Natural bitumen fields in the northeast of the Siberian Platform

(Russian Arctic sector)

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Abstract

In the northern and northeastern Siberian Platform, within the Anabar and Olenek zones, there are a number of hypergene bitumen accumulations (fields) and natural bitumen seeps, whose total resources are estimated at >5 bln tons. Bitumen fields are confined to a wide stratigraphic range from Precambrian to Mesozoic. A detailed geochemical study was performed for bitumens of the largest Olenek field, whose naphthides are localized mainly in Permian sandstones of deltaic and coast-marine genesis. Chromato-mass spectrometric analysis showed that normal alkanes are drastically reduced in the saturated fraction of the bitumens and most of terpanes are a homologous series of 25-norhopanes, which evidences the intense bacterial degradation of hydrocarbon pools. Identification of bicyclic sesquiterpenes, tetracyclic onocerane, and other biomarkers testifies that the organic matter of source rocks was rich in higher-plants remains. The concentrations of steranes are low, whereas those of earlier unknown 8-14-secosteranes are rather high. The set of geochemical data on the Permian bitumens of the Olenek field, including the isotopic characteristics of carbon (δ13C of –25.8 to –31.3‰), suggests that the coeval oil source rocks on the passive continental margin (at the place of the present-day Verkhoyansk fold belt) were the main source of hydrocarbons for the field.

Assessment of oil and gas resources, including giant bitumen pools, and their exploration in the framework of “The fundamentals of Russian state policy in Arctic up to 2020” have become a top-priority problem. Petroleum refining products might be economically feasible raw materials in the eastern Russian Arctic sector to be supplied via the Northern Sea Route.

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Introduction

In the north and northeast of the Siberian Platform, there are a number of bitumen fields (accumulations) in Precambrian, Lower and Upper Paleozoic, and, to a lesser extent, Mesozoic deposits. The main regularities of the formation and localization of naphthide fields there were determined by the historical and geological prerequisites of petroleum genesis and the formation of large zones of oil and gas accumulation and subsequent disintegration. Both processes changed in time and space, which determined the diversity of naphthide accumulations.

The recentmost geodynamic reconstructions starting from the Riphean have shown that the northeastern area of the modern Siberian Platform and the Verkhoyansk–Chukchi fold belt were a single plate with a geodynamic regime characterized by crustal cratonization, which led to a change of the rift stage of evolution by the platform one. From the Early Vendian and through the Paleozioc, Triassic, and Jurassic, the northeastern part of the craton was a passive continental margin modified by the Devonian rifting.

Favorable conditions for the accumulation of sedimentary strata enriched in organic matter (OM) arose repeatedly on the platform in the Riphean–Early Paleozoic and on the shelf of continental margin in the Late Paleozoic–Mesozoic. Normally, carbonaceous formations were characterized by a high petroleum potential, which was realized during the evolution of sedimentary-rock basins.

The abundant rising movements within the huge Anabar anteclise in the Mesozoic–Cenozoic led to the exposure and denudation of the most ancient horizons of the sedimentary cover and thus a wide spread of products of hypergene
transformation of oils: maltas, asphalts, and asphaltites. At the pre-collision (elision) stage of evolution of the Verkhoyansk–Chukchi Basin, generated hydrocarbons migrated to the marginal uplifts of the platform, thus favoring the formation of giant oil and, later, bitumen fields (e.g., Olenek) similar in genesis to the West Alberta (Canada) fields (Atabaska, Peace River, Cold Lake).


Geology of bitumen accumulation zones

The Anabar zone of bitumen accumulation. The Ras-sokha accumulation was revealed on the northern slope of the Anabar arch (Fig. 1A). It is localized in the zone where the sandstones of the Riphean Labaztakh and Burdur Formations make contact with Lower Cambrian dolomites. The pool is controlled by the surface of stratigraphic unconformity. As the Labaztakh Formation becomes eroded, bitumens are concentrated in still lower horizons, reaching its basement in the mouth of the Khastyr River (tributary of the Rassokha River) and passing into the Burdur Formation in the northeast. Bitumen-containing sandstones cover an area of ∼250 km² and are 10–15 m in thickness. Maltas selectively penetrate the interbeds and lenses of coarse-grained sandstones and gravelstones and sometimes fill caverns and pores of Cambrian dolomites. The bitumen resource potential of the Rassokha field is tentatively estimated at 200–300 mln tons (Gol’dberg, 1981).

