DIGITAL MODELING OF GRAVITY GRADIENTS FOR SOLVING STRUCTURAL PROBLEMS AND DIRECT HYDROCARBONS SEARCH

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As is known, in the observed gravitational field, under favorable conditions, individual local structures can be reflected in the form of local anomalies. In especially favorable conditions, in the presence of gravity anomaly maps of high-precision gravimetric surveys, the task of detecting gravity effects caused by oil and gas deposits (direct searches) can be set. Oil and gas saturated rocks have a negative excess density compared to the same rocks filled with water, and therefore, local minimums of gravity anomalies can be observed over large oil and gas deposits. Such favorable conditions are high-precision gravimetric surveys using digital gravimeters. Such surveys are carried out in the world practice as well as in Azerbaijan. Therefore, the issues of searching for promising structures and direct prospecting for hydrocarbons using digital gravity data is very relevant.

To identify weak local anomalies from digital gravity data, methods of higher derivatives of the potential of the gravity force and their various modifications are currently used, which in some cases makes it possible to identify local anomalies caused by low-amplitude structures in the sedimentary stratum, and under favorable conditions, large oil and gas deposits. The property on which this transformation method is based is that with increasing distance from the disturbing masses, the higher derivatives of the graviy potentials decrease faster than its first derivatives. Thus, on the maps of anomalies of gravity gradients and derivatives of the potential of a higher order, the effect of small and shallow disturbing masses is enhanced in comparison with the gravitational effect of large and deep structures. These methods include the method of higher derivatives of the gravity potential (the method of the third vertical derivative of the gravity potential), the method of averaged gradients, the horizontal derivative (horizontal gradient) of the force, etc. The Department of Geophysics has developed software for the implementation of these methods, as well as the method of the full normalized gradient gravity. Therefore, the purpose of this research is the digital modeling of the values of the full normalized gravity gradient of the calculated gravitational effects from homogeneous geological bodies of a regular shape occurring at different depths for further selection of optimal transformation parameters.

At the first stage, the gravitational effects from homogeneous balls lying at the same and different depths were calculated on a computer, and then the corresponding curves of the vertical component of gravity along the observation profile were plotted. At the second stage, the profile values of gravity were processed using the GNORM algorithm with various transformation parameters and the corresponding maps of the sections of the full normalized gravity gradient (FNG) were constructed in a modern interface. Analysis of the obtained results allows us to draw the following conclusions:

1. Digital modeling was performed along the profile of the gravity field from a geological body of a spherical shape with a radius of 1 km, lying at a depth of 4 km with an excess density of 0.2 g/cm^3. Using the GNORM program, the values of the total normalized gravity gradient were calculated to a depth of 7 km with a step of 2 km with the number of harmonics 5, 10, 15, 20. The optimal number of harmonics was 10, at which the maximum depth of G_{fng} coincided with the actual depth of the model geological body.

2. Gravitational effects from two geological spherical bodies lying at the same depth are calculated and digital modeling of G_{fng} values with different number of harmonics is performed. The optimal number of harmonics for accurate prediction of the actual depths of occurrence of geological objects was 35 harmonics.

3. Gravitational effects from two geological spherical bodies occurring at different depths of 4 and 3.5 km are calculated and digital modeling of G_{fng} values is performed for different values of the number of harmonics. The optimal number of harmonics is determined.

4. The dependence curves of the maximum value of G_{fng} on the number of harmonics, as well as the dependence curves of the differences between the calculated and actual values of the depths of the geological body occurrence on the number of harmonics for the cases of identical and different occurrence depths, are plotted. The optimal number of harmonics corresponds to the maximum and minimum values of the constructed curves.

5. The developed method for selecting the optimal number of harmonics can be used when processing a real gravimetric profile of a high-precision survey using the FNG method in order to predict zones of deconsolidation of rocks, as well as a possible accumulation of hydrocarbons.