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On the outlooks for gas and oil presence at the continental shelf of Eastern Arctic

Chairman of the Management Committee of Gazprom Alexey Miller has emphasized repeatedly the importance of the development of the Eastern Gas Program aimed at establishing the foundation for the future energy development of Eastern Siberia and the Russian Far East, both onshore and offshore [1, 2]. While a number of gas, condensate, and oil fields have been found onshore in the southern part of Eastern Siberia, the Sakhalin Island and its shelf, no fields have been discovered so far on the shelf of the underexplored Eastern Arctic seas. According to estimations, the predicted resources of hydrocarbons (HC) in the Laptev Sea, East Siberian Sea, and Chukchee Sea are 5.95, 5.58, and 3.3 milliard t of oil equivalent, respectively.

The Laptev Sea shelf has been insufficiently investigated in terms of its geology and geophysics. The most complete stratigraphic column was determined for seismic uplifts crossing lowered areas in the western and southern coastal sea area parts, where Upper Proterozoic, Paleozoic, and Mesozoic deposits are commonly found. When estimating the oil and gas potential of the subsurface of the Laptev Sea shelf, the external geological equivalent with the North Sea oil and gas basin, in which oil and gas occurrence in Paleozoic (primarily Lower Permian), Mesozoic (Jurassic and Upper Cretaceous) deposits was determined, were traditionally considered. Within the Rebekovskoye and Trofimovskoye uplifts and the Minin Bar, Lower Cambrian deposits also have potential. Paleozoic and Mesozoic deposits, according to the latest predictions, contain up to 85 % of oil and gas resources. Cenozoic deposits are only considered to account for up to 15 % of oil and gas resources.

The Laptev Potential Oil and Gas Province (POGP) is regarded as the primary regional object of offshore prospecting. The differences in the geological structure and stratigraphic column of the sedimentary cover allow to identify as part of the Laptev POGP Northern, Southern, Western, Eastern, and Central Laptev potential oil and gas areas (POGA) (fig. 1).

In the western coastal part of the Laptev Sea, there is large Yenisei Khatanga deflection identified by S.V. Aplonov as the apotheosis of the Ob Paleocean. However, the western Yenisei part of this deflection, by the column of the oil- and gas-bearing complexes of sedimentary deposits, allows to regard it as a complete geological equivalent of the Arctic deflection of the Paikhoy Taimyr oil- and gas-bearing area, which should be taken into consideration when estimating its oil and gas potential.

The oil and gas potential of the Northern Laptev POGA to the north of the Northern fault is associated with the terrigenous reservoirs, predominantly of the Upper Cretaceous part of the sedimentary cover column, lying at depths of up to 3 km. In the Western Laptev POGA, oil and gas potential is considered associated with the Late Paleozoic / Early Mesozoic terrigenous complex, presalt carbonate Paleozoic and, possibly, Upper Proterozoic deposits, i.e. with deposits lying at depths of up to 5 km and over. For this reason, Late Paleozoic and Early Mesozoic deposits also have more potential in the southern parts of the Rebekovskaya and Trofimovskaya uplift areas and on the Minin Bar. The oil and gas potential of the Eastern Laptev POGA is associated with the Mesozoic and Paleocene/Eocene terrigenous reservoirs in the terrace-like side of the Ust Lena graben and Eastern Laptev uplift, potential oil and gas accumulation areas (POGAA). In the northern parts of the above potential oil- and gas-bearing area, oil and gas potential is associated with Cretaceous and Paleogene deposits at depths of up to 4.5 km.

A number of Russian companies have already declared their interest in the geological investigation of the subsurface of the Laptev Sea shelf (fig. 2), oil and gas potential of
which is also indicated by information about the North Sea, an external geological equivalent of the Laptev Sea. It is known that oil and gas potential of Lower Permian, Lower Triassic, Jurassic, Upper Cretaceous, and Paleocene deposits have been determined in the North Sea.

The East Siberian Sea and Chukchee Sea shelves are among the least studied in the Russian Arctic shelf. There are no internal geological equivalents at the adjacent Russian mainland. Here, the Hyperborean Epicaledonian plate is identified in the northern part, and the Novosibirsk Epicimmerian plate in the southern part (fig. 3). In the first plate, the carbonate Carboniferous, Triassic/Jurassic and Cretaceous/Paleogene deposits within the De Long and Shelagsky uplifts are considered as having potential. In the second, less studied plate that has less potential, the Medvezhinsky cape and Blagoveschenskaya structural terrace that are part of the Ust Indigirka POGA, are considered as having potential. The most objective and complete information about

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the specifics of spatial changes in the lithologic-stratigraphical profiles of permeable reservoir rocks and impermeable cover rocks, as well as their thickness and oil and/or gas potential can be obtained by drilling stratigraphic wells (a limited number) on peninsulas and islands, which would allow to associate seismic data with the profiles of these wells and determine the areas on which future prospecting and exploratory operations should focus.

