

Improving the Development System in the Block 4 of Deposit No. 31 of Romashkino Field According to the Logging Reinterpretation and Simulation

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Abstract. This article describes the works carried out in the oil and gas production department “Dzhalilneft” to optimize the development of oil reserves from block 4, deposit No. 31 of the Romashkino field. Based on the logging reinterpretation, geological structure of the deposit is adjusted to make rational technological decisions and development of geological and engineering operations. Reinterpretation results of old geophysical data allowed correlating geological section on layers and adjust the previously constructed maps for development of Bobrikovian Lower Carboniferous. The work was performed to identify, study and further map erosion ‘incisions’. Based on the results of the reinterpretation of old geological and geophysical data for each well, change the values of reservoir characteristics of productive intervals, effective-oil-saturated strata, we obtained growth of oil reserves. According to the new geological model of block 4, deposits No. 31 the measures are suggested to optimize the placement of project wells for production drilling; wells are recommended for side and horizontal sidetracks, as well as geological and engineering activities for penetration of reservoirs previously unidentified and uninvolved in the development. The proposed measures have helped to reduce the geological and economic risks of drilling of unsuccessful wells, achieve the design level of oil production and oil recovery factor.

Keywords: Bobrikovian horizon, geological and hydrodynamic simulation, erosion incisions, hard-to-recover reserves, logging reinterpretation, reservoir properties, reservoir, reserves.

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Development of oil company depends on the replenishment of its resource base at the expense of reserves increment in two areas: further exploration and increase of the oil recovery factor. This problem is under study in the oil and gas production department “Dzhalilneft” of PJSC “Tatneft”, including by re-interpretation of well logging of drilled wells and on the basis of approved geological and technical actions clarification and development of new ones.

As a result of re-interpretation of old geological and geophysical data for each well there is a significant increase of oil reserves. Modern geophysical methods for studying wells are substantially improved both technically and with software products interpreting the results.

Oil-bearing deposits of Tournasian and Bobrikovian horizons, including deposit number 31, require detailed consideration. The deposit number 31 of Romashkino field is in industrial development since 1977. Experience in operating deposit suggests that there are certain difficulties in achieving estimated oil production rates. The reason is not only in technical and technological aspects of development, but, more importantly, in accuracy of representation of the deposit geological structure. Geological survey of oil and gas production department works to achieve the maximum match of forecast constructions with the actual ones according to drilling data of new wells. In this connection, based on reinterpretation of well logging, well sections are clarified, productive strata and their analogs are

allocated, correlation schemes and geological and statistical sections are built (Fig. 1).

According to the results the following is clarified: representation of geological structure of deposit in the structural surfaces, the absolute values of reservoir properties of the host rocks, reservoir distribution by area and section, oil-bearing boundaries and values of effective oil-saturated strata, oil-saturated rock volumes and oil reserves contained therein.

This approach allowed us to adjust the previously constructed maps for development of productive Tournasian, Bobrikian and Radayevskian strata of the Lower Carboniferous for making the most efficient technological solutions and the

