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# GEOLOGICAL ENGINEERING

## FORMATION OF A GEOLOGICAL MODEL OF OIL AND GAS FIELDS BASED ON NEW GEOLOGICAL AND GEOPHYSICAL DATA (BY THE EXAMPLE OF THE KULTAK FIELD)

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**Abstract:** *The article presents the results of building a geological model of oil and gas fields based on new geological and geophysical data on the example of the Kultak field. Using the Schlumberger-Petrel software package, it is recommended that to build permanent models of oil and gas fields, a geological model was built*.
**Keywords:** *geological model, geological exploration, well, geological profile, geological structure, lithological composition, productive horizon, oil and gas content.*

**INTRODUCTION.** High efficiency of exploitation of an oil and gas field is possible only with proper planning and timely implementation of activities for its development. At present, decisions to carry out such activities are made considering the results of three dimensional modelling of deposits. Therefore, the correctness of three-dimensional geological models is of great practical importance. Since the results of a direct study of an oil and gas bearing object in wells, as a rule, are not enough to obtain a complete picture of its structure, various kinds of a priori information, as well as expert ideas and hypotheses about the object being modelled, are of particular practical importance. The need to consider such data is especially significant in the case of poorly explored, insufficiently drilled fields.

Considering the preceding, in this paper, the goal was to build a geological model of oil and gas fields based on new geological and geophysical data, using the Kultak field as an example.

**MATERIAL AND METHODS.** The Kultak field, located in the Bahoristan district of the Kashkadarya region, was chosen as the object of study.

Building a geological model is necessary for building a geological and technological model. With the aim of subsequent construction of a filtration model and carrying out hydrodynamic calculations, the geological model must provide correct extrapolation of lithology, porosity, oil and gas saturation and permeability data to a three-dimensional grid.

A geological model was constructed using the software package Schlumberger Petrel recommended for building permanent models of oil and gas fields [5]. Based on a partial reinterpretation of seismic data and GIS, a 3D grid is built, a structural frame is created, depth transformation is also carried out, and zones and layers are created. Based on all the data obtained, a three-dimensional geological and geophysical model of the Kultak field is being built. On Fig. 1 shows a schematic diagram of creating a model using the Schlumberger-Petrel software package.

The process of building a three-dimensional geological model is divided into the following stages:

- the creation of a structural model;
- the creation of a lithological model;
- the creation of a model of porosity and permeability properties (PPP);

- building a saturation model.

The structural model is understood as constructing stratigraphic surfaces of the corresponding horizons. The lithological model implies the distribution of reservoirs and non-reservoirs in space. The model of reservoir and filtration properties includes spatial distribution of porosity and permeability [7].

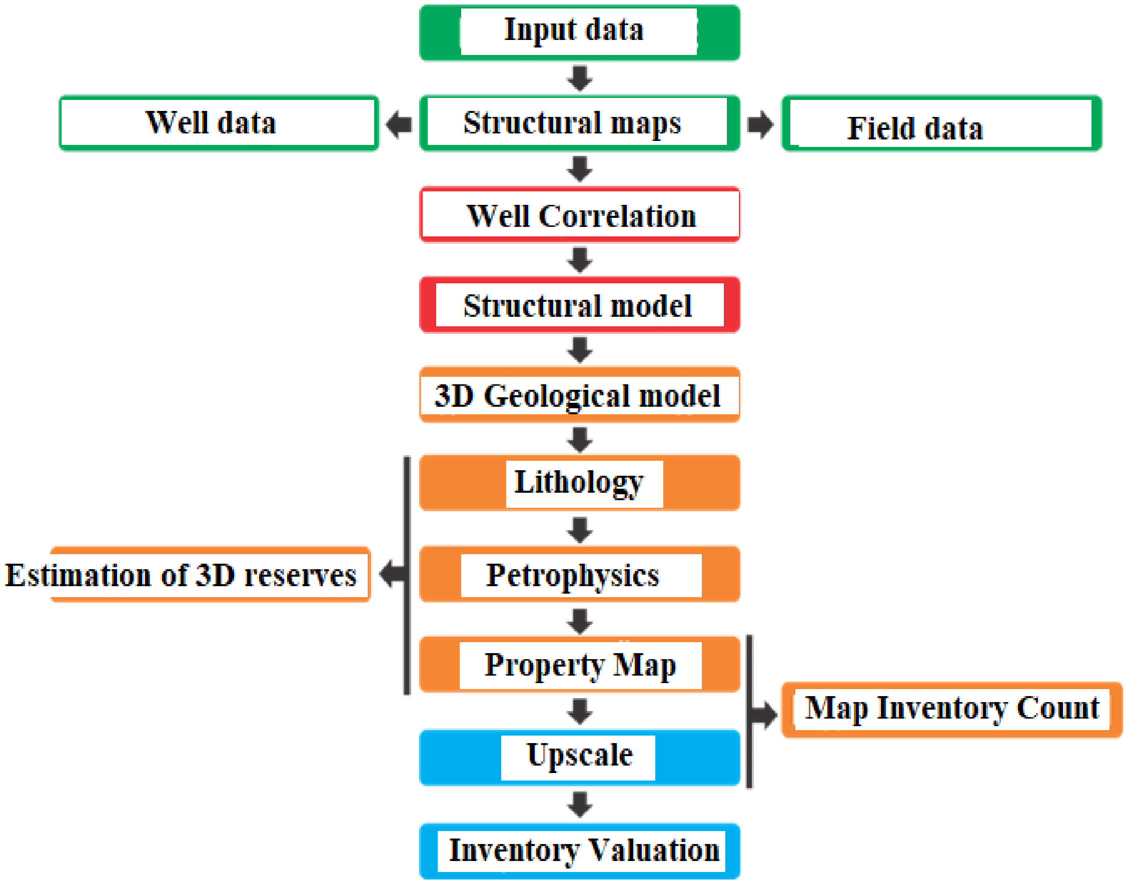



**Fig.1.** Scheme of creating a model

Hydrocarbon reserves are calculated integrally, i.e. by summing the hydrocarbon reserves in each cell.