Stratigraphic drilling on Arctic islands has so far been done by the Subsurface Exploration Division of Rosgeo. High efficiency of such wells was proven in process of regional studies of the geological structure and oil and gas potential of the Barents and Kara seas subsurface [3, 4]. Unfortunately, stratigraphic well drilling is not financed by the state in the present economic situation. However, stratigraphic drilling in Russia can be resumed if the Ministry of Natural Resources and Environment and the Federal Subsurface Management Agency provide financing of 10–15 %, and the other 90–85 % investments are made by Rosneft, Gazprom, and foreign contractors. For the first time, employees of the All-Russian Gramberg Institute for Ocean Geology negotiated about such an offer with commercial companies in 2005.

In the Eastern Arctic oil and gas province, exploration operations are most feasible in the western near edge zone of the Drem-Head deflection (bordering the Northern Chukchee deflection) and on the Shlaginsky uplift. Carbonate Carboniferous, Triassic, and Jurassic/Cretaceous deposits in the sedimentary deposit column can be considered as having potential in the Eastern Arctic oil and gas province. In the Novosibirsk POGP, Paleozoic, Mesozoic, and Cenozoic deposits are considered as having oil and gas potential. However, the main focus, according to most researchers, should be on the Triassic/Paleogene terrigenous part of the column. Exploration operations here are advised in the western part of the Blagoveshchenskaya structural terrace. The Northern cape and the eastern near edge zone of the Zhokhovskaya trough can also...
be regarded as areas that possibly have oil and gas accumulation potential.

The highest potential in the Russian part of the Chukchee Sea shelf may be associated with the Northern Chukchee deflection, in the near edge zone of which Upper Paleozoic, Triassic, Jurassic/Cretaceous, and Paleogene deposits are commonly found. Less potential is associated with the Mesozoic/Cenozoic deposits of the Southern Chukchee deflection, where, according to seismic data, anticlinal bends are known, and delta complexes may be commonly found at the Cretaceous level at the bottom of the column, as predicted by analogy with Alaska.

Fig. 3. Map of oil and gas geological zoning and oil and gas potential of East Siberian Sea and Chukchee Sea and recommended stratigraphic wells 4 and 5 (see below): 1 – boundary of largest and large structures on shelf; 2 – slips, oblique-slip dip faults, and faults with unclear kinematics; 3 – shelf edge; 4 – boundary of potential oil and gas provinces; 5 – boundary of potential oil and gas areas. Oil and gas geological zoning (POGA: A – De Long; B – Northern Chukchee; C – Ust Indigirka; D – Southern Chukchee)
A special expert committee of the Ministry of Geology recommended drilling a number of necessary stratigraphic wells. A well in the eastern part of the Lena river delta (well 1, see fig. 1) will have the top priority among all these wells. The well will allow to study a potentially oil- and gas-bearing column of the Cenozoic complex of the Ust Lena rift-related deflection. It is also advised to drill a 4000 m deep well in the Laptev Sea, in the coastal eastern part of the Begichevskaya saddle on the Peschany Island (well 2 is the most important, see fig. 1). The Gramberg Institute for Ocean Geology also plans to drill (before the first two wells) stratigraphic well 3 with a projected depth of 4150 m on the Vilkitski Island in the Kara Sea north of the Gydan Peninsula. In the East Siberian Sea (see fig. 3), it is proposed to drill stratigraphic wells 4 (4500 m deep) in the eastern part of the Novaya Sibir Island and well 5 (4000 m deep) in the north-eastern part of the Bolshoy Lyakhovsky Island.

The geological columns of the stratigraphic wells shown in fig. 1 and 3, along with the seismic profiles, will allow to identify reference and marker horizons and determine the specifics of the regional geological structure more accurately. After the stratigraphic drilling is complete and its results have been processed, it will be possible to plan and implement additional 2D and of partially 3D seismic operations on the shelf of the Eastern Arctic seas. This is particularly important, since it is predicted that most geological resources of free gas and oil in the Mesozoic and Paleozoic deposits will be found there.

It is for this reason that the geological exploration program for the period until 2020 developed by the Russian Ministry of Natural Resources and Ecology [5] provides for gradual relocation of operations to the Eastern Arctic, it is predicted that 3 to 5 large fields will be discovered in the Laptev Sea. On the East Siberian Sea shelf, potentially bearing Upper Paleogene / Upper Cretaceous, Lower Cretaceous / Triassic, as well as Upper and Middle Paleozoic deposits likely exist in the Northern saddle, East Siberian and other uplift zones. Rosneft is already beginning geological exploration operations at the East Siberian 1 licensed area in the East Siberian Sea. According to estimations, the predicted recoverable resources in the area include 1.367 milliard t oil and gas condensate, as well as 1.166 trillion m³ gas.

It is evident that during the development of program documents relating to the exploitation of mineral resources of the Russian Eastern Arctic, primarily hydrocarbon materials, investment projects along with the development of the supporting transportation infrastructure should also be regarded. The expansion of the hydrocarbon resource base by means of the Arctic shelf of the Laptev Sea and the East Siberian Sea is, undoubtedly, a top priority strategic goal of the Russian Federation and is closely related to the development of transport in the Arctic. Most notably, the role and significance of the Russian national Arctic transportation corridor, the Northern Sea Route, will rise drastically.

The knowledge about the geological structure of the Eastern Arctic sea shelf subsurface and its oil and gas potential allows to count on significant increase in the hydrocarbon potential of the Russian Federation not only in the western, but also in the underexplored eastern Arctic seas.

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