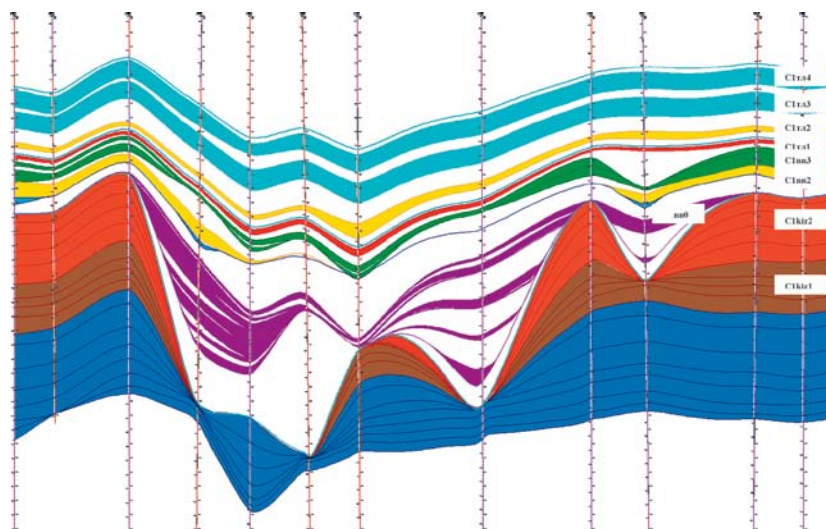


Fig. 1. Geological and stratigraphic profile of Tulsian-Tournasian sediments.

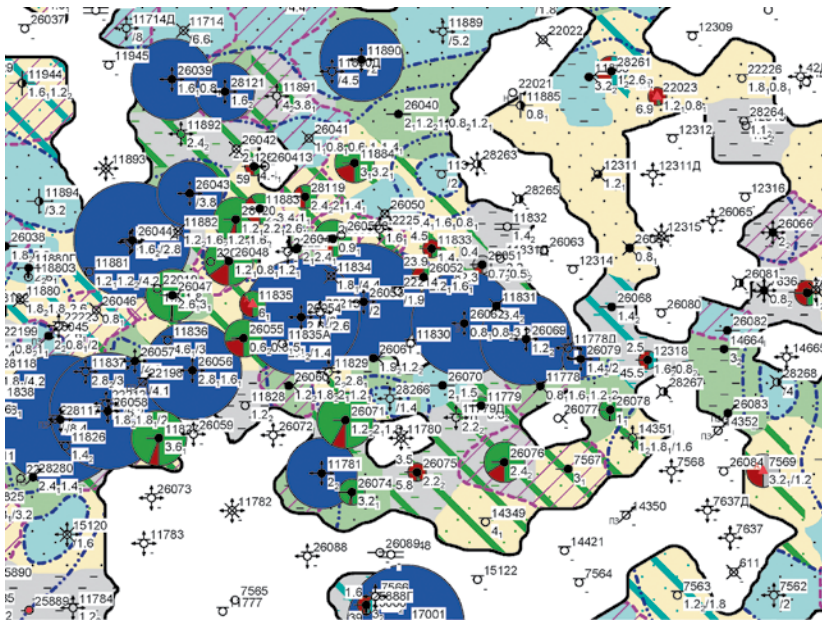


Fig. 2. Detail of the development map for block 4, deposit 31, formation S1br3.

development of geological and technical measures to optimize the development of reserves for block 4 of deposit number 31 (Fig. 2).

The peculiarity of the structure of block 4, deposit number 31, as well as its structure as a whole, is in the presence of erosion violations in carbonate deposits of Tournasian tier, where a complete washout of Elkhovskian mudstone is recorded, as well as the lack of them in the well section. According to correlation sections and construction of reservoir distribution maps a variety of incisions is indicated on the area in the form of channels, troughs and small areas with different depth of erosion, indicating about the frequent change

of depositional environment. Brines of shallow basin, penetrating through cracks and leaching carbonates of Tournasian tier, destroyed them to the formation of cavities of micro and macro-sizes to karst formations.

Destroyed material was washed out to the nearest deflection of Kama-Kinel system. Destroyed zones were filled with terrigenous deposits of Bobrikovian-Radaevskian age, which are associated with elevated values of clastic strata overlying carbonate deposits of Tournasian stage (Fig. 3). Incision depth to carbonates of Tournasian tier is different: from a few to tens of meters, and complete erosion of Tournasian carbonates and part of the section top of Zavolzhsian Upper Devonian. This is clearly seen in the logging curves, as shown in the example of well No. 14351, where density of isohypses changes sharply on the structural plan, thickness of Tournasian carbonates are reduced and thickness of clastic formations is increased.

The lack of influence of the injection well number 17001 in Bobrikovian sediments on surrounding production wells may serve as hydrodynamic component to confirm the presence of erosive incision (Fig. 4).