**RESULTS AND DISCUSSION.** The proposed methodology consists of 6 main steps described below. The following information on wells serves as initial data: well coordinates, wellhead elevation, and thickness of geological horizons.

Stage 1. Setting wells. Based on the sound data, a single sequence of layers is formed for the entire geological object [6]. For example, there is information about three wells for a geological object. Two wells have three layers, and the last one has four layers. As a result, a sequence of four layers is formed for the entire geological object. If the well does not contain any layer, then its thickness (Z-coordinate thickness) is set to zero. This approach makes it possible to provide an unambiguous construction of the boundary between two wells: each edge passes between the corresponding elevations.

Stage 2. Construction and editing of sections**.** Automatic construction of units based on triangulation [2] of the surface of a geological object (computation area) by wells is proposed. The bottom line is that after triangulation, the cuts are formed based on the resulting edges of the triangles. Triangulation provides several useful benefits. Firstly, sections are created between nearby wells. Secondly, the resulting network of cells does not contain arbitrary intersections except controlled intersections in wells.

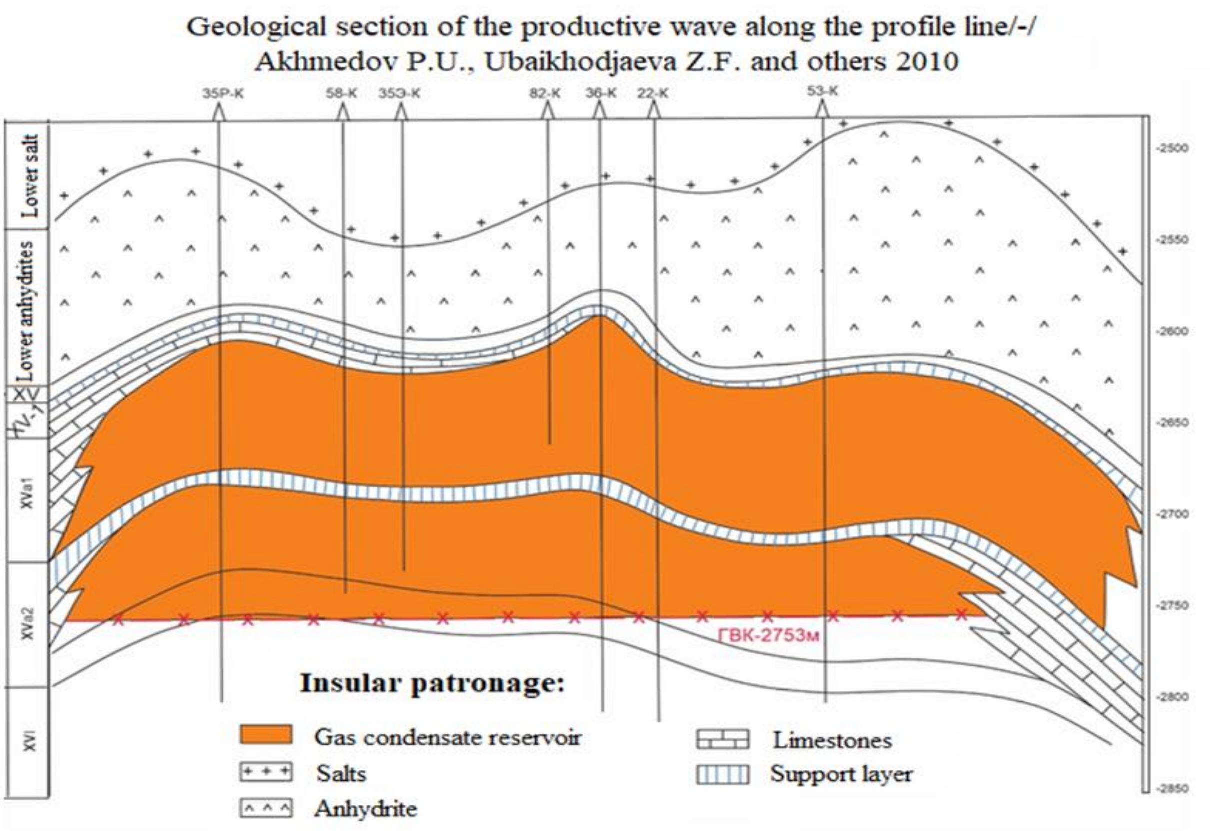



**Fig. 2.** Deposit Kultak

Stage 3. Formation of these sections**.** Each section contains information about how the boundaries between the layers pass on it (Fig. 3 and 4).

