Intriduction

According to modern schemes of oil and gas zoning, the Arctic regions of the Siberian platform and
the Laptve Sea shelf cover the Anabar-Khatanga and Lena-Anabar oil and gas regions (OGR) of the
Lena-Tunguska oil and gas province (OGP) and the Laptve Sea prospective oil and gas province
(POGP).

At present, 16850 km of seismic CDP profiles have been worked out in this territory and deep wells
have been drilled in the continental part, the complex analysis of which allows to build regional
models of the geological structure on a new level and to specify oil and gas potential of this region.

Geological structure and petroleum potential of the Anabar-Khatanga and Lena-Anabar OGR

The Anabar-Khatanga and Lena-Anabar OGR, tectonically located within the Anabar-Khatanga
saddle and the Leno-Anabar regional depression, are in the extreme north of the Siberian Platform and
administratively located in the north-east of the Krasnoyarsk Region and the north-west of the Sakha
Republic (Yakutia), on the coast of the Laptve Sea. The analysis of geological and geophysical data
allows to draw a conclusion that a Neoproterozoic-Mesozoic sedimentary basin has developed in this
territory, within which the thickness of platform sediments reaches 14-16 km [Kontorovich et al, 2019].

The analysis of seismic cross-sections and drilling data allows to identify 5 regional-developed
seismogeological megacomplexes in the sedimentary cover of this region: Riphean, Vendian,
Paleozoic, Permian and Mesozoic, which are controlled by seismic marker horizons in the top and
bottom (Figure 1).

Figure 1 Seismic section showing seismogeological characteristic of the Neoproterozoic-Phanerozoic
deposits of the Siberian platform Arctic regions. Legend: 1 - reflector, 2 - seismic complex, 3 – faults,
4 – seismic line.

Mesozoic seismogeological megacomplex. It lies in the upper part of the sedimentary cover
and includes terrigenous deposits of the Triassic, Jurassic and Cretaceous. At the time cross-sections, the
Mesozoic seismocomplex in the bottom is controlled by the reflecting horizon T0, in the top by the
surface. In the north of the Siberian platform, the thickness of the Mesozoic complex decreases
regionally from 3000 m to 0 m in the south. Reducing the thickness of these deposits also occurs over the Beregovy ridge, the Salt dome mezoswell and the contrasting anticlinal structures.

In the north of the Lena-Anabar depression and in the Anabar-Khatanga saddle, in areas where the thickness of the Mesozoic is more than 1000 m, a reflecting horizon K0, characterized by a high energy level, is identified in this megacomplex, associated with the top of Jurassic.

Permian seismogeological megacomplex. It is controlled by the reflecting horizons T0 at the top and P0 at the bottom. The reflector P0 is identified practically on the entire studied territory and is absent only in the southeast, where the Cambrian emerges on the surface. The reflecting horizon P0 controlling the bottom of the Permian complex, is at the same time associated with a large pre-Permian (early Permian?) sedimentation break. In the Lena-Anabar OGR, this break is clearly fixed on time cross-sections and in various parts of this territory the underlying Riphean-Cambrian reflecting horizons are cut off by the erosion surface. In the Permian megacomplex two stable reflection horizons are identified, associated with the tops of the Lower Kozhevnikov and the Tustakh formations. The thickness of Permian deposits also regionally increases in the north direction; the maximum thicknesses, reaching 2500-3000 m, are fixed in the northern part of the Khatanga Bay.

Paleozoic seismogeological megacomplex. It is controlled at the top by reflector P0, the reflection horizons PZ0 in the Vendian development zone and RR in the areas of its absence is associated with the bottom of the complex. The reflecting horizons PZ0 and RR, associated, respectively, with the tops of the Vendian and Riphean, are characterized by a high energy level and reliably traceable on time cross-sections.

Vendian seismogeological megacomplex. It is controlled at the seismic cross-sections by the reflecting horizon PZ0 at the top and by the reflector RR at the bottom. The megacomplex is characterized by a two-membered structure. The lower part of the Vendian is represented by carbonates and has a thickness of 650-700 m; the upper part is composed of sandstones, siltstones and argillites of the Kessyusin formation. Lying at the top of Vendian - the lower parts of Cambrian, the terrigenous deposits of the Kessyusin formation is enriched with organic matter and is considered as an oil producing one. The fundamental difference between the Vendian megacomplex and the overlying deposits is that it is not cut off by the erosion surface, but is wedged out to the elevated blocks of the Riphean.

Riphean seismogeological megacomplex. It is controlled at the bottom by the reflection horizon R0 and at the top by the reflector RR. Associated to the base of the Riphean megacomplex, the reflecting horizon R0 separates at the seismic cross-sections high-amplitude Riphean wave fields, emphasizing the platform shape of the sediments, from the rocks of the Archaean-Proterozoic basement characterized by a chaotic seismic record. In the most complete sections of the Riphean, developed in the southeast of the Lena-Anabar depression and in the Anabar-Khatanga saddle, the thickness of the Riphean megacomplex reaches 8 km, and in it are identified from four to five conformable seismogeological complexes for which tops the energetically expressed reflecting seismic horizons are confined. In the southern direction, towards the Anabar dome, the Riphean reflecting horizons regionally rise and are cut off by the reflecting horizon P0, confined to the pre-Permian sedimentation break. At the same time within the most contrasting basement highs the thickness of the "cut off" Riphean deposits is 3-4 km.