Logging reinterpretation had great value on the allocation of oil-bearing intervals and productive formations, mapping of reservoir distribution (Fig. 5).

As a result of logging interpretation and digitizing, boundary values by oil saturation are clarified that can be attributed to lowering penetration of mud filtrate into the formation. By the results of reinterpretation of old geological and geophysical data for each well, reservoir property values of productive intervals and their conditional values were

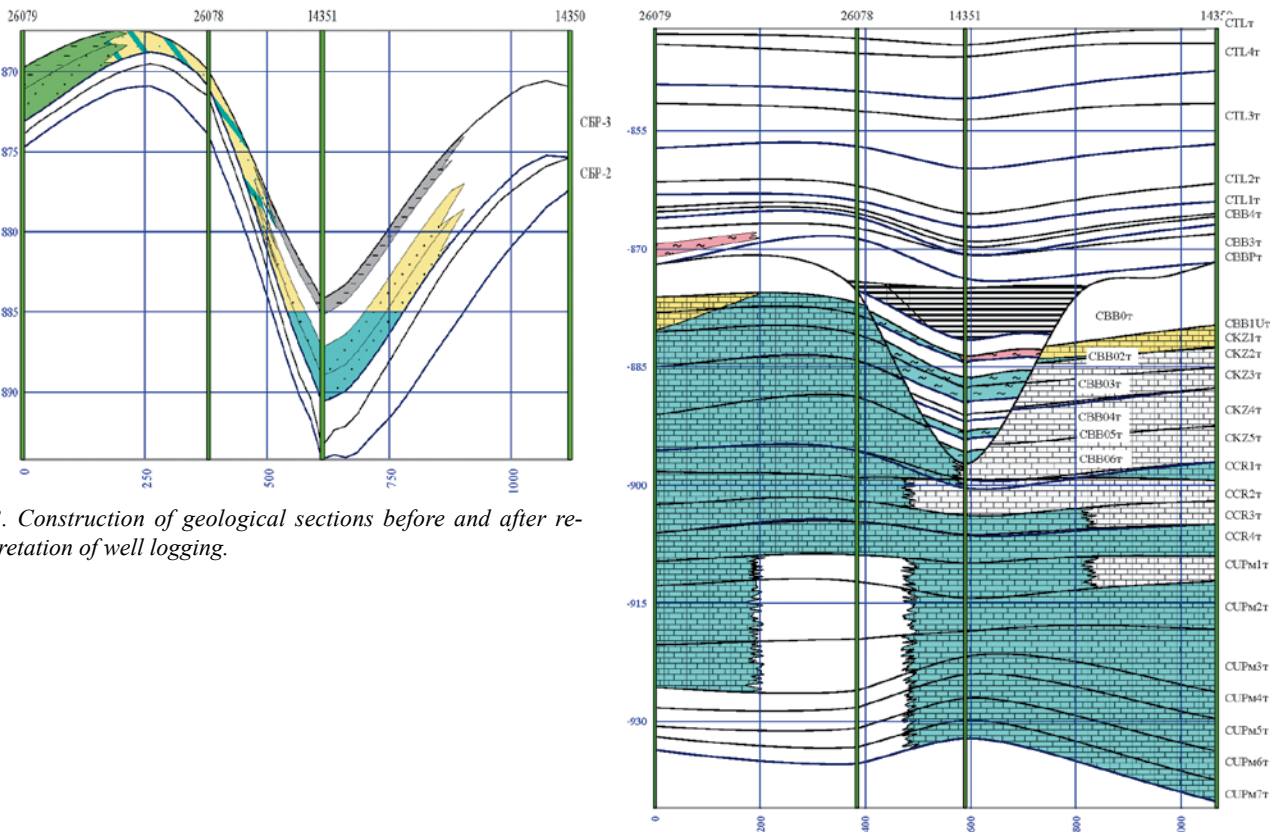


Fig. 3. Construction of geological sections before and after re-interpretation of well logging.