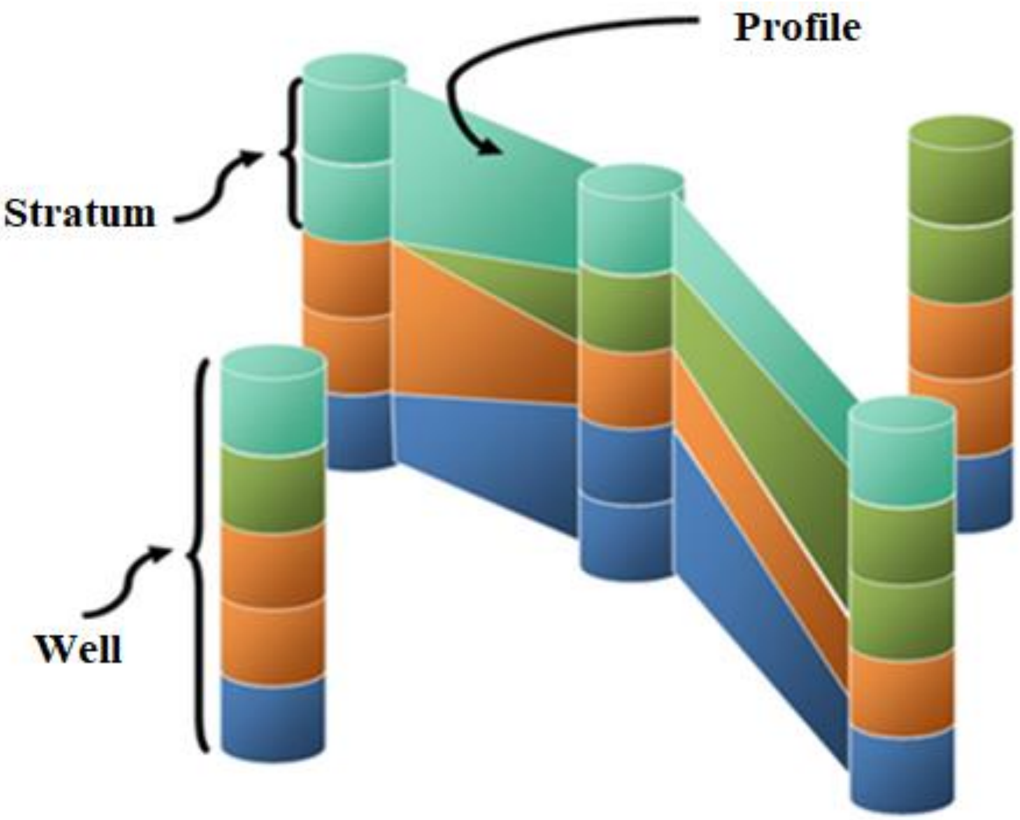



**Fig 3.** Wells and sequence of sections

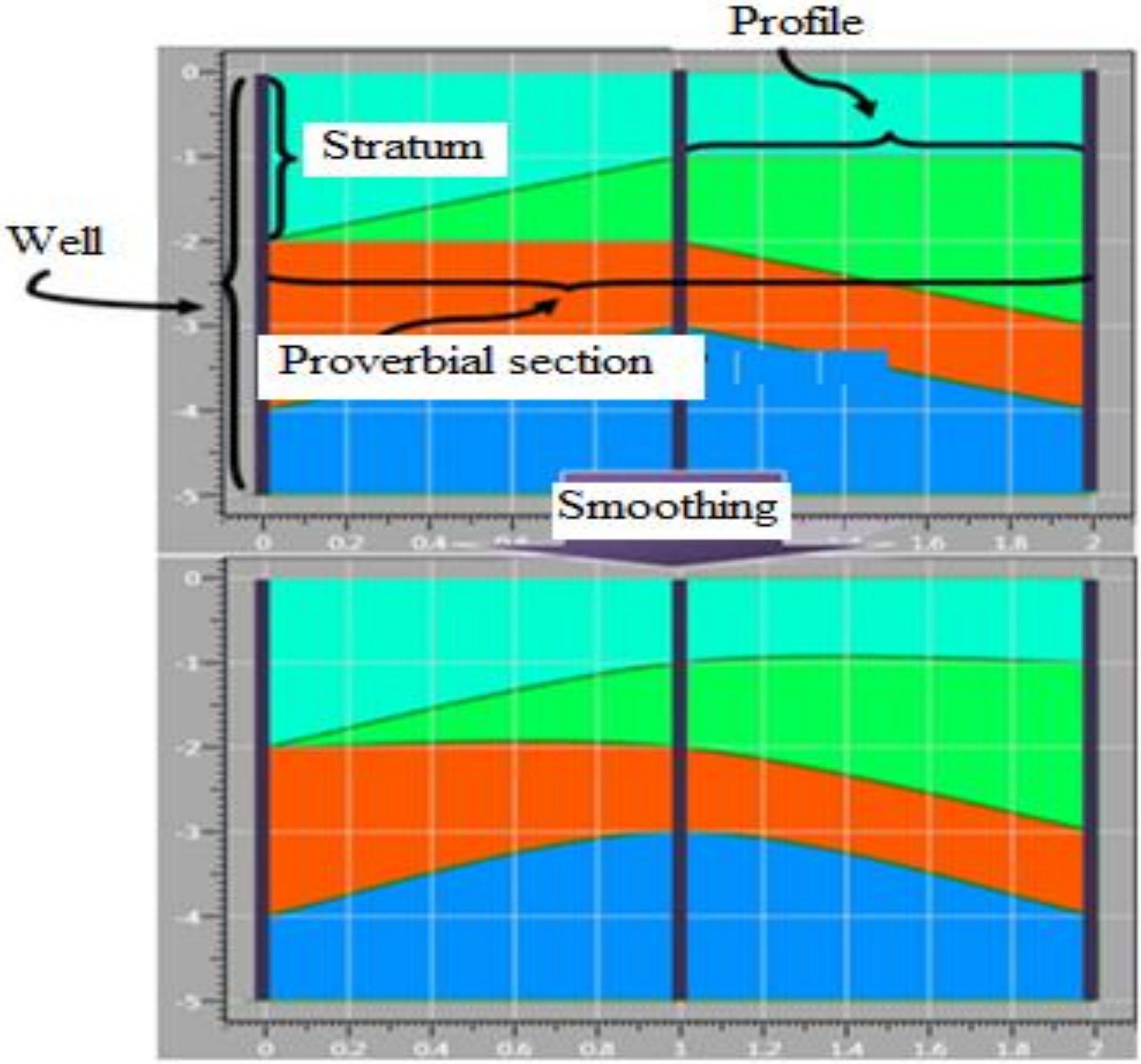



**Fig 4.** Smoothing layer boundaries on a sequence of cuts

Stage 4. Interpolation of boundaries between layers. To build a surface based on data from multiple points, interpolation/extrapolation is used. The input data are the wells' coordinates and the result of the discretisation of the section lines. Heights at discrete points are taken based on information about the boundaries between layers in the section. The result of interpolation/extrapolation is the height value for a fixed set of points for all layers. When working on interpolation/extrapolation, the following algorithms were implemented in C++ and Fortran:

- Kriging interpolation;
- Shepard interpolation (several options);
- radial-basic interpolation (with various RBF functions).

As expected, the implementation of the algorithms in Fortran showed greater performance (approximately two to three times faster) than the C++ implementation.

Stage 5. Segment interpolation. Very often, especially in construction cases, separate areas of segments of geological layers need to be obtained with an even, flat surface. Achieving such a result using interpolation/extrapolation for the entire array of points of a particular layer is a challenging task since most interpolation algorithms consider the influence of all input points [1]. Those algorithms that consider only the nearest points also do not allow obtaining a smooth surface (Fig. 4).