The East Anabar accumulation (Fig. 1B) is traceable on the eastern flank of the Anabar arch for a distance of ∼200 km along the surface exposures of Vendian and Lower Cambrian bitumen-saturated horizons in the basin of the Malaya Kuonamka and Bol’shaya Kuonamka Rivers.

The Vendian bitumen-bearing horizon in the erosion zone of Precambrian weathering is 2–17 m thick. The average porosity of carbonates is 9–13%, permeability is (6–30)⋅10⁻³ µm², and the reservoir is of fracture-pore-cavern type. Bitumen in the rocks amounts to 0.7–1.0, more seldom, up to 2.2 wt.%

Several bitumen-bearing horizons have been recognized in the Lower Cambrian section (Chabur Horizon):

1. Basal sandstones 5 m in thickness with 2–2.2 wt.% bitumen.
2. Limestones and dolomites of the lower and upper members, ∼40 m in thickness, with a fracture-pore-cavern reservoir; bitumen content is ≤1.24 wt.%.
3. Sandstone beds of the upper part of the Chabur Horizon, 12 m in total thickness; bitumen content is ≤3.5 wt.%. The bitumen complex is screened by clay-marly limestone strata crowning the Aldan Stage. According to composition, the bitumens of the East Anabar accumulation are asphaltites (occurring mainly in sandstones) and asphalts (in carbonates).

The bitumen band in the Vendian–Lower Cambrian deposits on the monocline slope is just a fragment of a big ancient oil accumulation that occupied part of the recent eroded Anabar arch. Bitumen-saturated rocks monoclinaly submerge in the eastern direction, toward the most subsided part of the Sukhanki basin, where the least altered and most concentrated accumulations of heavy oils rather than bitumens might be expected. The area of bitumen-containing rocks covers tentatively ∼6000 km², and the bitumen resources are estimated at 2–2.3 bln tons (Bazhenova and Kushmar, 2006).

The Siligir–Markha bitumen accumulation (Fig. 1C) is the largest field of natural bitumens in the Middle Cambrian deposits of the Siligir Formation and in the Upper Cambrian deposits. It was described by K.K. Makarov (Makarov and Kosolapov, 1968) on the southern slope of the Anabar antecline, in the basin of the Markha River and the upper reaches of the Siligir River. Bitumen seeps form a NW-striking band 40–50 km thick and 210 km long. In natural exposures
bitumens occur as sinters along the bedding planes and abundant fractures and fill the pores, caverns, and interstices in limestones (characterized by porosity of 6–8%). In the wells drilled in the region of kimberlite pipes and in the Markha core wells, big bitumen seeps are traceable to a depth of 500 m and more. The total bitumen resources of the Siligir–Markha field are estimated at 2 bln tons.

The hydrogeological wells drilled recently in the Daldyn–Alakit region have provided new interesting data on the occurrence of oil-bitumen seeps in sedimentary rocks and kimberlite bodies. During well testing, low-yield inflows of high-viscosity oils were obtained.

In the southern group of wells of the Udachnaya kimberlite pipe, oil and bitumen seeps are observed from a depth of 100–150 m to the well bottom (1500 m). The degree of saturation increases to a depth of 700 m. The thickness of saturated sites varies from fractions of meter to few meters. In the western group of wells, oil saturation in the depth range 100–650 m is low; oil occurs as rare zones in caverns and at permeable sites. In the depth range 650–900 m, the oil saturation is higher; there are interbeds of highly oil-saturated reservoirs up to 1 m in thickness. In the depth range 1180–1475 m, the deposits are enriched in oil: The thickness of intensely oil-saturated sites reaches 11 m.