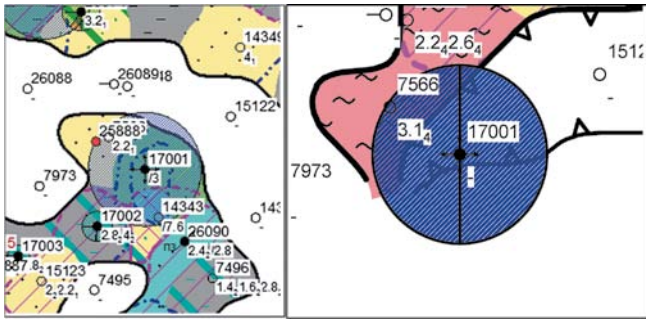


Fig. 4. Determination of reasons for the lack of influence in injection well No. 17001.

changed, which naturally led to the refinement of effective, oil-saturated thickness and volume of oil-saturated rocks. As a result, in a number of areas a significant increase in oil reserves is implemented.

Well number 7473 can serve as an example; it was drilled in the productive deposits of Pashiyskian horizon of the terrigenous Devonian. Because of the high water cut of production well was conserved in 1997. According to findings of old geophysical studies for the well number

7473 upper horizons of the section (namely, Upper Devonian Kynovskian and Lower Carboniferous Bobrikovian) stand out as analogs, i.e., characterized by substandard values of reservoir properties.

As a result of this re-interpretation of well logging, sediments S1br2 of Bobrikovian were interpreted as weak oil saturated (Fig. 6). In order to develop reserves on the site in question it was suggested to reopen the well, followed by perforation of the production string in the interval 1143.4-1145 m of Bobrikovian.

Fig. 7 shows a development map of S1br3 formation, based on the results of the detailed correlation of well sections and data of technological performance of their work. In well number 26074 it was offered to produce additional perforation of S1br2 formation, whose occurrence interval on the old loggings was interpreted as an analogue. After digitizing loggings, S1br2 formation is interpreted as clay reservoir with oil-saturated thickness of 2.8 m.

Adjustment of well points of the project fund is no less important result of re-interpretation of well logging and clarification of geological structure of the deposit block. Figure 8 shows the development map fragment with applied