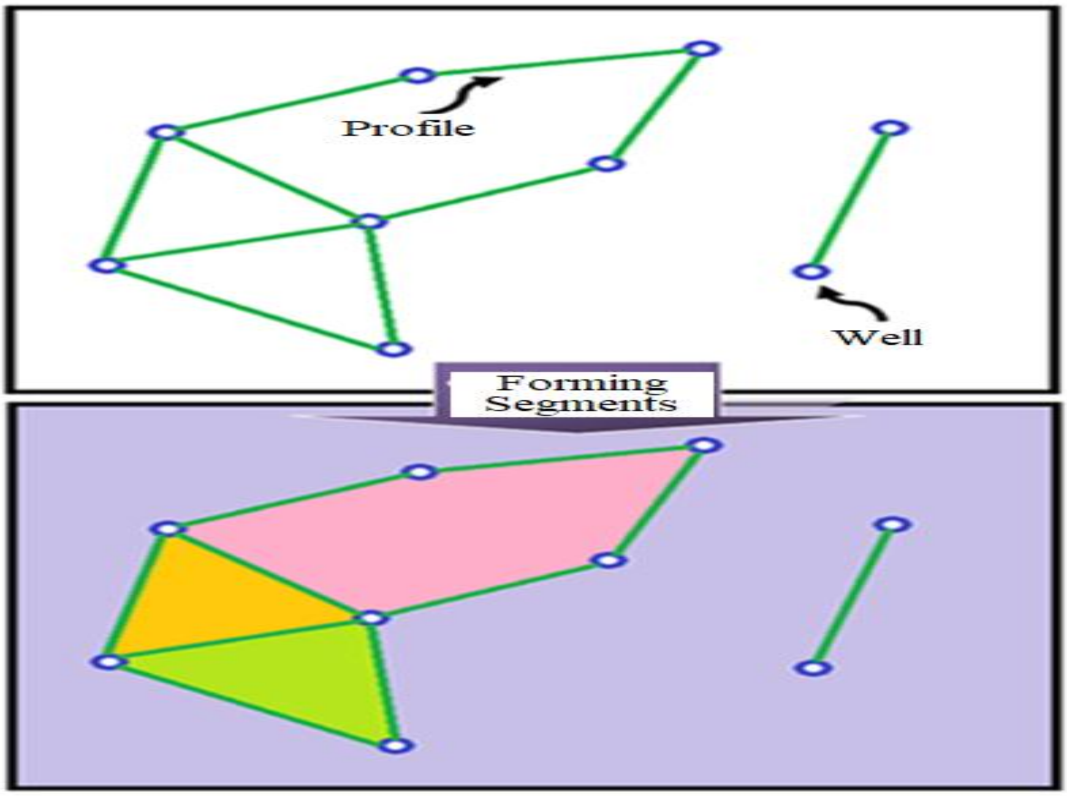
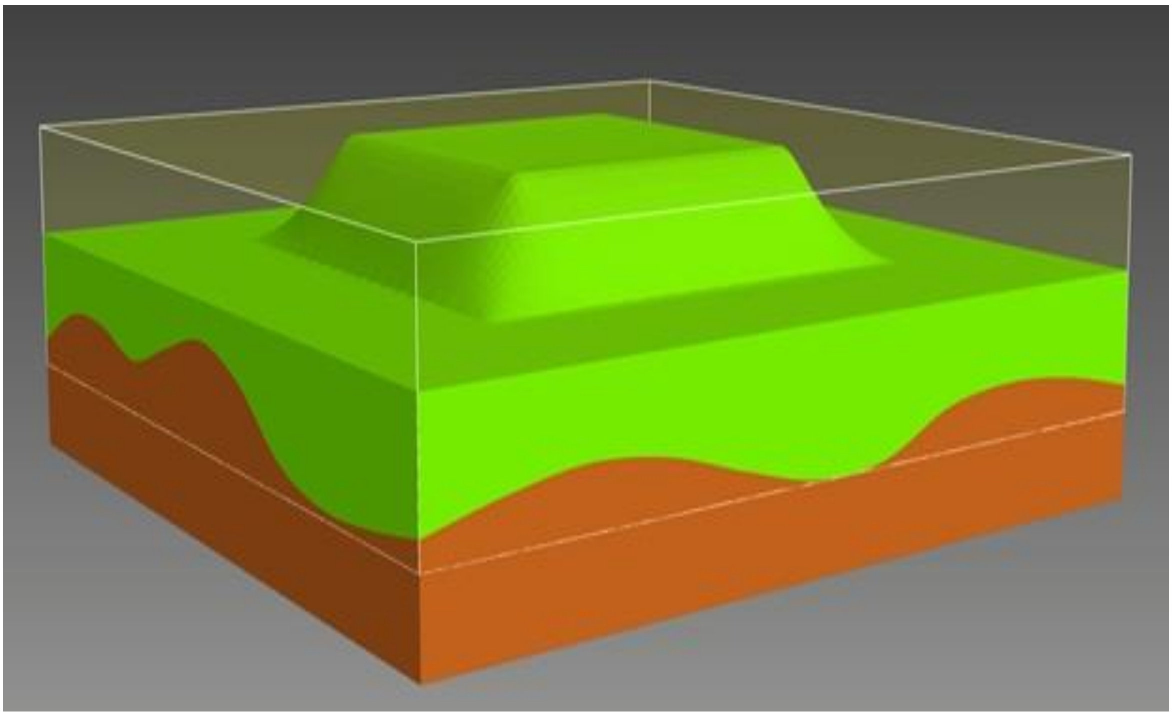