The orebody in the kimberlite pipe also abounds in oil and bitumen seeps, which occur in zones of fractures and brecciated structures, in calcite veins and caverns, along the gliding planes, at the contact of the kimberlite body with the host rocks, and even in the pipe interior (Bodunov et al., 1986; Kontorovich et al., 1981).

The Olenek bitumen accumulation zone. The Central Olenek bitumen field is localized in the arch of the Central Olenek uplift (Fig. 1D). It has been best studied along the left bank of the Olenek River, in the near-mouth part of the Kersyuke River. Here, the Vendian–Cambrian Kesyusa Formation lies, with a stratigraphic discordance, over the cavernous dolomites of the Vendian Turkut Formation; there is a basal member of gravelstones and sandstones with lenses of small-pebble conglomerates in its basement. The basal horizon is selectively saturated with bitumen, which serves as cement. These rocks are dark gray and dark brown, have a specific asphalt odor, and are of massive, banded, and, more seldom, spotty structures. The bitumen concentrations vary broadly: The maximum values reach 2 wt.% but the most frequent values are within 0.3–1.5%. The thickness of zones of intense bitumen saturation varies from 0.3 to 4 m. The underlying dolomites are also saturated with bitumen filling caverns. The bitumen resources are estimated at 150–200 bln tons.

The Olenek accumulation (field) of natural bitumens on the northern slope of the Olenek uplift is confined mainly to the Permian terrigenous deposits on the platform flank of the Lena–Anabar basin and, to a lesser extent, to the underlying Upper Cambrian carbonate rocks (Fig. 1E). Along with the Upper Cambrian bitumen-saturated cavernous dolomites (Lapar Formation), there are asphalt seeps in fractures and asphaltite seeps in calcite veins running through the Middle and Upper Cambrian carbonate deposits.

Natural bitumen seeps in the Permian deposits are traceable for about 120 km in the surface exposures in the basins of the lower reaches of the Olenek River and its tributaries—Buur, Khorbusuonka, etc. Along the rock dip to the axial part of the Lena–Anabar basin, horizons of bituminous rocks stretch for more than 50 km to well R-50 (depth 1050 m). Nine bitumen-hosting horizons were stripped in the well section; the sample core contained liquid oil (Fig. 2).

To estimate tentatively the Olenek bitumen resources and prospects for their use, twenty core wells were drilled at the Ust'-Buur site of the field in 1966–67.

The Permian deposits containing most of the field bitumens transgressively lay over the dolomites of the Upper Cambrian Lapar Formation. The deposits are inequigranular polymict sandstones of deltaic and shallow-water marine genesis alternating with members of interbanded fine-grained sandstones, siltstones, and mudstones (Gramberg et al., 1960). The exposed Permian beds occur almost horizontally; with their northeastward dipping beneath the Mesozoic deposits, the slopes increase to 1–2°. The total thickness of the exposed Permian deposits is estimated at 100–150 m; in the northern and northeastern directions it increases, reaching 340 m in well R-50. The Permian deposits are overlain with unconformity by the Lower Triassic clayey rocks.

Thirteen sandstone and silty-mudstone members are recognized in the Permian section (Fig. 2). The lower two are present only in the section of well R-50, whereas at the Ust'-Buur site they wedge out (Ivanov, 1979). The fifth sandstone member (P1-V) is the most persistent in strike; its thickness reaches 45 m. In the seventh sandstone member (P1-VII), bitumen-saturated rocks are the most persistent in abundance over the area. The thickness of zones of continuous bitumen saturation in this member reaches 15 m, and the concentrations of bitumens are as high as 10%. Usually, the distribution of bitumens is uneven and most often controlled by the rock porosity and permeability. The average contents of bitumens in saturated sandstone horizons of the field are estimated at 3.5%. According to the classification by Uspenskii et al. (1964), most of the bitumens are asphaltites and asphalts.