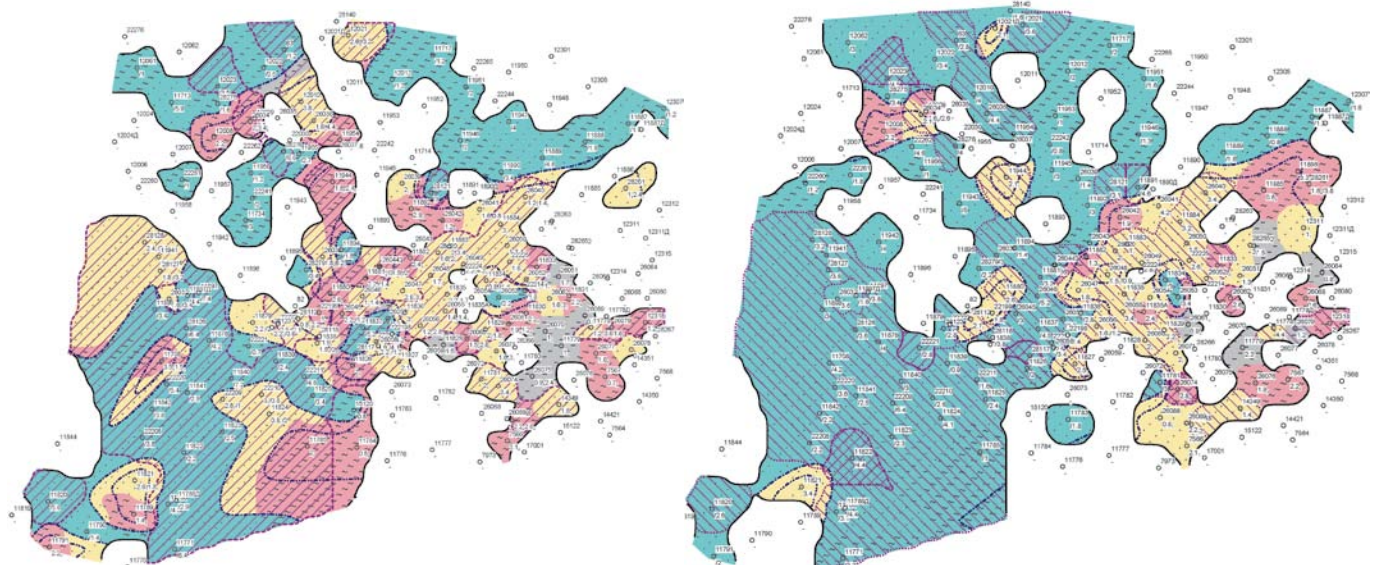


Fig. 5. Maps of reservoir distribution after re-interpretation of well logging for block 4, deposit 31 of Bobrikovian for the formations S1br2, S1br3.

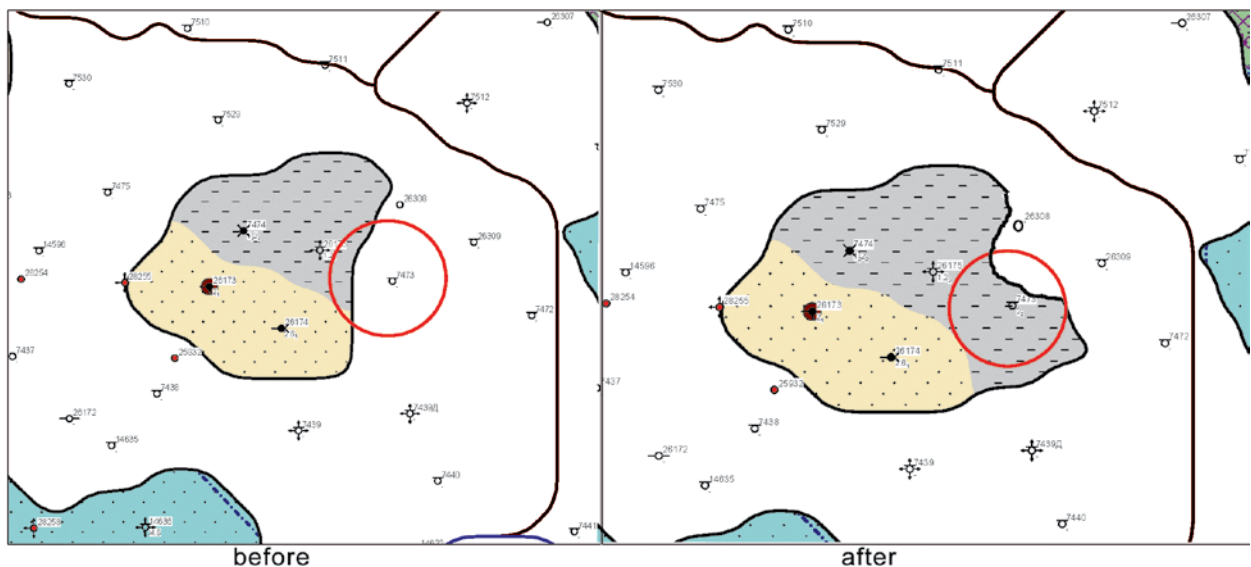


Fig. 6. Detail of development map for the formation S1br2 before and after re-interpretation of plot for well No. 7473.