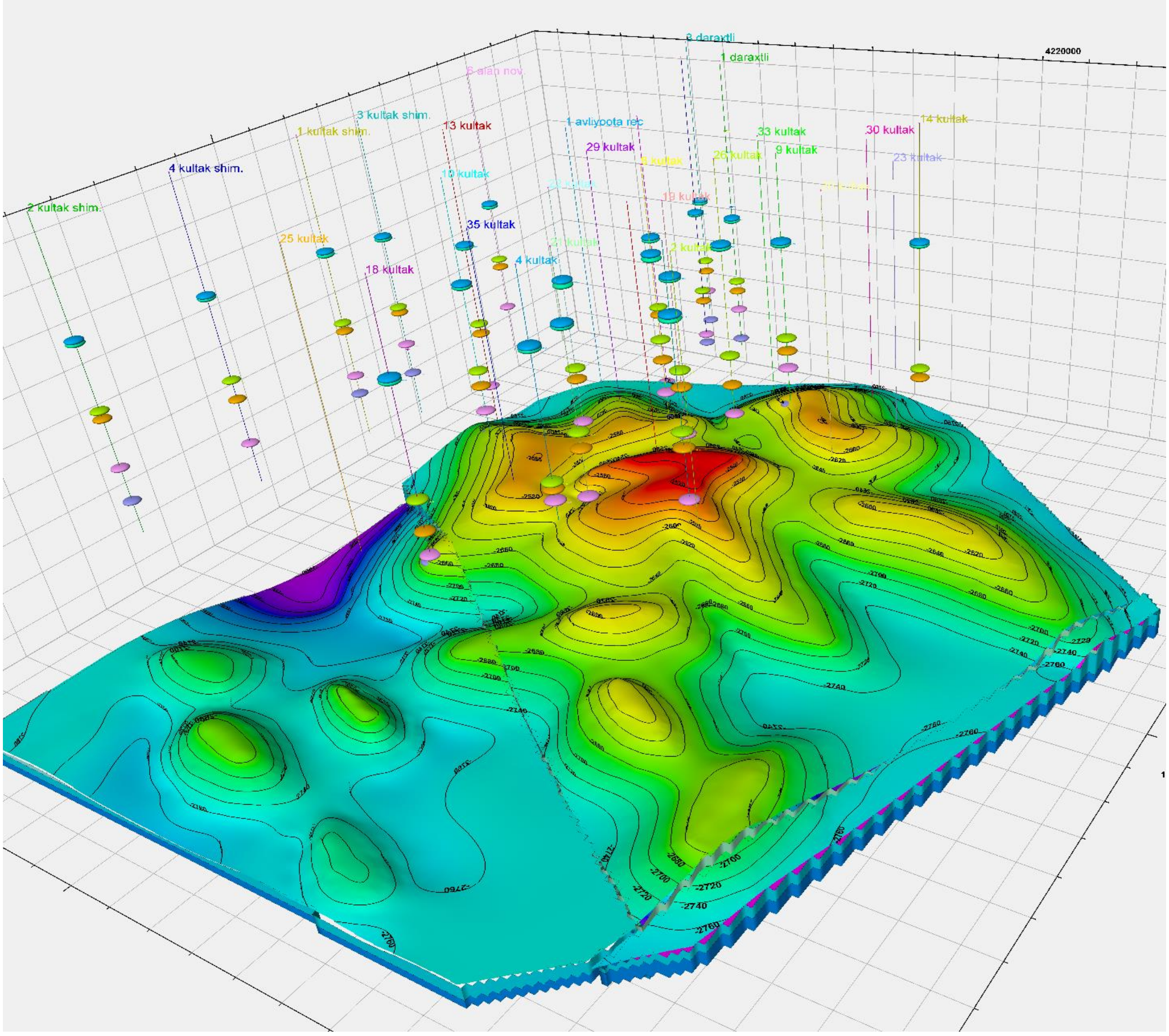