Within the studied region, the Neoproterozoic-Paleozoic reflecting horizons regionally plunge to the north. The lowest depths are fixed in the southern part of the study area, within the North-Siberian megamonoclysis and in the northeast, in the near Taymyr zone; the largest - in the most submerged parts of major depressions - the Yenisei-Khatanga regional sag, the South Laptev and Lena-Anabar synclises.

The analysis of geological and geophysical data also allows us to conclude that the dominant influence of the modern structural and tectonic structure of the northern areas of the Siberian Platform has had three fundamentally important tectonic processes:
1. The pre-Permian (early Permian?) sedimentation break, as a result of which the paleorelief of the
studied territory was leveled and a poorly dislocated surface - peneplain was formed. Given that in the
Anabar-Khatanga OGR under the terrigenous sediments of Perm there is the Devonian-Carboniferous,
and in the Lena-Anabar OGR – Cambrian, it can be assumed that to the beginning of the pre-Permian
sedimentation break the relief of the studied territory was plunging regionally in the west direction,
towards the Yenisei-Khatanga regional depression.
2. A salt tectogenesis, as a result of which in the Anabar-Khatanga OGR have been created coming
to the surface and buried salt diapirs that formed in the structural plans of the Upper Devonian,
Carboniferous, Permian and Mesozoic anticlinal structures.
3. The intensive young Late Cretaceous and Cenozoic tectonic movements, which have
predetermined the differentiation of the relief and the formation of positive and negative structures of
various orders.

The main prospects for the oil and gas potential of the Anabar-Khatanga OGR are associated with
Permian terrigenous deposits, to a lesser extent with the carbonates of the Devonian-Carboniferous
and Cambrian. In the Perm rock complex in the Lower Kozhevnikov and the Tustakh formations,
clayey packs enriched with organic matter are capable of generating significant volumes of
hydrocarbons are identified. In the Anabar-Khatanga region, the most interesting in relation to oil and
gas are the anticlinal structures associated with the salt domes. Near the known diapirs intersecting
the entire of the Upper Devonian, Carboniferous and Permian deposits, structural-tectonic traps
associated with the wedging out of terrigenous and carbonate reservoirs onto salt stocks can form;
over the subsurface salt domes, in the Permian and Mesozoic deposits classical anticlinal traps can be
formed. The analysis of the seismic cross-sections also allows to identify in the Cambrian, Devonian
and Carboniferous carbonates the wave fields characteristic of organogenic structures, which may also
be of interest in the oil and gas potential.

Geological structure of the Laptev Sea POGP

The analysis of time cross-sections indicates that a thick mass of normally sedimentary platform
deposits has developed in the Laptev Sea POGP, within which it is possible to identify 6
seismogeological complexes controlled by reliably traced reflecting seismic horizons (Figure 2).

![Figure 2 Seismogeological cross-section along the line reg_1 “Anabar-Khatanga OGR – Laptev Sea
POGP”](image-url)

At present, the views on the geological structure of the Laptev Sea area, in which no wells have been
drilled, differ cardinaly. Many researchers consider that the western and central parts of the Laptev
Sea shelf are a continuation of the ancient Siberian platform, and both ancient and young sedimentary
complexes from the Riphean to the Cenozoic are developed on this territory [Vinogradov et al., 1976, Kim et al., 2012]. Another group of experts adheres to a fundamentally different point of view and believes that in the water area the sedimentary cover is composed of Upper Cretaceous-Cenozoic terrigenous deposits lying on the Early Cimmerian basement [Daragan-Sushova et al., 2010, Khoroshilova et al., 2014]. The analysis of available seismic materials does not allow answering this question. The analysis of wave fields allows us to note that the Anabar-Khatanga and Laptev Sea basins are separated by a contrasting basement high, characterized by a chaotic wave field character that does not allow stratifying seismic complexes identified in sea cross-sections.

Conclusions

In the Anabar-Khatanga and Lena-Anabar OGR, the structural surfaces of various sedimentary complexes are largely similar. The main influence on the modern structure of these regions was rendered by: the pre-Permian (early Permian?) sedimentation break, as a result of which the relief of the territory has been leveled; processes of salt tectogenesis, which predetermined the formation of salt domes and associated anticline structures and newly Upper Cretaceous and Cenozoic tectonic movements, which predetermined the modern differentiation of the reliefs of various sedimentary complexes. Prospects for the oil and gas potential of the Anabar-Khatanga OGR are related to the Permian terrigenous deposits and Cambrian-Devonian carbonates, and the platform deposits of Riphean and Vendian are also of interest in the Lena-Anabar OGR.

Modern geological and geophysical data do not allow to stratify seismogeological complexes in the Laptev Sea shelf. At the same time, from the structural-tectonic and general geological positions the Laptev Sea basin is in favorable conditions for the discovery of hydrocarbon reservoirs. There is a large sedimentary basin, which consists of six seismogeological complexes; the relief of the territory is largely differentiated and in the structural plans of the marker reflecting horizons large positive and negative structures of 0-I orders are identified - oil and gas formation zones and oil and gas accumulation zones

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References