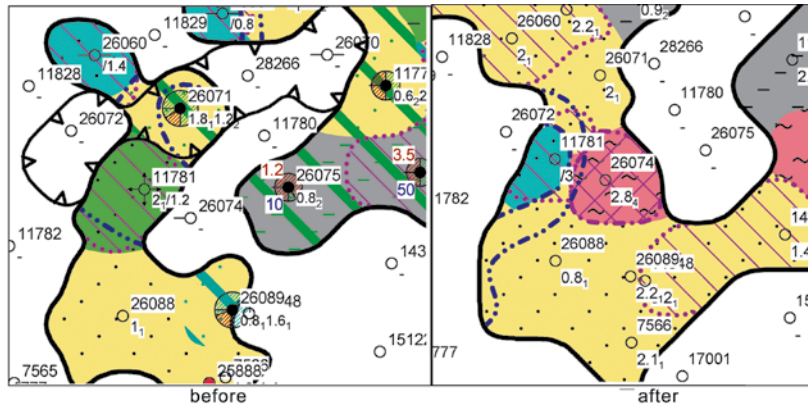


Fig. 7. Plot of well No. 26074 before and after the re-interpretation of well logging.

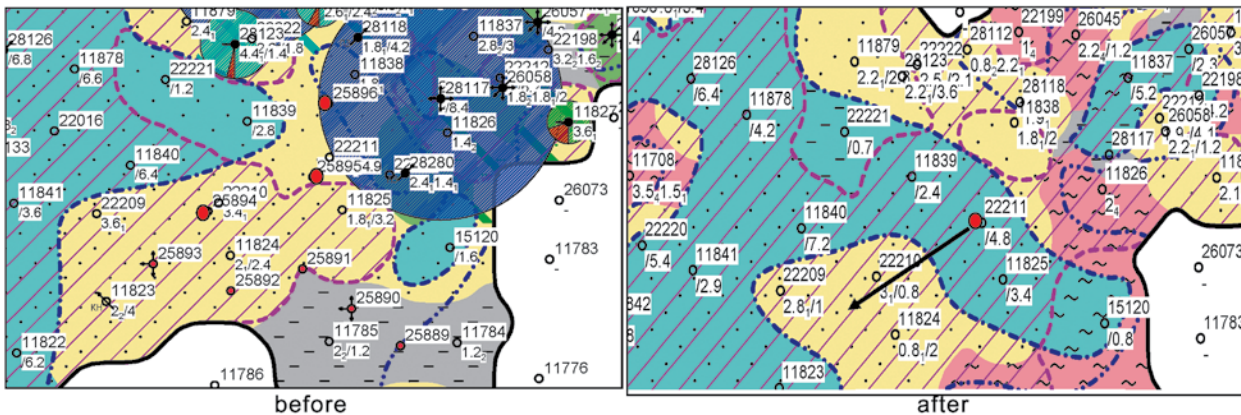


Fig. 8. Detail of development map for the formation S1br3 before and after re-interpretation of plot for well No. 11825.

additional project wells for drilling.

According to re-interpretation results constructing of a three-dimensional geological and hydrodynamic model for block 4, deposits No. 31 was performed. Deposit simulation allowed us to obtain new representation on the distribution and occurrence of reservoir rocks and concentration of residual reserves in them.

Construction of various development maps, lithology, reservoir flooding was performed on the statistical data. The difficulties were revealed to determine saturation of certain areas, because most of the wells are working with a high

percentage of water cut, though reasons for their flooding are not unambiguous. As a result, the development maps show partially or fully water flooded area, in which the drilling of new wells does not correspond to the current indicators. For such maps, in principle, it becomes very difficult to plan activities, and risky to drill new wells.

In this case, additional geophysical and hydrodynamic studies are provided.