**Fig. 4.** Formation of segments for interpolation

Stage 6. Formation of 3D objects. Based on the interpolation, a triangulated layer surface is obtained. In this case, the interpolation result for each layer consists of the same set of points but with a different Z coordinate. Next, each pair of surfaces is considered for the bottom to go beyond the top. If such a situation is detected, the lower surface is corrected. Then both characters are closed by side faces. As a result of a series of such surface closures, a three-dimensional geological model is formed (Fig. 5).



**a)**




**b)**

**Fig 5** a, b. The result of building a three-dimensional geological model

Kultak facility prepared for drilling is administratively located on the territory of the Bahoristan district of the Kashkadarya region of the Republic of Uzbekistan. The gas deposit at the Kultakskoy field is confined to the Upper Jurassic carbonate deposits, which form a brachianticlinal fold within the southeastern end of the Dengizkul swell-like uplift, which complicates the Chardjou step of the Turonian plate.

According to data on the top of the Senonian deposits, the Kultak structure is a gently sloping southwest-trending brachiaticline fold 23x16 km in size. The height of the fold is 210-215.0 m. The crest of the fold is located in the area of exploration wells No. 1,27,16,19. Changes in structural plans are insignificant for deeper Cretaceous and Jurassic horizons, except for the Callovian-Oxfordian carbonate sequence. They are expressed in a slight increase in the fold amplitude and a change in the strike to latitudinal. Significant differences in structural plans from those described above are observed in the upper sections of the carbonate formation (XV, XV-a $_1$ and XV-a $_2$ horizons). They are expressed in a significant change in the configuration of the structure and the appearance of a series of local folds complicating it (Fig. 6). Such a complex structure of the surface of the system is due to the presence of bioherm formations in the upper part of the carbonate formation. The same uneven (dissected) character has the roof of the LPA (lower pack of anhydrite), also associated with the presence of organogenic structures, on the top of which the thickness of the LPA sharply increases.

According to the results of deep exploratory drilling and seismic exploration of CDP within the Eastern Block field, six bioherms were identified called by us domes. The first is located in the north of the structure; the second is on the eastern wing of the fold; the third is on the system's crown to the south of the first; the fourth is in the southwest, in the area of wells north folds to the south of the first (wells No. 1 and 2-north Kultak, etc.) and the sixth is located between the third and fifth domes (the area of wells No. 3 and No. 27).

The boundaries of the distribution of bioherms are established based on the results of a detailed dissection of the sections of all drilled wells, their stratification, taking into account the interpretation data of seismic surveys of the CDP (S.N. Zuev, 1993). CDP, according to this same According to the data, the Chilgumbaz area is separated from the Kultak structure by an intermittent fault in the latitudinal strike.

