–10	210	1.2	Strong sandstones, friable clays, marls
Barremian	2280	2380	8–10	210	1.15	Sandstones with limestone, gypsum, siltstone
Hauterivian	2380	2470	8–10	210	1.15	Siltstones, laminated clays, gypsum
Valanginian	2470	2770	8–10	210	1.15–1.22	Sandy clays, strong sandstones with

						gypsum
Kimmeridgian–Tithonian	2770	2820	15-20	210	1.1	Gypsum is white and pink, swelling upon contact with water. Salt is colorless; pink salt contains inclusions of white gypsum. Anhydrite is gray to colorless with interlayers of dark gray limestone.
Kimmeridgian–Tithonian (XV horizon)	2880	3170	15-20	210	1.1	Limestones are fractured, gray to dark gray; the lower part is clayey. Anhydrites are present.
Callovian–Oxfordian (XVa horizon)	3170	3370	15-20	210	1.1	Limestones are gray and dark gray, dolomitized, dense, platy, with interlayers of detrital, algal, and biomorphic limestones.
Callovian–Oxfordian (XVI horizon)	3370	3570	15-20	210	1.1	Dark gray limestones, dense, aphanitic, clayey, massive.
Middle Jurassic (XVII horizon)	3570	3600	15-20	210	1.1	Gray to dark gray fine-crystalline layered limestones and limestone shell rocks with thin layers of sandy-clayey shales and marls. Sandstones are gray, fine-grained, calcareous, and clayey.

ОБЗОРНАЯ КАРТА
Инвестиционного блока "Узбекистон мустакиллиги"

