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## New Information on the Structure, Geological Development and Oil and Gas Potential of the Northwestern Territories of Yakutia and the Adjacent Shelf of the Laptev Sea

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# New Information on the Structure, Geological Development and Oil and Gas Potential of the Northwestern Territories of Yakutia and the Adjacent Shelf of the Laptev Sea

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**Abstract.** In the XX-th century, scientific ideas prevailed on the genetic connection of the marginal Arctic territory, stretching far into the Laptev Sea shelf, with the mesozoids of the Verkhoyansk-Kolyma's mountain-fold system. At the same time, this coastal strip of elevation was considered as the northwestern branch of this system. At the end of the last century, there have been significant changes in these views. The opinions of the geological development of the northern continental and adjacent shelf areas during the pre-Cenozoic geological epochs get very broad support under the conditions of a typical platform regime. The latest results of the seismic survey of the CDP-2D carried out in the Laptev Sea area was played an important role. The geological model of the structure and oil and gas content of the large area of the articulation of the continental land and the adjacent East Arctic shelf is justified and for the first time a preliminary characteristic of the new large Olenek-Laptevskaya oil and gas bearing region was given. The marginal structural-tectonic elements of sub latitudinal strike are constituent parts of the southern side of a large sedimentary basin, mainly located on the shelf Laptev Sea (Olenek-Laptevskaya syncline). The tectonic regime of the concordative deflection, carried out earlier under the conditions of the passive continental margins of the Siberian Platform, was replaced with the conditions typical for the areas of interplate activation at the end of the Cretaceous and further in the Paleogene-Neogene. At the same time, the predominant stretching established earlier in the spreading zone on the continuation of the Gakkel ridge in the south-west direction was replaced by the conditions of regional subhorizontal compression. The obtained results indicate a regional continuation on the shelf of a large Riphean focus of oil and gas formation, established earlier by seismic prospecting in the northeast of the Siberian platform. As a result, it assumes the presence of a very significant hydrocarbon potential, much exceeding the high predictive estimates of past years.

## 1. Introduction

In the Republic of Sakha (Yakutia), including its northwestern territory, geological exploration for oil and gas are carried out almost 90 years old. Literally since the early years of this period the continental territories addressed in article are constantly assessed as highly prospective in the oil and gas relation. In recent decades, the Laptev Sea shelf has been covered by geophysical works (seismic exploration of CDP-2D) in connection with the worldwide increased interest in the oil and gas content of the shelves of the marginal and inland seas. Significant problems are related to stratification of reflecting seismic



horizons, and the identification of features of the deep structure of the explored areas, cause the total lack of drilling operations, including deep wells.

The relevance of this article is obvious in the light of the data on high predictive hydrocarbon potential of the articulation area of the continental land and the adjacent fragment of the Arctic shelf of the Russian Federation. In addition, the solution of problems on the limits of shelf propagation, features of its deep structure in connection with the forthcoming resuscitation and the further development of the Northern Sea Route is of considerable interest. The main task solved in the article is directed to a detailed integrated research of the available geological and geophysical materials, including the latest data obtained in recent decades, and possible clarification of the above issues, taking into account new theoretical concepts.

## **2. Methods**

The methods of the research is based on a comprehensive synthesis and analysis of all available data from different years on the structure of the sedimentary cover, its geological development and potential oil and gas bearing in mind the multivariate stratification of reference seismic horizons, alternative approaches to the geological boundaries in the continental territories in the marine waters, and the results of various geological and paleotectonic structures.

## **3. Traditional geological representations of past years**

Until the end of the 80s of the last century, published scientific and stock geological literature was dominated by scientific ideas about the genetic connection of the Arctic Territory, stretching far into the Laptev Sea shelf with the mesozoids of the Verkhoyansk-Kolyma mountain-fold system. At the same time, this coastal strip was considered as the northwestern branch of this system. Located to the south-west of it the largest Mesozoic depression was estimated as the Lena-Anabar regional deflection. Further to the south, traditionally platform areas (Anabar antecline and other large structural elements within the Siberian platform) are traditionally distinguished. Lena-Anabar deflection was characterized as a typical regional deflection, genetically related to the Verkhoyansk-Kolyma mountain-fold system of the Mesozoic age to the end of the XX century in accordance with the traditional views of the past years in most cases. It was considered that from the north it is bounded by the leading folds of the Olenek (Lena-Anabar) zone of the Mesozoic, which in their structure are very close to the folds of the Kitchinsky, Yundulung and other uplifts of the Predverkhoyansk deflection, and represent, like the latter, the projections of the folded base at a geosyncline wing of the deflection. The folded zone of the Mesozoic, which is the western branch of the West Verkhoyansk mega anticlinorium, is buried here under the seabed of the Laptev Sea and extends between the Olenek advanced folds and the Laptevian middle massif.

