Geodynamic Risks of Developing Oil and Gas Deposits in Grozny

Malik Gaysumov[1,3], Ibragim Kerimov[1,2], Salavdi Badaev[1,3]

[1]Academy of Sciences of the Chechen Republic, 13, M. Esambaev Ave., 364024, Grozny, Russia
[2]Millionshchikov Grozny State Oil Technical University, 100, Kh. Isaev Ave., 364051, Grozny, Russia
[3]Complex Institute of the Russian Academy of Sciences, 21 a, Staropromyslovsky Ave., 364051, Grozny, Russia

doi: https://doi.org/10.21467/abstracts.93.108

ABSTRACT

Exploration and development of hydrocarbon resources are associated with significant technological and geodynamic risks, which, in turn, can cause huge losses of complex and expensive production, cause large-scale environmental disasters and disasters. Geological exploration work itself, as well as the entire vast infrastructure, including exploration and mining areas, settlements, long linear structures, pipelines, roads, power lines, etc., are exposed to the dangers of accidents. Long-term development of oil and gas deposits leads to a change in the stress-strain state of the geological environment and, as a result, is accompanied by negative geodynamic processes. Numerous literary sources cite displacements of the earth's surface, increased seismic activity, and other negative phenomena that occur during the development of oil and gas fields.

In the process of long-term exploitation of the fields, the development of infrastructure and further urbanization of the territory take place. In the Grozny oil-bearing region, these include the Starogrozny and Oktyabrsky fields, which in the process of development turned out to be on the built-up territory of Grozny.

Features of the modern geodynamics of the territory. In geological terms, the oil deposits of the said deposits are located in anticlinal folds which are limited by faults and discontinuous disturbances characterized by intensive modern geodynamic processes. According to high-precision measurements of modern vertical movements of the earth's surface, V.A.Sidorov and others have established intense local anomalies of vertical movements of the earth's surface. It was found that these modern movements are high-amplitude (up to 50 mm/year), short-period (from 0.1 years to the first years), spatially localized (from 0.1 km to the first tens of kilometers) and have a pulsating and in some cases alternating direction. We can confidently identify a single block corresponding to the Starogroznenskaya and Oktyabrskaya structures, which is bounded by faults with high geodynamic activity; in the East, the value of relative vertical displacements is - +(25÷28 mm/year), in the West – (8÷12) mm/year. The block is 30-35 km long and 6-7 km wide.

Grozny oil-bearing region is traditionally considered a territory with high seismic activity. Weak earthquakes in this area occurred very often, both before exploitation and during various periods of exploitation. Against the background of tectonic, earthquakes occurred here with proven technogenic nature at the Starogroznensky, Oktyabrsky, Gudermessky oil fields. Earthquakes occurred against the background of a sharp drop in reservoir pressure, excessive oil withdrawal, or the beginning of water injection into reservoirs to intensify oil extraction.

Earth subsidence caused by oil recovery. Field development is accompanied by a change in the stress-strain state of the rock mass in the field of deposits. The reservoir is subject to compressive pressure, the value of which is equal to the difference between the mountain and reservoir pressure. With a decrease in pressure during the development process, the geostatic equilibrium is violated and the reservoir (reservoir) is compressed in the volume of the reservoir with subsequent deformation of the rocks that can propagate into the roof of the reservoir, its layers, etc. up to the surface, where they appear mainly in the form of

DOI: 10.21467/abstracts.93

vertical displacements-subsidence. This leads in some cases to significant subsidence and is accompanied by deformations of ground structures, casing collapse and other negative processes. For more than 100 years of operation, more than 140 million tons of oil were extracted from the Starogroznensky field, and more than 40 million tons from the Oktyabrsky. Currently, deposits are in the final stages of development.

The deposits are multilayer, they are in long development, the operating mode is elastic-water, it is characterized by a significant drop in reservoir pressure and, accordingly, changes in the stress state of both the reservoir and the host rocks. For these deposits, the authors calculated the values of the formation roof subsidence both for granular (Miocene deposits) and cavernous-fractured (Cretaceous) reservoirs over the period from the beginning of the development of deposits to the present.

Next, calculations were performed for the transfer of reservoir deformations to the daily surface. During the study period, the Miocene deposits have been in operation for the longest time, but the subsidence of the earth's surface caused by mining is insignificant. This is due to a relatively small drop in reservoir pressure of 3.6-4.5 MPa, as well as the elastic properties of the formation. The greatest falls in reservoir pressure occurred in the Cretaceous deposits of both fields. Against the background of intensive extraction of oil reservoir pressure has decreased from 69 to 72 to 41 to 43 MPa. The total amount of subsidence of the reservoir roof and, accordingly, the surface over the entire period of operation is not large, they reach about 345-422 mm, and the average annual rate of subsidence is 6-8 mm. However, it should be noted that the process of subsidence occurs against the background of the general uplift of the territory.

Conclusion. At the present stage of geological development, the territory of the city of Grozny is defined as geodynamically active, consisting of multi-rank tectonic blocks, limited by faults and discontinuous violations, and characterized by intensive upward movements of these blocks. Stress discharge is expressed in the deformation of the rock mass and in the case of rapid (abrupt) discharges of tectonic stresses – in the form of earthquakes. Long-term development of oil fields has led to changes in the stress state of reservoir rocks and, consequently, to elastic deformation of the surrounding rock mass, especially the overlying rocks, contributing to the development of intensive geodynamic processes of both natural and man-made nature with negative manifestations on the surface and, consequently, consequences for residential buildings and infrastructure structures.

Acknowledgements: This work was supported by Russian Foundation for Basic Research (RFBR), project number 18-45-200001 r_a.

 DOI: 10.21467/abstracts.93