Low-Frequency Seismic sounding Method (LFS)

Since 2005 CJSC Gradient successfully uses mobile, efficient and environmentally friendly method of oil and gas prospecting - Low-Frequency Seismic sounding (LFS). LFS surveys were carried out on 160 sites with a total area of more than 1500 km². LFS method is successfully applied on license areas of PJSC Tatneft, PJSC Gazprom, OJSC LUKOIL, OJSC Rosneft, PJSC Gazprom Neft etc.

**Geological objectives**

- **Prospecting and evaluation works on oil and gas targets** to identify oil/gas bearing areas in frontier regions and to evaluate hydrocarbon potential of structures that identified by seismic;
- **Detail works at discovered oil and gas fields** to delineate hydrocarbon fields and provide recommendations for location of deep wells and sidetracking;
- **Identification of geological inhomogeneities in the rock mass** to prevent accidents while drilling.

**LFS effectiveness is more than 86%**

Since the company foundation, 136 wells were drilled based on the results of LFS survey, 118 of them confirmed the positive forecast. Thus, the success rate of LFS method is more than 86%.

Implementation of the LFS technology in conjunction with traditional seismic survey will allow to identify and to contour hydrocarbon deposits as well as to maintain high level of the deep drilling effectiveness.

**Work stages**
Prospecting and evaluation works on oil and gas targets

During the operational period of LFS survey 2 structures that located 6 km away from each other were analyzed. This area has identified resources in the Vereiskian - Bashkirian formations. Based on the results of the work, the western structure was characterized as zone of low hydrocarbon potential. The eastern dome structure is divided into two parts by identified oil-bearing zones.

Drilling after undertaken LFS survey at the top of the south-western dome has not identified oil-saturated reservoir. Exploratory drilling within the eastern structure detected the commercial oil flow from Vereiskian - Bashkirian Middle Carboniferous formations.

Detail works at discovered oil and gas fields

Based on the results of LFS survey, extension of the oil-bearing area was identified only in the southern part of the high, with its absence in the northern part of the dome.

Maps of prognosis evaluation of oil potential based on the LFS data

Structure map by top of permeable part of the B2 layer (based on the processing of wells № 2, 2_1 drilling results)

Primary drilling of the well № 2 to the northern part of the high had detected a sharp decline of the structural plan in a northern direction and the absence of the oil-bearing area. The Lower Carboniferous Bobrikovskian reservoir (B2 layer) was detected by the follow-on side tracking of the well № 2_1 in the north-eastern direction to the oil-bearing area that was identified by LFS method. Reinterpretation of the seismic survey based on the wells № 2, 2_1 drilling results exclude the presence of the northern structural nose of the high.
Identification of geological inhomogeneities in the rock mass

LFS technology can be used to solve unconventional exploration tasks. One of these tasks was to identify geological inhomogeneities in the geological environment that overlain the well-known explored condensate field in order to reduce the risk of drilling hazards and to eliminate accidents.

LFS studies are conducted with the use of 3D - numerical simulation and allow to receive inhomogeneity presence prognosis above the main producing horizon. Under inhomogeneities are understood the presence of decompression zones, formations with abnormally high reservoir pressure (AHRP) and natural or artificial hydrocarbon deposits (that formed due to leaks across strings of the drilled development and exploratory wells).

Conducted work on one of the largest condensate fields with complex geology (salt-dome tectonics) produced excellent results. Joint with customer analysis of the obtained outcome together with the involvement of drilling hazard data from the already drilled wells showed close agreement between the location of inhomogeneities identified by LFS method and the known downhole trouble intervals in the wells.

Results

Based on the results of prospecting and evaluation, detail works by LFS method the customer receives the following:

- Maps of prognosis evaluation of oil potential of the identified and developed seismic structures;
- Maps of morphologic similarity spectra of the studied area;
- Recommendations for optimization of further geological exploration and well location.

Based on the results of the geological inhomogeneity identification in the rock mass by LFS method the customer receives the following:

- 3D cubes and maps of inhomogeneity in the rock mass.