In the south, the Lena-Anabar deflection borders with the Anabar antecline. It is separated from the Predverkhoyansk deflection by Atyrkansky, and from Khatangskiy by Ust-Anabarskiy rapids.

The Lena-Anabar deflection has an asymmetric structure like the Predverkhoyansk. The northern, at a geosyncline, its wing is steep and characterize by angles of incidence from 10° to 40°; the slope of the wide southern platform-shaped wing does not exceed 1° on average. The length of the deflection is about 600 km, the maximum width is 150 km.

In the development of deflection, almost the same stages are observed as for the Predverkhoyansk deflection.

In the Lena-Anabar deflection, the Lower-Lenskaya, Taimylyrskaya, Buolkalahskaya and Yuelinskaya depressions are distinguished (from the east to the west), separated by the Berelihsy, Charkyskiy and the Wirtenyskiy transverse uplifts (rapids), respectively. The last three depressions usually unite in the Anabar-Olenekskiy deflection.

In the zone of the foremost folds, the Ust-Olenekskaya and Pronchishchevskaya mega anticline are distinguished at a geosynclinal wing of the Lena-Anabar deflection, in the vaults of which there are several brachyantichinal, generally small, folds. Permian and Triassic deposits appear in the cores, overlapping on the wings with Jurassic and Cretaceous sediments. The folds are broken by quite

numerous faults. The northern wings of the mega anticlines are omitted from the faults and buried under cover of the Cenozoic deposits [3, 4, 16, 18].

#### 4. New submissions

In the last decades of the twentieth century, there have been significant changes in these estimates and characteristics. First of all, the point of view of scientists was widely supported on the geological development of the northern continental and adjacent shelf territories in the Cambrian period in the conditions of a typical platform mode [2, 12, 16]. The latest results of marine seismic studies of the CDP-2D a significant role in the development of new submissions was played carried out to date in the Laptev Sea waters [4, 6, 8, 17, 19].

One of them justified the geological model of the structure and petroleum potential vast area articulation of continental land and the adjacent East Arctic shelf is substantiated. And for the first time preliminary characteristics of a new large Olenek-Laptevskaya oil-and-gas bearing region is given. This oil-and-gas bearing region covers on land two super-ordered structural elements - the Anabar-Khatangskaya saddle and the Leno-Anabar regional deflection. These structural-tectonic elements are constituent parts of the southern side of a large sedimentary basin, located mainly on the shelf of the Laptev Sea (Olenek-Laptevskaya syncline).

The established features of the structure and geological development of the newly isolated oil and gas bearing basin suggest that it is very similar to the well-known Viluisk hemisyncline, where a number of gas condensate deposits have already been discovered. The obtained results also indicate a regional continuation on the shelf of a large Riphean focus of oil and gas formation, established earlier by seismic prospecting in the northeast of the Siberian platform. As a result, it assumes the presence of a very significant hydrocarbon potential, which is much higher than the high predictive estimates of previous years for the platform territory of the adjacent continental land and also the latest forecast for the Laptev Sea shelf [1, 4, 5, 7, 8, 9, 11, 13, 15, 20]. These materials confirm, in particular, the existing scientific views on the typical platform nature of the multi-tiered sedimentary cover, accumulated in the late Precambrian - the Phanerozoic in the territory of the modern Laptev Sea. At the end of the Cretaceous period and further in the Paleogene-Neogene, the tectonic regime of the consedimentational deflection, carried out earlier in the conditions of the passive continental margin, was replaced by the conditions peculiar to the areas of interplate activation. Herewith the preferential stretching established earlier in the spreading zone on the continuation of the Gakkel ridge in the south-west direction was replaced by the conditions of regional subhorizontal compression [11, 17].