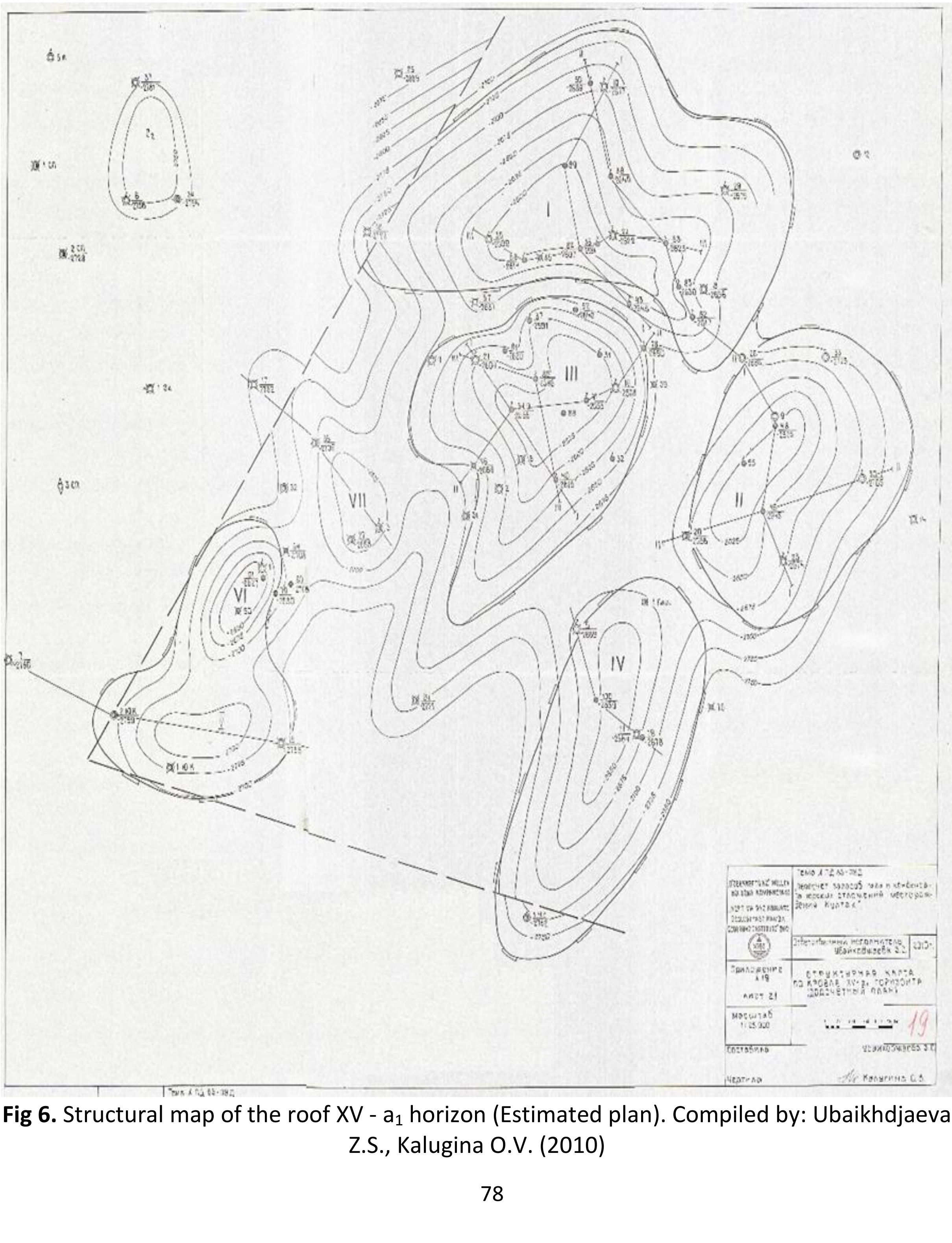



**Fig 6.** Structural map of the roof XV - $a_1$ horizon (Estimated plan). Compiled by: Ubaikhdjaeva Z.S., Kalugina O.V. (2010)

Taking into account these CDP seismic data and new data on the reinterpretation of healthy logging data, detailed correlation of sections, a unique geological model of the field was developed (Fig. 7). As can be seen from these data, the outer contour of the structure, except the western part, complicated by a fault line, has not undergone fundamental changes. The main changes took place inside the circuit. The presence of organogenic bioherm structures in the upper part of the section shows a significant influence on the structural plan. In the XV-$a_1$ horizon, the boundaries of their distribution are outlined, which significantly increases the reliability of the geological model of deposits.