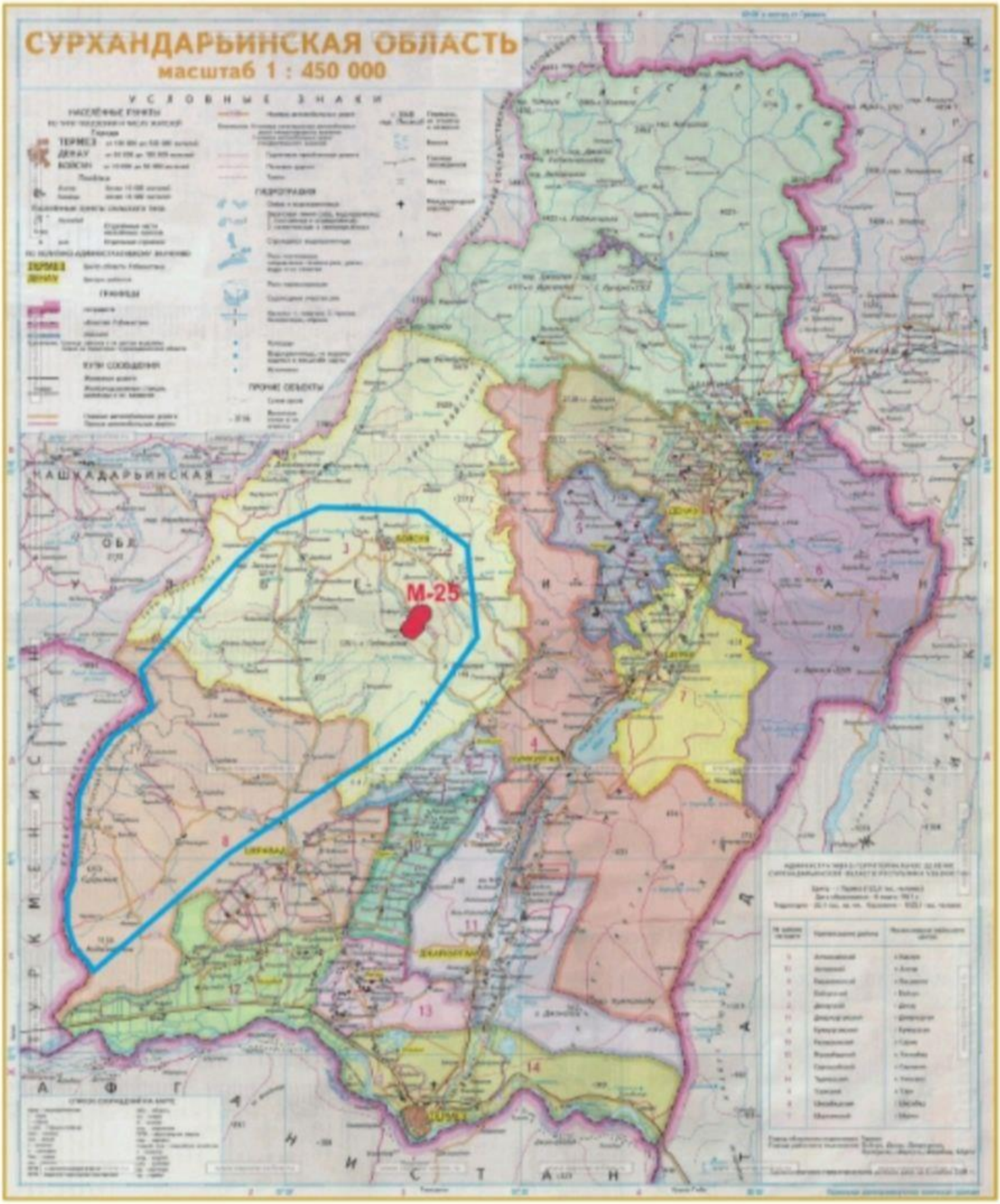

Fig. 2. Overview map of the investment block "Uzbekistan Mustaqilligi" (Independence of Uzbekistan).

The historical name of the Gadzhak-Boyangora field. According to the State Register of Geographical Object Names, it was previously registered by the state under the name "Bayangara," then "Gadzhak," and then the name was changed from "Gadzhak" to "25 Years of Independence" (M-25) in 2016. The investment block in which the field is located was renamed from "Boysun" to "Independence of Uzbekistan." The first geological exploration work at the Gadzhak field (formerly the M-25 field) was conducted back in 1938, and the first signs of mineralization were obtained in 1941 as a result of drilling an exploratory well non-industrial oil, as for gas-bearing deposits, they were discovered in 1976 in the Jurassic carbonate deposits.

The M-25 gas condensate field, a research target (where innovative technology implementation is planned), is stratigraphically complex and confined to Jurassic presalt carbonate deposits, i.e., a commercial gas reservoir of the XV and XVa carbonate horizons of the Jurassic. The total size of the reservoirs is 11.2 km long, 11.6 km wide, and 719 m high along the XV horizon, and 8.6 km long, 8.4 km wide, and 435.5 m high along the XVa horizon. The reservoirs are porous-cavernous-fractured. The reservoir type is massive and tectonically sealed.

FEATURES OF THE M-25 DEPOSIT.

1) However, the high content of hydrogen sulfide ((H2S - 8% or more) and carbon dioxide (CO2-12.7%), the main part of methane (80-82%) in the layers with high formation pressures up to 65 mPa-AHFP and formation temperature: T=125-133°C. The bedding of the layers is at an angle of up to 450, the layers in one field can have a difference in depth of up to 500 m and the complexity of the mining and geological conditions of the field required completely different technologies and equipment, which simply did not exist at that time.

2) Consequently, the equipment used at the field must be resistant to high temperatures, pressures, sulfur and carbon dioxide aggression.

3) Due to the mountainous terrain, which poses the main challenge for geological exploration, and the limitations in site preparation for well drilling, drilling of several directional wells from a single site, i.e. from a well cluster, will be introduced.

4) The structure is a suprathrust brachyanticline fold of complex shape and structure. The southeastern and eastern parts of the fold are adjacent to a regional thrust fault. The thrust fault in the pre-salt zone extends south of the deposit, with a slickenside dipping toward the center of the Baysun trough, reaching a dip angle of 60°. The thrust fault resulted in ductile salt flow within the M-25 structure, leading to wedge-shaped injection into the near-fault zone (the exposed thickness is 1,620 m) and a simultaneous significant reduction in thickness within the crest of the pre-salt structure (up to 35 m). In the supra-salt zone, the thrust fault can be traced back to the Paleogene and beyond.

5) When drilling deep wells with abnormally high pressure, geological complications arise:

- Drilling mud absorption; / Gas emission from drilling mud;
- Clumps and collapses of the borehole walls, formation of a trench;
- Narrowing of the wellbore.

As a result, the following risks arise, affecting the time and material resources for well construction:

- Losses of drilling fluid: / Seizure/breakage of drilling tool
- Collapse of casing columns;

- Repeated re-drilling of additional lateral wellbores.

6) requirements for well designs, their drilling, methods of opening up formations and well development

The well design is based on an analysis of the lithological characteristics of the rock formations, expected complications during drilling, accumulated well drilling experience at the given and similar fields, the expected flow rate, and the diameter of the tubing used. The composition of the well significantly influences the choice of well design.

