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Structural 3D Modeling and Creation of a Three-Dimensional Grid

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Abstract: Structural modeling allows obtaining geometrization of the simulated geological object. The result is a structural model which is also called a structural framework.

Structural modeling allows obtaining geometrization of the simulated geological object. The result is a structural model which is also called a structural framework. The structural framework is a set of surfaces of roofs and soles of layers in three-dimensional space (Fig. 1.). There is a general algorithm for constructing a structural model based on well data and seismic data. The first step is to calculate the thickness of layers and dense bridges in wells, taking into account the inclinometry of wells. Then maps of the thickness of the layers and dense bridges between the layers are built. On the basis of thickness maps from the reference reflecting horizons, the surfaces of the roof and the soles of productive layers are built. To model a structural framework with faults, the stages of constructing a structural model of faults and embedding them into an already created structural model are added.

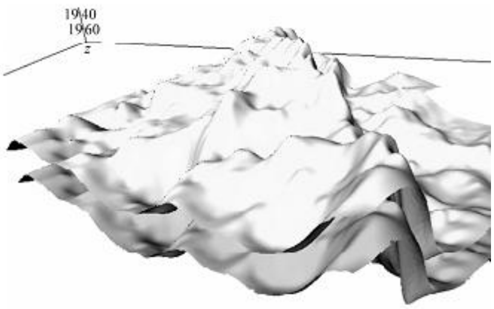

Fig. 1. Structural model of the roof and sole of the productive reservoir

The last stage of structural constructions is the control of the accuracy of construction within the wells. This sequence of actions is the most common and excludes the intersection of roofs and soles of productive layers. There are various modifications of the construction of the structural framework implemented in three-dimensional geological modeling packages, differing mainly in the degree of automation of structural modeling and taking into account additional limitations.

Structural surfaces are 2D grids. Considering the size of the deposits, for structural constructions, it is recommended to choose the following sizes of 2D grid cells: 25×25, 50×50 or 100×100 meters. At the same time, it is desirable to fulfill the condition that the marks of the intersections of two wells do not fall into one cell of the 2D grid.

The construction of structural surfaces of productive layers is carried out from the reflecting horizon (down, up) or between them.

Algorithms for constructing structural surfaces today are very diverse and allow you to build surfaces of any complexity and with almost any amount of source data. The most common are algorithms based on crayking, splines and triangulation. The total thickness of the deposits of intermediate horizons is almost never equal to the thickness of the deposits between the reference horizons. At the same time, the reference horizons and the strata between them are assumed to be more reliable than the strata of intermediate horizons. In this regard, the thickness of the intermediate horizons is being corrected in order to match them with the thickness between the reference horizons. The method of proportional correction is most often used,

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when the thickness of intermediate horizons is adjusted depending on their weight in the total thickness of intermediate horizons [1] according to the formula (1).

$$\mathrm{H_c} = \frac{H_a}{\sum H_a}\Delta H,\ \Delta H = H_b - \sum H_a,$$

where H_a- thickness of deposits between reference horizons; H_b- the thickness of the intermediate horizon.

The stage of creating a three-dimensional grid is the process of dividing the space between the roof and the sole of the deposit into three-dimensional cells. The construction of a three-dimensional grid is determined by the structural framework and the accepted conceptual model. The structural framework plays the role of a form that restricts the three-dimensional grid, and the role of a guide for the grid layers. There are two global types of grids – regular and irregular. Regular grids are limited to a certain geometry of grid cells, and irregular grids can accept any geometry of cells. There are two most common basic types of grids – the XY regular type and the Corner point type, which differ from each other in the shape and orientation of the cells. The XY regular type selected for all modeling objects is characterized by the fact that all grid cells have the same length and width. The Corner point type is a more flexible system where the cell size varies [1]. Three-dimensional grids are also divided according to the principle of vertical cutting of layers into grids. In particular, it is possible to choose grids with an equal number of layers (Fig. 2), distributed between the roof and the bottom of the formation (as a rule, it is used in reservoir deposits and allows establishing a connection with the contour area), and an equal value of the cell thickness (applicable for massive or significantly varying in thickness of reservoir deposits (Fig. 3)) [2].

Meshes with equal cell thickness are sensitive to the choice of the surface from which the construction is performed. The mesh constructed from the sole (see Fig. 3), is very different from the grid constructed from the roof (Fig. 2). It is recommended to take into account the regularities of sedimentation conditions when choosing the direction of stratification.

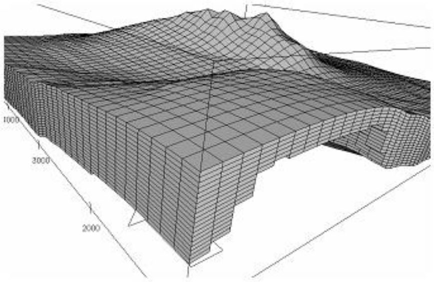

Fig.2. A fragment of a three-dimensional grid with an equal number of layers

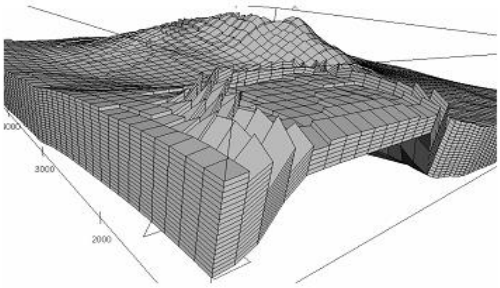

Fig. 3. A three-dimensional grid with an equal cell thickness built from the roof