Section of block 4, deposit 31 was chosen for geological and hydrodynamic modeling. After the adaptation of the model, maps were obtained for various parameters in the

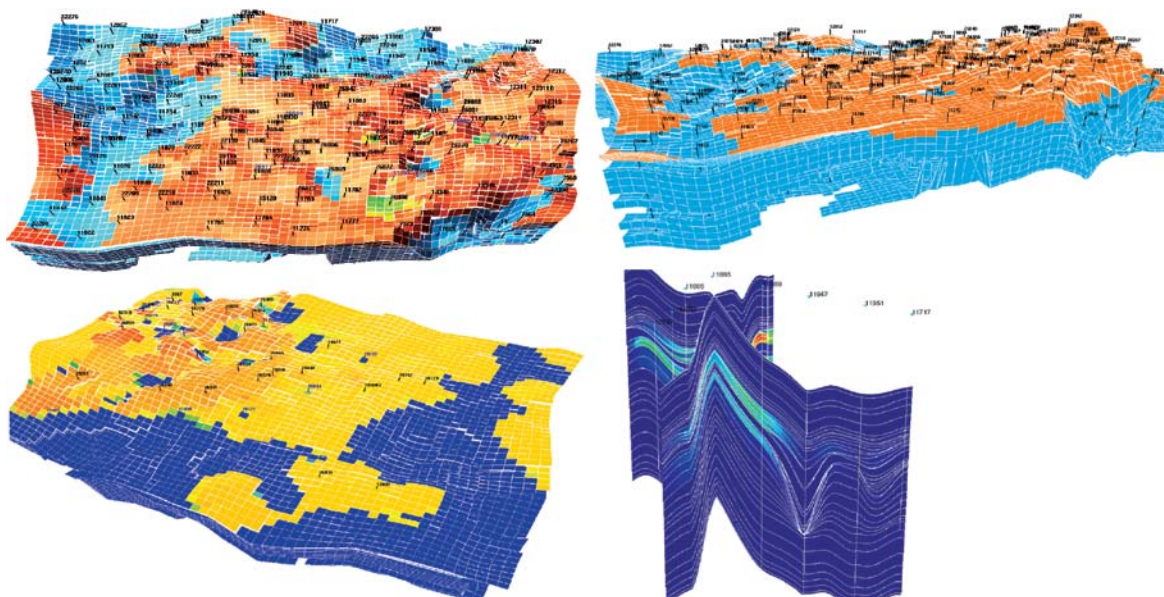


Fig. 9. Construction of three-dimensional geological and hydrodynamic models.

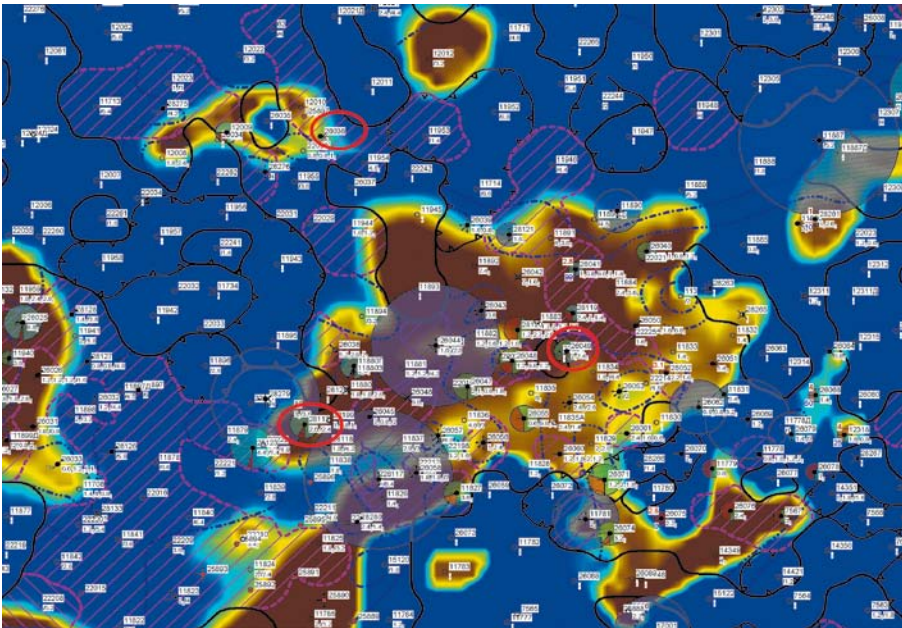


Fig. 10. Averaging of three-dimensional model into two-dimensional model.