In recent decades, in the world practice of geological exploration for oil and gas, an important role is played by studies on the petroleum potential of the shelves of the seas adjacent to the continental land of different countries, including the Russian Federation. This is a very promising direction, the realization of which is almost universally accompanied by new major discoveries.

The shelf of the seas washing the Arctic Lands of the Republic of Sakha (Yakutia), including the vast fragments of the two eastern Arctic seas (the Laptev Sea and the East Siberian Sea) until recently have been very poorly studied.

The situation changed somewhat in recent years, when the sea of Laptevs with a sufficiently high density of seismic profiles was covered by the marine seismic survey of CDP-2D. However, the complete absence in the indicated water area of any deep drilling data has led to an ambiguous interpretation of the obtained seismic materials.

In 2015, in the IOGP SB RAS, the geological model of the modern structure of the territory of the compound of the continental land and the Laptev Sea shelf was developed for the first time. Herewith, the complex geological and geophysical data available along the Arctic coast. Confirmation of preliminary representations of past years about the presence of Laptev Sea basins in the sedimentary cover of large structural elements platform type was obtained.

The presence of Mesozoic folding, genetically related to the northwestern sub latitudinal branch of Verkhoyansk, was previously observed in the sedimentary cover. The Lena-Anabar deflection, traditionally allocated on the Arctic coast of the Laptev Sea, and the zone of development of large-

amplitude coastal uplifts are actually constituent parts of the southern side of the new largest Olenek-Laptevskiy oil and gas basin or province. Taking into account its ancient location (Riphean), the hydrocarbon potential of the new oil-and-gas province can be predicted much higher than previously thought. The Laptev Sea shelf in question and the adjacent continental land are very unevenly studied. The shelf has comprehensive geophysical information, which along the Arctic coast is complemented by deep and core drilling materials.

According to these data, a large geoblock of a complex structure is segregated on the shelf. It assumes a subplatform mode of formation of a sedimentary cover - from the Riphean to the Cenozoic inclusive. A series of promising complexes are singled out in its structure.

Numerous manifestations of hydrocarbons on the adjacent land indicate the possible oil and gas potential of the shelf. One of the largest in the world Olenek zone of bitumen in the immediate vicinity of the coast is located.

In the complex analysis of data Lena-Anabar deflection, the adjacent part of the Anabar anticline and the Laptev Sea shelf, the maximum densities of the hydrocarbon resources are projected in the coastal areas of the water area. At the same time, a series of geological analogies are outlined, in particular, the genetic similarity of the regional uplifts zone in the Lena-Anabar deflection and the Hapchagai zone of oil and gas accumulation in the Viluisk-Aldan system of dislocations. The adjacent part of the shelf is compared, according to a number of criteria, to the industrial oil and gas regions in the extreme east of the Arctic.

As the most promising areas are allocated sites with the predicted productivity of two or more complexes that make up modern rift structure like the Ust-Lena rift [14].

It is assumed that they are all marginal parts of a single larger depression in the structure of the sedimentary cover, the predominant part of which is within the shelf. The specified super-hollow was allocated in 2014 - 2016 Corresponding member RAS A F Safronov on the territory of the Laptev Sea shelf under the name «Olenek synecline».

## 5. Conclusion

The regular confinement of uniquely large oil and gas resources to these negative forms in the structure of the sedimentary cover is forecasted if they comply with the following required conditions: ancient laying; the multi-tier structure of the sedimentary cover; long-term inherited development with a regular change in tectogenesis regimes; preferential development in platform conditions; the presence in the history of the formation of depressions in the stages of rifting, etc.

At the end of the Cretaceous and further in the Paleogene-Neogene, the tectonic regime of the consedimentary deflection, carried out earlier under the conditions of the passive continental regional of the Siberian Platform was replaced here with the conditions typical for the areas of interplate activation. Herewith the predominant stretching established earlier in the spreading zone on the continuation of the Gakkel ridge in the south-west direction was replaced by the conditions of regional subhorizontal compression.

The obtained results also indicate a regional continuation on the shelf of a large Riphean focus of oil and gas formation, established earlier by seismic prospecting in the northeast of the Siberian platform. As a result, it assumes the presence of a very significant hydrocarbon potential, much exceeding the high predictive estimates of past years.

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