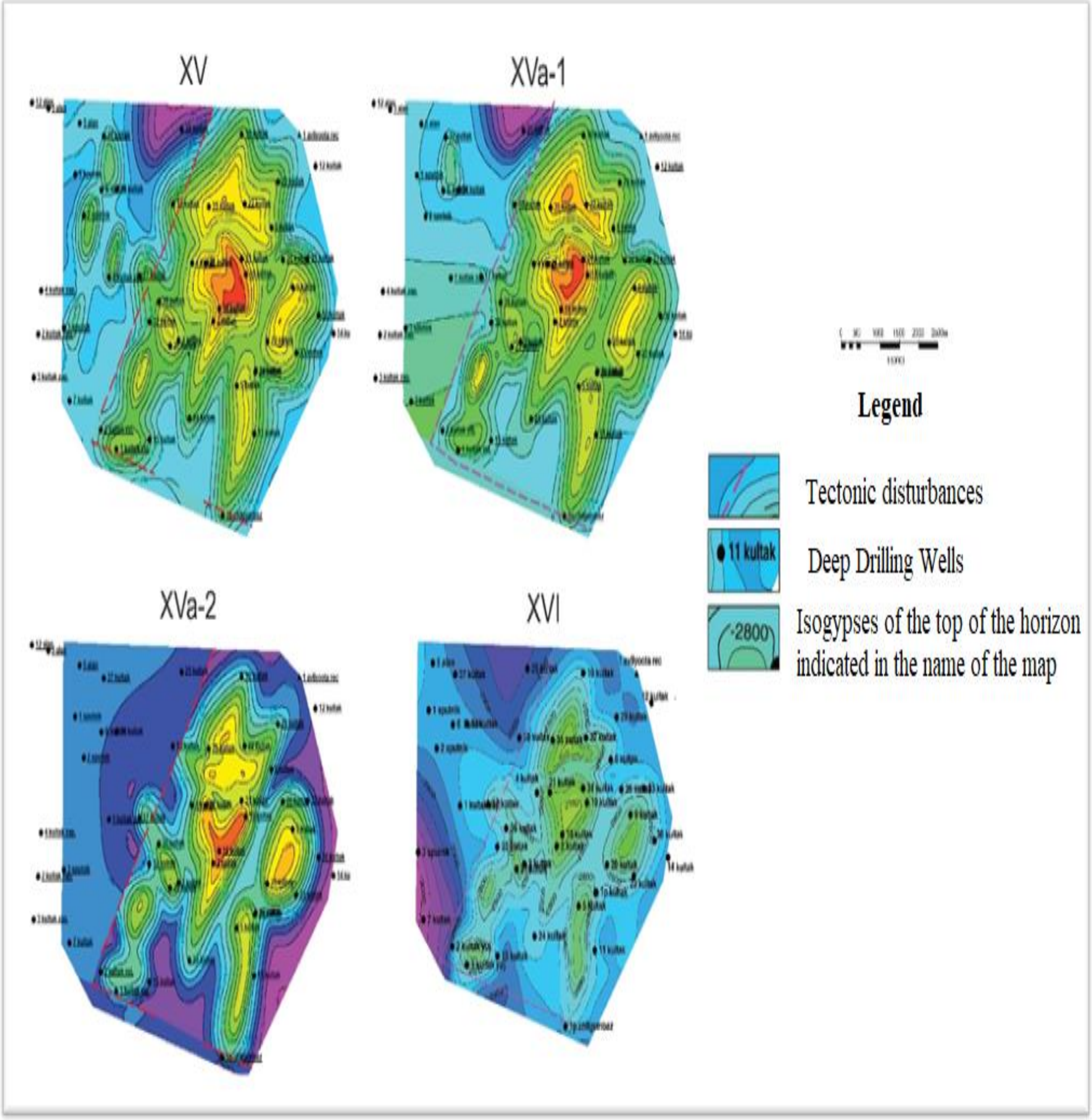



**Fig 7.** Structural constructions on roofs XV, XV a-1, XV a-2 and XVI horizons. Scale 1:50000

**CONCLUSION.** Based on the generalisation of the actual geological and geophysical material and the refinement of the geological structure of the Kultak field, the following conclusions are formulated:

1. In this work, the Kultak field was chosen as a pilot object for building a three-dimensional geological and geophysical model of the field since it is located in the zone of organogenic structures.

2. According to the structure of the pore space structure, two types of reservoirs are mainly distinguished: fractured-porous (pore) - clearly indicated by the logging complex and porous-fractured (complex) - not always clearly distinguished, and the third is purely fractured, not distinguished by the logging complex.

3. The three-dimensional geological and geophysical model of the field developed in this work based on the Petrel software package from Schlumberger provides optimisation of further exploration work on the area and, in the future, serves as the basis for the development of a hydrodynamic model in the process of planning the drilling of production wells.

**References**


1. A.A. Abidov. “*Oil and gas potential of lithospheric plates”,* **1994**.
2. A.A. Abidov. “*Oil and gas geology Russian-Uzbek dictionary”,* **2000**.
3. V.P. Alekseev., B.B. Tal- Virsky. Tectonics and prospects of oil and gas potential of the Beshkent megadeflection. *“Collection of scientific works of JSC "IGIRNIGM"”,* **2000**. 74
4. O.A. Karshiev. Construction of three-dimensional date geological models for areas and deposits of the complex structure of NHC "Uzbekneftegaz". *“Tashkent, JSC "IGIRNIGIGM"”,* **2014**
5. G.M. Zaloeva., S.B. Denisov., S.I. Bilibin. *“Geological and geophysical modelling of oil and gas deposits”,* **2008**.
6. E.A. Gladkov., E.E. Gladkova. Three-dimensional geological and technological model of a hydrocarbon field based on individual wells adaptation. “*Gas industry”,* **2010**. 36.
7. H.N. Musaev., T.I. Mumindzhanov., H.F. Khudoyberdiev. “*Patterns of distribution of micro components in formation waters associated with oil and gas fields of the Bukhara - Khiva region”,* **2008**
8. V.D. Ilyin., N.K. Fortunatova. *“Methods of forecasting and searching for oil and gas-bearing reef complexes”*, **1983**.
9. A.G. Ibragimov., S.T. Khusainov. On the age of reef complexes of Western Uzbekistan. “*Uzbek geological journal”,* **1980**.
10. O.A. Karshiev. “*Construction of three-dimensional date geological models for areas and deposits of the complex structure of NHC Uzbekneftegaz JSC. IGIRNIGIGM”,* **2014**
11. A.Kh. Nugmanov. “*Conditions of formation and patterns of placement of oil and gas traps in the Jurassic sediments of Southwestern Uzbekistan”,* **1986**.
12. Kh.N. Musaev., T.I. Mumindzhanov., Kh.F. Khudoyberdiev. Patterns of distribution of micro components in formation waters associated with oil and gas fields of the Bukhara -Khiva region. *“Oil and gas”,* **2008**
13. L.B. Rukhin. “*Fundamentals of lithology”,* **1969**.
14. J.L. Wilson. Carbonate facies in geological history. “*Translated from English. Moscow”,* **1980**.
15. G.M. Zaloeva., S.B. Denisov., S.I. Bilibin. “*Geological and geophysical modelling of oil and gas deposits”*, **2008**.
16. M.A. Zhdanov. “*Oil and gas field geology and calculation of oil and gas reserves”,* **1970**. 486.