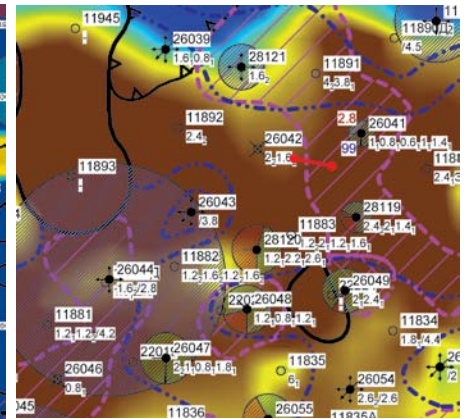


Fig. 12. Repeated abandonment of well No. 26042 with drilling horizontal sidetrack.

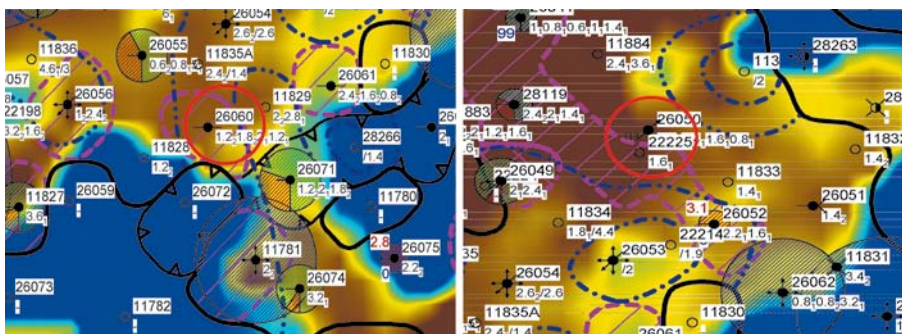


Fig. 11. Wells No. 26060 and No. 26050, according to the results of research are available for transfer in the production fund.

three-dimensional visualization. They are maps of initial and current oil saturation, open porosity, permeability and other (Fig. 9-10).

After performed conversions, the analysis of current(residual) oil saturation maps was performed and geological and technical measures were proposed to optimize development system of the block.

Proposed geological and technical measures based on the analysis of new lithologic maps were focused on optimization of project wells location, such as the transfer of drilling point for well 25895 (Fig. 8).

1. When comparing the water cut for neighboring wells and residual oil saturation of the target formation, wells can be distinguished, which require the application of water-isolating techniques.

On the block in question as a result of geological and technical measures wells No. 26036, 26049, 28112 (Fig. 10) are offered for water-isolating operations.

2. Selection of the wells for stimulation or bottomhole area treatments is made as the result of comparing the reservoir properties: porosity, permeability and fluid flow rates, as well as difference between the calculated and actual depression. Wells with identified inconsistencies are usually characterized by a lower flow rate compared to neighboring wells, located in similar geological conditions.

The wells No. 26050, 26060 are recommended for

research of IGN to determine the nature of water and oil saturation of reservoirs and according to the results transfer them into a production fund (Fig. 11). The well No. 26042 is recommended to eliminate with drilling horizontal sidetracks in a south-easterly direction from the old bottom (Fig. 12).

Thus, from the above we can draw the following conclusions.

1. Construction of lithological maps according to the detailed correlation provides more informative distribution of lithological bodies in area and section.
2. Digitisation and reinterpretation of well logging of drilled fund allows to:
 - Significantly clarify understanding of the geological structure of the target object;
 - Adjust the volume and presence of residual oil reserves (in some cases the increment, which is important for the recovery of the resource base);
 - Adjust the position of the project wells fund and avoid drilling of empty and highly watered wells.
3. Adoption of new geological and technical measures can:
 - Significantly expand the information content of the current state of deposit development;
 - The most reasonable plan activities to optimize the existing production system of oil reserves;
 - To achieve projected levels of oil production and estimated oil recovery factor.

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