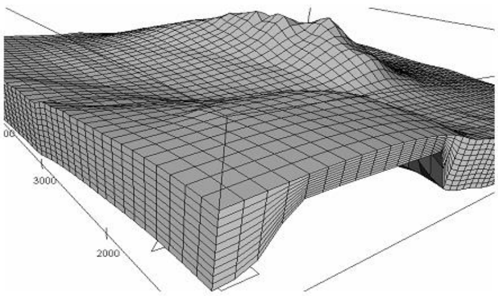

Fig. 4. Three-dimensional mesh with equal cell thickness constructed from the sole

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The size of cells laterally, as a rule, corresponds to the size of cells of structural surfaces (25×25, 50×50, 100×100 m). The vertical cell size is selected based on the discreteness of logging data or the results of the interpretation of geophysical well surveys (GIS). The minimum vertical cell size cannot be less than 20 cm, this is the GIS recording step.

The process of determining the values of porosity and permeability in the cells of a three-dimensional grid within the simulated deposit is called petrophysical modeling. Like the previous stage, petrophysical modeling can be performed in a deterministic or stochastic way and their combination. The result of the simulation are cubes of porosity (Fig. 5) and permeability.

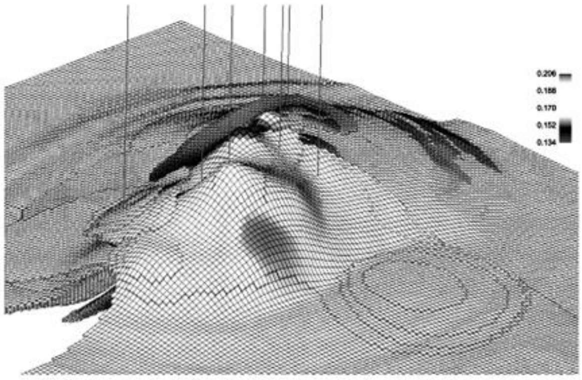

Fig.5. Fragment of the porosity cube (only collector cells with porosity coefficient values distributed in them are shown)

The porosity distribution in the three-dimensional geological model should be consistent with the borehole data. Only in this case can a conclusion be made about the correct distribution of the parameter. Using histograms of the distribution and applying the statistical criterion 2א, we can answer the question of the correspondence of the two distributions. The essence is to compare the studied porosity distribution in the reservoir with the normal distribution. Porosity has a distribution close to normal [1, 2].

The purpose of this stage is to obtain a spatial saturation distribution within the deposits in the form of cubes of oil or gas saturation (Fig. 6).

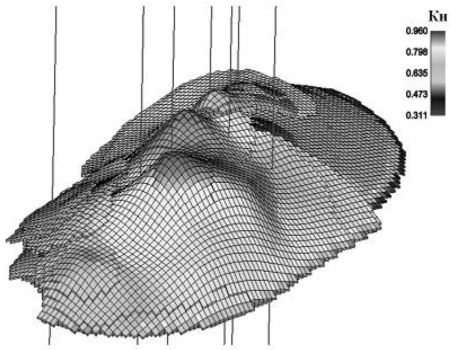

Fig. 6. Fragment of an oil saturation cube with a transition zone

To model the nature of reservoir saturation with fluids, the results of core studies and GIS interpretation are used. There are two main approaches to saturation modeling. The first approach is a horizontal method of distributing oil into deposits, taking into account the laws of reservoir physics and well data. At the same time, there are often contradictions with the initial data based on the results of GIS interpretation. Let's consider an example of such a frequently encountered contradiction in practice. In the lower part of the formation, geophysicists isolated a 2 m thick layer with an oil saturation of 0.8, and in the upper part of the formation, a 0.7 m thick layer with an oil saturation of 0.65 was isolated. To account for such contradictions, the second approach is used.

In the second approach of oil saturation distribution, a stratigraphic method of interpolation of oil saturation values from wells along the 3D grid layers is used. To create a transition zone within the deposit, a trend is used that takes into account the critical value of oil saturation on the WNC, and the mark of the WNC [4]. The ability to set the trend weight during interpolation makes it possible to obtain a change in oil

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saturation in the productive reservoir that corresponds to the concepts of the physics of the oil reservoir, while the oil saturation values determined in the wells are key. The critical oil saturation on the oil content contour is set in accordance with the values recommended for laboratory core studies.

Reference:

1. Methodological guidelines for the creation of permanent geological and technological models of oil and gas and oil fields. Part 1: Geological models / JSC "VNIIOENG". -M., 2002.
2. Potekhin D.V., Putilov I.S. The experience of correcting the distribution of lithology in three-dimensional geological modeling based on ideas about the geological structure of oil deposits // Geology geophysics and development of oil and gas fields. - M., 2005. - № 9-10. - pp. 48-50.
3. Dementiev L.F., Khitrov E.A., Shurubor Yu.V. Application of information measures in oilfield geology. - Perm, 1994.
4. Davis J.S. Statistical analysis in Geology. - M.: Nedra, 1990. - pp. 97-104. Methodological recommendations for the creation of digital models of terrigenous reservoirs of the CGM GUGR. - M., 2006. - p. 52.