Bitumen resources were calculated with different degrees of reliability for the Ust'-Buur site and the Olenek field as a whole. The predicted bitumen resources of the field were estimated over the area whose southern boundary coincides with the outcrops of Permian bituminous rocks from the Olongdo River in the east to the Tonoldo River in the west. The northern boundary runs along the latitude of well R-50. This area covers 4800 km². The resources of beds with bitumen concentrations of >2% and 0.1–2% are estimated at 1.3 and 2.2 bln tons, respectively. Probably, these values are somewhat underestimated, because the bitumens of the Lapar Formation were not taken into account in the calculations. At the Ust'-Buur site, the bitumen resources were estimated by commercial criteria at 18 mln tons.

The Kelimyar (Kulumas) bitumen seep is localized on the right bank of the Olenek River, 2 km below the mouth of the Kulumas River. Among the clay-silt strata of the Kelimyar
Formation (Middle Jurassic), viscous bitumen sinters were found in a concretion-like clay-siderite interbed. The sinters fill fractures with traces of gliding planes. Often, bitumens occur inside small “banks” of crushed shells, mainly Retroceramide remains. By group composition (oils—45–73%, asphaltenes—1.4–6.2%), the bitumens are malthas. By hydrocarbon composition, the malthas are mainly alkanes dominated by high-molecular homologues (Kashirtsev, 1988).

Fig. 2. Schematic juxtaposition of the well sections at the Olenek bitumen field. 1, dolomites; 2, conglomerates; 3, sandstones; 4, siltstones; 5, mudstones; 6, bitumen-saturated rocks.
Geochemistry of natural bitumens at the Olenek uplift

The results of geochemical studies of natural bitumens from the above fields and seeps are reported in detail by Davydovskaya et al. (1969a,b), Gol’dberg (1981), and Kashirtev (1984, 1988). Let us dwell on the recently obtained data on the molecular composition of the Olenek bitumens.

Methods of geochemical studies. Chloroform extracts from bituminous rocks after the precipitation of asphaltene fractions with excess petroleum ether were separated into methannaphthene and naphthene-aromatic hydrocarbons and benzene and alcohol-benzene resins on chromatographic columns filled with ASK silica gel + Al₂O₃ mixture. The fraction boundaries were determined from the refraction index and glow under exposure to ultraviolet light.

Chromato-mass-spectrometric studies of saturated HCs were carried out on a setup including an Agilent 6890 gas chromatograph with an Agilent 5973N high-efficiency mass-selective detector. The chromatogram contained a quartz capillary column (i.d. 0.25 mm, length 30 m) impregnated with the HP-5MS phase. Carrier gas (helium) flow rate was 1 ml/min, evaporator temperature was 320 °C, injector temperature was 100 °C, and isothermal plateau lasted 4 min. The temperature was increased from 100 to 290 °C with a rate of 4 °C/min and then was maintained constant for 30 min. The ionizing voltage of the source was 70 eV, and the source temperature was 250 °C. Hydrocarbon chromatograms were obtained by total ion current (TIC) and selective ions m/z 123, 177, and 191 (for di- and triterpanes), m/z 217 and 218 (for steranes), and m/z (for secosteranes).

Discussion

The bitumens of the Olenek uplift acquired their modern composition as a result of oxidizing processes of different intensities during the rise of oil-bearing horizons to the hypergenesis zone or the opening of bitumen pools by hypergenesis. This process was well studied at the Olenek uplift (Connan et al., 1979; Jobson et al., 1979; Kashirtev et al., 2001; Peters et al., 2005; Petrov, 1984; Reed, 1977; Rullkotter and Wendisch, 1982). The biodegradation of the Permian bitumens was so intense that touched even tricyclic cheilanthanes, which are the most resistant to this process. In contrast to hopanes, regular hydrocarbons have a ring A broken between carbon atoms C4 and C5 (Fig. 5, structure I). The mass spectra of all three steroid biomarkers of the Olenek bitumens have an intense ion m/z 95, i.e., the ring A is unbroken. Otherwise, we would observe an intense ion m/z 97. As seen from the mass spectra, the Olenek bitumens contain secoesteranes with a chain broken between C8 and C14, as in secohopanes, most resistant to biodegradation (Fig. 5, structure II).

