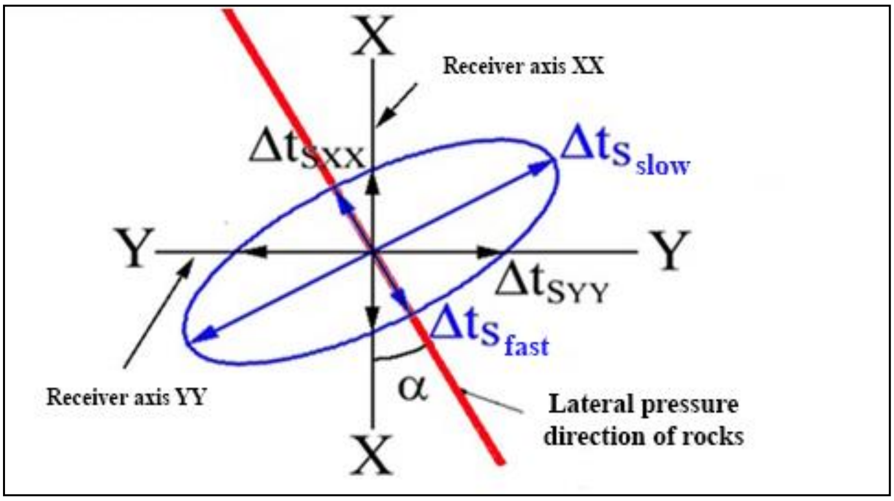


***Fig. 2 Results of the research conducted at field X by means of full-waveform logging apparatus, where: α – speed anisotropy angle referred to the direction of receiver XX, SF – fast shear wave, SS – slow shear wave, SXX – recorded shear wave in XX direction, SYY – recorded shear wave in YY direction.***

This horizontal wells selection at reservoir X included the wells, where after the start (in the first 3 months) the hydraulic fracturing treatment has been conducted. Hence we may conclude that the best drilling direction for horizontal wells or horizontal sidetrackings at field X are north-east-east and south-south-west directions. When drilling in this direction, i.e. perpendicular to the regional stress direction (according to the conducted research), it is assumed that due to the rock stress difference the fractures resulted from the hydraulic fracturing treatment develop in the best way along the direction of rock stress (~130-145 degrees). Therefore, the highest fracture length can be achieved, and consequently, the bigger formation coverage and the higher well productivity can be obtained [3,2].

In the future it is necessary to conduct additional research at reservoir X and to consider the possibility of drilling new wells in north-west direction, as the only well drilled in this direction has shown the highest productivity.

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## REPEATED HYDRAULIC FRACTURING IN HORIZONTAL WELLS WITH UNCEMENTED LINER

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The oil and gas industry has recently faced the problem of reducing the productivity in horizontal wells which are equipped with assemblies for multi-stage hydraulic fracturing in uncemented liner condition. The quantity of such wells is growing every year. In 2013, LLC «Gazpromneft-Vostok» conducted first multi-stage hydraulic fracturing and by today 15 of such wells have actually been put into operation, 2 of which are carrying out acid multi-stage hydraulic fracturing. As a result, the actual problem is to find solutions for performing effective repeated stimulations on a given formation employing existing assemblies.

The proposed solutions are simplified to the following options:

1) Small-sized liner technology;
2) Technology with a chemical deflector (blocking existing cracks by insulating compound);
3) Cup-to-Packer technology;
4) Spot Frac technology (clipping of zones by a two-packer assembly);
5) "Blind" multi-stage hydraulic fracturing.

The aim of this work is to analyze existing, potential possible methods of repeated stimulations of wells with multi-stage hydraulic fracturing, selection of suitable methods for approbation, selection of candidate wells in the company perimeter and calculation of the incremental oil rate. In connection with the goal of the research, the following tasks are set in the work:

1) to analyze horizontal well stock with the multi-stage hydraulic fracturing;
2) to study the existing methods of repeated multi-stage fracturing;
3) to carry out analytical calculations for the selection of candidate wells;
4) to review the results of a repeated "blind" hydraulic fracturing.

The subject of the study is horizontal wells with the uncemented liner, where the multi-stage fracturing was previously performed. To solve the problems the following methods are used: study of literature sources, actual data analysis, hydraulic fracturing process modeling. Keywords of study: horizontal wells, multi-stage hydraulic fracturing, uncemented liner.

The calculation of potential production rate of horizontal wells with hydraulic fracturing was conducted by the method of Li [1]. In July 2017, as part of the search for solutions, a «blind» hydraulic fracturing was conducted on one of the horizontal wells. As per planned 3 stages 70 tons of proppant each there was a premature stop pumps during the first stage of the main hydraulic fracturing. The incremental oil rate of 4 tons/day was obtained after bottomhole cleaning, lowering the electric submersible pump and starting the well. This result allows us to conclude that the correct selection of candidate wells and the technological success of the repeated multi-stage hydraulic fracturing will allow obtaining a larger oil increase.

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## FORMATION OF THE GROUNDWATER CHEMICAL COMPOSITION UNDER AEROTECHNOGENIC IMPACT (THE KOLA PENINSULA)

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The impact of anthropogenic factors leads to a change of all landscape elements, including deterioration of natural water quality. The enterprises of the Kola Mining and Metallurgical Company have polluted the atmosphere with sulfur compounds, copper, nickel for many years. At the same time, soil, as a landscape element, is a biogeochemical barrier for chemical elements input to ecosystems from the polluted atmosphere. Soil degradation leads to decrease in their sorption capacity and, consequently, to groundwater contamination with heavy metals.

Taking into account the peculiarities of the water chemical composition, geological structure and the degree of anthropogenic impacts, two principally different areas were identified [3]. The first area is the Khibiny massif area (the eastern part of the lake Imandra catchment) and the second one is area exposed to anthropogenic impact of «Severonikel» plant (the western part of the lake Imandra catchment) – Figure 1.

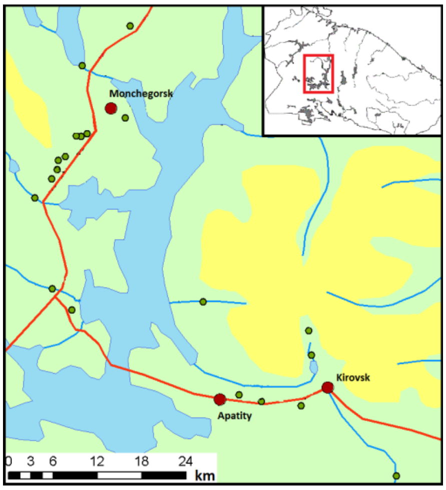


*Fig. 1 Map of the studied area and sampling points*

In the groundwater in the eastern part of the Imandra lake basin catchment, the concentrations of a number of chemical elements, especially nickel and rare earth elements, are lower than in the western part, which may be due to both metallogenic features of the territory and the lack of man-caused impact of the plant [3]. Formation of the groundwater chemical composition is a very complex process. It is determined by a combination of factors that create a certain geochemical situation. The most important process in the formation of the groundwater chemical composition is the interaction of water with water-bearing rocks.