Reservoir fluid and the presence of aggressive components (carbon dioxide CO_2 and hydrogen sulfide H_2S) significantly impact the strength and durability of well casing. In terms of reliability and safety, the well design must ensure:

strength of columns and sealing of the wellhead in cases of gas and water shows, emissions and open fountaining;

resistance to the hydrostatic pressure of the drilling mud column;

resistance to loads in cases of absorption of drilling fluid with a drop in its level.

achieving the design depth;

conditions for safe work without accidents and complications at all stages of well construction; conditions for the protection of the subsoil and the environment, primarily due to the strength and durability of the well lining, the tightness of the casing strings and the annular spaces they cover, as well as the isolation of fluid-containing horizons from each other, from permeable rocks and the daylight surface;

necessary protection of casing strings and tubing from the effects of carbon dioxide and hydrogen sulfide contained in the formation fluid;

maximum unification in terms of casing pipe and wellbore sizes;

use of efficient equipment, optimal methods and operating modes;

Table 2. Well design characteristics

The drilling interval for the production casing is represented by Jurassic rocks

No.	Casing Name	Setting Interval (m)	Casing Ø (mm)	Hole Ø (mm)	Cement Top
1	Extended Conductor	0–40	660.4	840	To wellhead
2	Conductor	0–500	473.1	609.6	To wellhead
3	Intermediate Casing	Vertical: 0–2650Along hole: 0–2846	339.7	444.5	To wellhead
4	Production Casing	Vertical: 0–3060Along hole: 0–3300	244.5	311.2	To wellhead
5	Production Casing (Liner)	Vertical: 2830–3600Along hole: 3046–3880	177.8	212.7	From 2830 / 3046 m to wellhead

(Kimmeridgian-Upper Oxfordian and Upper Callovian-Lower-Middle Oxfordian). These are anhydrites and limestones. Drilling may encounter complications such as mud losses and gas and water shows. For drilling this interval, it is recommended to use a biopolymer-weighted drilling mud. Freshly prepared drilling mud treated with polymer reagents should be used. If mud losses occur, add a filler of varying textures, depending on the intensity of the losses. To impart colmatation properties to the mud and provide partial weighting, add calcium carbonate of various fractions as a preventative measure C and promptly eliminate the negative impact of the aggressive component gas (H2S and CO2) to add slaked lime and zinc oxide to the solution formula.

The development of a promising deposit was given new life in the context of independent Uzbekistan, which strives to apply the best international practices in the country's economy in general and its oil and gas sector in particular.

The field's hydrocarbon reserves were first reviewed and approved by the State Reserves Commission (SRC) in 1975. Subsequently, the HC reserves were recalculated and approved by the SRC in 2009 and 2020. Based on the results of 3D areal seismic exploration and well drilling data, a report was prepared on the calculation of hydrocarbon reserves and associated components, followed by approval by the State Reserves Commission under the State Geology Committee of the Republic of Uzbekistan. (The estimated commercial initial reserves of hydrocarbon raw materials are "million m3", for categories ABC1 and C2).

Uzbekistan's large reserves of this mineral open up new opportunities for the implementation of modern technologies in geological exploration, production, and processing. Thus, the project in Surkhandarya Region represents not only a new strategic approach to diversifying the country's fuel base but also a foundation for sustainable development in the future.

GEOLOGICAL AND PHYSICAL CHARACTERISTICS OF THE DEPOSIT.

The lithological-stratigraphic characterization of the well sections of the M-25 field was carried out using diagrams of electrical, radioactive and other types of logging, with the identification of stratigraphic boundaries and horizons in accordance with the stratigraphic scheme developed in 1958 and unified at the Samarkand meeting in 1971, with the adjustment of the position of individual stratigraphic boundaries based on research materials from subsequent years.

The sedimentary cover of the Surkhandarya Depression and its surrounding mountains is composed of Mesozoic and Cenozoic deposits, represented by rocks of Triassic, Jurassic, Cretaceous, Paleogene, Neogene, and Quaternary ages. The Mesozoic-Cenozoic section is characterized by a complex structure, strong and rapid thickness variability, and a diverse lithofacies composition of the deposits both cross-sectionally and along the strike.