Figure 3 presents TIC chromatograms of the studied Vendian, Permian, and Jurassic bitumens. It is seen that the Permian bitumens underwent the strongest biological oxidation; they virtually lack normal and branched alkanes. The concentrations of terpanes are much higher than those of acyclic hydrocarbons. Terpanes were also subjected to bacterial action, as evidenced from the different degrees of stability of particular hydrocarbons and homologous series. Chromatograms scanned by ions m/z 123, 177, and 191 show that regular hopanes are almost completely transformed to a homologous series of 25-norhopanes, with a predominance of 25-noradiantane C₂₈ (Fig. 4). Usually demethylated hopanes are biomarkers of intensely biodegraded naphthides (Reed, 1977; Rullkotter and Wendisch, 1982; Volkman et al., 1983). Demethylated hopanes are assumed to have inherited the distribution pattern of initial regular hopanes; in the study area this is specific only for the Permian oils of the Tigyan–Anabar uplift, where adiantane usually prevails over hopane. The high concentrations of 25-noradiantane C₂₈ might be due to the selective bacterial degradation of pentacyclic hydrocarbons (Kashirtev, 2003; Peters and Moldovan, 1993). Among the identified terpanes, a homologous series of secohopanes (hopanes with a broken chain between carbon atoms 8 and 14) (Dessort and Connan, 1993) is of special interest. These tricyclic structures are reliably identified by the main fragmentary ion m/z 123 and additional ion m/z 193 (instead of 191). This, along with the ions of the molecular mass determining the tricyclic structure permits the identification of a homologous series of secohopanes. The latter are often present in biodegraded naphthides, which suggests that the carbon ring was broken during the bacterial oxidation of hydrocarbons in the pool. If so, demethylated secohopanes must be produced along with regular ones, but this is not the case. Most likely, 8-14-secohopanes are primary compounds synthesized in minor quantities by prokaryotes during the OM transformation. They appear to be the most resistant to biodegradation, and their significant “residual” amounts are due to the bacterial utilization of labile hydrocarbons in the pool.

The unknown structures were identified as 8-14-secoesteranes C₂₇, C₂₈, and C₂₉ (Fig. 5). Two structurally similar (or, maybe, even analogous) tricyclic hydrocarbons were earlier found in biodegraded oil at the Kelamayi field in China (Jiang et al., 1990). These hydrocarbons have a ring A broken between carbon atoms C4 and C5 (Fig. 5, structure I). The mass spectra of all three steroid biomarkers of the Olenek bitumens have an intense ion m/z 95, i.e., the ring A is unbroken. Otherwise, we would observe an intense ion m/z 97. As seen from the mass spectra, the Olenek bitumens contain secoesteranes with a chain broken between C8 and C14, as in secohopanes, most resistant to biodegradation (Fig. 5, structure II).

Earlier, 8-14-secohopanes and their precursors were found in extracts of Jurassic coals and Tertiary mudstones in China (Lu et al., 1985). It is not ruled out that such deposits might also contain precursors of 8-14-secoesteranes.

The biodegradation of the Permian bitumens was so intense that touched even tricyclic cheilanthanes, which are the most resistant to this process. But in contrast to hopanes, regular compounds with a typical marine distribution pattern have also been preserved here along with demethylated structures.
There are diverse concepts of the relationship between the Olenek uplift naphthides of different ages and their genesis. A.I. Gusev, one of the first researchers of the uplift geology, assumed that all surface bitumens, independently of the age of the host deposits, formed from the same Precambrian genetic source. This viewpoint was supported by many other researchers (Demokidov and Pervuninskii, 1952; Polyakova and Stasova, 1983). Another, the most popular, hypothesis was

