Analysis of Geo-Pressures when Drilling Deep Wells- A Factor for Improving the Efficiency of Exploration and Reducing Geological Risks

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ABSTRACT

At present, there is a general tendency to increase the depth of drilling wells for oil and gas. A significant number of wells, especially in areas with a strong sedimentary cover, are drilled to depths of 5-7 thousand m. Drilling wells to such depths is associated with increasing difficulties in their wiring due to the complexity of mining and geological conditions, which primarily include an increased frequency of meeting strata with abnormally high reservoir pressures. The lack of information about the actual values of pore and reservoir pressures at specific depths, as well as data on the strength limits of the traversed rocks, leads to an inaccurate choice of the density of the drilling fluid and causes various complications: hydraulic fracturing and absorption of drilling fluid, emissions and open fountains, collapses of unstable rocks, tacks of drilling tools and casing pipes. The design and descent of intermediate and casing columns in the absence of clear criteria for the allocation of plastic clays that need to be covered with stronger pipes leads to the collapse of the columns due to incomplete attachment of plastic clays. In this regard, successful conducting of deep wells in complex mining and geological conditions in the presence of abnormally high reservoir pressures in powerful clay strata of rocks is possible only when solving a number of interrelated technological tasks, including determining and predicting pore and reservoir pressures along the section, initial and current rock strength limits, evaluating the state of the wellbore at the current time and predicting possible complications over time when the density of the drilling mud changes, determining the optimal density of drilling mud over time to maintain the necessary stability of the trunk and prevent the possibility of hydraulic fracturing in the open trunk, determining the optimal depth of descent of intermediate technical columns, as well as identifying plastic clays in the section in order to overlap them with high-strength casing pipes to prevent the columns from collapsing. The solution of this complex of necessary technological tasks can be carried out only on the basis of complex use of technological, geological (core, sludge) and geophysical data (B.L. Alexandrov, 1987). The article deals with the issues of improving the efficiency of exploration and reducing their geological and environmental risks when drilling deep wells for oil and gas in the conditions of development of abnormally high pore and reservoir pressures in the sections of wells on the example of fields in the Tersky-Sunzhensky oil and gas region of the Eastern Caucasus, the geological section of which is the most typical in terms of the considered tasks. The Tersky-Sunzhensky oil and gas bearing region is characterized by the presence of abnormally high reservoir pressures in sections of Mesozoic sediments, represented by both powerful carbonate strata (upper Cretaceous, upper Jurassic) and terrigenous rocks (lower Cretaceous), and the overlying Maikop and lower Chokrak deposits are represented by a powerful thickness (up to 1500-3000 m) of clay deposits, pore pressures in which can reach the value of mountain pressure. Almost all the identified structures of the Tersky-Sunzhensky oil and gas region are divided by a network of faults into blocks, the shifts between which sometimes reach hundreds or even more than a thousand meters. This area belongs to the seismically

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active Alpine folding zone, where the magnitude of the earthquake can reach 6-8 magnitudes, and the epicenters of earthquakes are confined to depths from 3 to 50 km, while a significant number of them are located within the depths of drilling wells. It is natural to assume that the formation and development of discontinuous disturbances occurred due to the unloading of the resulting stresses in the rock strata, that is, at the moments of the manifestation of earthquakes. It is know that earthquakes occur as a result of rapid dilution of stresses accumulating in the earth's interior, accompanied by significant displacements of rock thicknesses relative to each other along tectonic faults, and with repeated earthquakes, the amount of rock displacement along the faults increases. Thus, the presence of additional accumulating stresses in the rock strata and resulting in earthquakes during their unloading will have additional complications when drilling wells. Under these conditions, knowledge of the pore and reservoir pressures in the section is not yet sufficient to justify the optimal density of the drilling mud, especially when opening layers (thicknesses) with significantly different petrophysical characteristics and strength limits with a single barrel. Finding the wellbore in the open state for a long time can cause its complication by reducing the strength limit of rocks under the influence of dynamic pressure drops, the influence of chemical processes of interaction of drilling mud and pore water, and other factors. Therefore, it is necessary to conduct a point-by-point assessment of the wellbore condition and predict its stability over time. To quantify the stability of the wellbore and determine the optimal density of the drilling mud, it is necessary to determine the rock stress limits – the strength limit, plasticity, and hydraulic fracturing pressure The estimation of the limit stresses of clay strata can be determined by the values of petrophysical or geophysical parameters (Fig.1). The assessment of the stability state of the well consists in comparing the value of the pressure drop between the rock and static pressure in the well with the initial and current strength limit of the rock, taking into account the time factor.

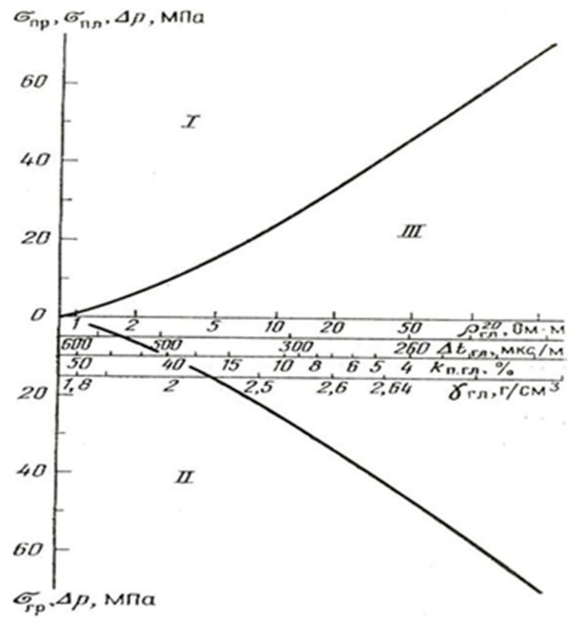

Figure 1. Dependence of the ultimate stresses of clay strata on their petrophysical parameters and assessment of the state of rock stability taking into account the pressure drop. I – the area of critical initial pressure drops that determine the plastic flow or brittle destruction of rocks; II – the area of critical initial pressure drops that determine hydraulic fracturing of rocks; III – the area of optimal pressure drops that determine the stable state of rocks on the well wall

Based on the analysis, it is concluded that it is expedient to create a permanent center in each large oil and gas region to provide deep well drilling with continuous assessments of geofluidic pressures, zones of abnormally high pore and reservoir pressures, and the stability of the trunk according to geophysical, geological and technological parameters of drilling.

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