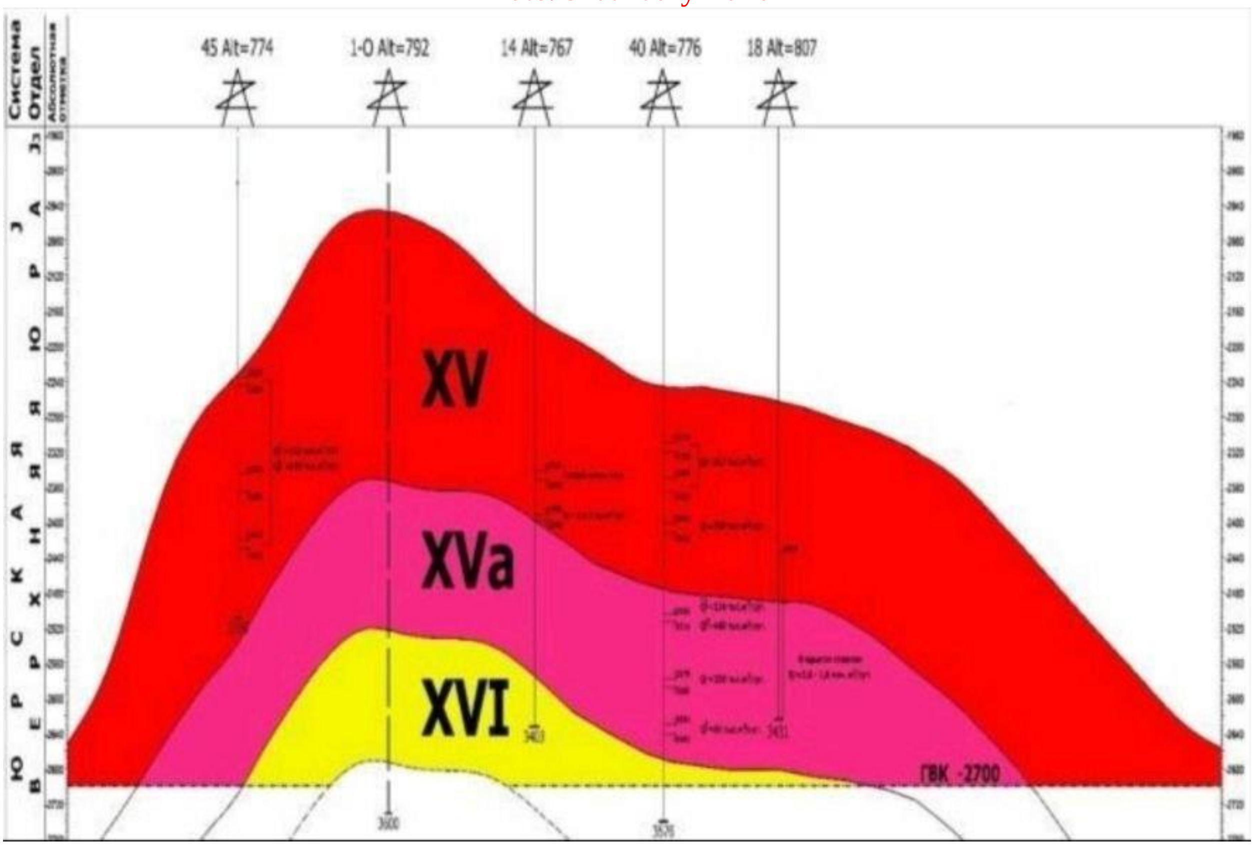

Figure 4. Productive horizons of a gas field, schematic geological section.

The industrial gas content of the field is associated with carbonate deposits (total thickness of about 600-700 m); Jurassic

Horizon XV is represented by the replacement of anhydrites and limestones;

The XVa horizon is represented by limestones, predominantly of shallow-water lagoonal facies;

The 16th horizon is composed of uneven interbedding anhydrites and limestones, clayey limestones with marl interlayers.

Table 3. Characteristics of deposits of the M-25 field

Horizon	Reservoir Type	Dimensions (km × km)	Area ($\times 10^3$ m²)	Roof Elevation (m)	OWC Elevation (m)	Thickness (m)
XV	Massive, tectonically sealed	11.2 × 11.6	91,889	−2100	−2819	719
XVa	Massive, lithologically & tectonically sealed	8.6 × 8.4	49,270	−2383.5	−2819	527

Thickness of productive horizons (layers). The structural features of the massively productive sulfate-carbonate strata of the Mustaqillikning 25 Yilligi deposit include the uneven distribution of reservoirs and the dense rocks separating them, which are layered and lenticular in nature, the stratified nature of the deposits, extensive fracturing, and the commercial productivity of low-porosity reservoirs. This is primarily due to the active tectonic regime during the Kimmeridgian-Tithonian period, as well as during the organogenic stage of the region's development.

The productive strata here are characterized by a complex structure. Reservoirs are primarily thin interlayers and lenses of limestone, dolomitized limestone with inclusions of lenses and crystals of microcrystalline anhydrite with low porosity values (1-10%), only in isolated cases exceeding this value (16-18%).

Conclusions. Despite the challenges of drilling and developing the M-25 fields, the use of modern technologies should enable the construction and operation of these fields, the development of which was once considered impossible, extremely difficult, or extremely costly.

Wells at the fields are being developed and new technologies are being applied in the well construction process, including intelligent well completions. All this allows us to confidently say that further development of the region is far from complete, and that the development of new technologies will enable the exploitation of hydrocarbon reserves previously considered either ineffective or impossible.

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