![Chromatograms of saturated-hydrocarbon fractions of bitumens from the Olenek field deposits of different ages](image)

Fig. 3. Chromatograms of saturated-hydrocarbon fractions of bitumens from the Olenek field deposits of different ages. A, From Vendian sandstones of the Kesyusa Formation (Central Olenek accumulation); B, from Permian sandstones (Olenek field); C, from Jurassic shell rocks of the Kelimyar Formation (Kulumas accumulation). Numerals mark the number of carbon atoms in normal alkanes, P, pristane, Ph, phytane, 25nTt, demethylated 25-nortetracyclane, 25nh28, demethylated 25-noradiantane, H30, hopane.
Fig. 4. Mass chromatograms obtained by selective ions $m/z$ 123, 177, and 191. The numbers of ion fragmentation structures and schemes follow the numbers of peaks.
Fig. 5. Mass chromatograms by selective ions $m/z$ 217 and 219 and mass spectra of 8-14-secosteranes. For explanations, see the text.
put forward by the geologists and geochemists from the Research Institute of Arctic Geology, who believed that all Vendian and Cambrian bitumens, including those of the pre-Permian (Lapar dolomites) erosion zone, are more oxidized than the overlying Permian bitumens. Thus, they recognized two cycles of oil accumulation: pre-Permian and post-Permian. In the first cycle, oil was generated by Precambrian strata, and in the second cycle, by the Permian deposits in the near-axial part of the Lena–Anabar basin (Danyushevskaya et al., 1969a,b; Ivanov, 1979; Kaban’kov, 1954). Sorokov (1963) proposed one more original hypothesis of oil genesis. Based on the group composition and the degree of oxidation of bitumens, he also recognized two genetic groups of bitumens: (1) Vendian–Lower Cambrian bitumens of the Turkut and Kesyusa Formations and (2) veined bitumens of the Teyussala (Yukeebil seep), cavernous bitumens of the Lapar Formation (Upper Cambrian), and massive bitumen pools in the Permian sandstones (Sorokov considered all these bitumens to have been generated by Permian rocks). It is incredible that the researcher was so sagacious, because the modern geochemical criteria (isotopic composition of carbon, distribution of biomarkers, etc.) confirmed the propriety of his genetic classification.

Our chromato-mass-spectral data show that the Permian bitumens contain terpenoids whose genesis is related to higher-plant remains in the OM of oil source rocks. These are, first of all, bicyclic sesquiterpanes (Fig. 4, peaks 1–3 and 5–7), some tricyclic structures, e.g., drimane (Fig. 4, peak 4), and tetracyclic onocerane (Fig. 4, peak 34). All these hydrocarbons are atypical of Vendian–Cambrian naphthides. Note that the range of the carbon isotope compositions of the Permian bitumens is rather wide ($\delta^{13}C$ from $-25.8$ to $-31.3\%e$), which suggests the presence of both continental and marine (ancient aquagene?) OM in the oil source rocks. At the same time, the Vendian–Cambrian bitumens of the Olenek uplift have a lighter carbon isotope composition than the Permian ones, $-32.5$ to $-34.6\%e$ (Kashirtsev, 2003). The geochemical features of Precambrian oils have been well studied (Kontorovich et al., 2000), and the Olenek bitumens of this age interval are characterized by commensurate parameters.

The important fact throwing light upon the genesis of the Permian bitumens of the Olenek field is a similar set of unusual and continental biomarkers in the bitumens of the Permian basal sandstone member on the western and eastern flanks of the Bulkur anticline (Fig. 6) in the lower reaches of the Lena River (Tuora-Sis uplift). As in the Olenek uplift bitumens, pentacyclic terpanes here are mainly demethylated 25-noradiantane. Also, secohopanes and secosteranes were identified. All this, along with the similar carbon isotope composition ($\delta^{13}C$ of $-28.0$ to $-29.8\%e$), suggests that the Tuora-Sis bitumen seeps are traces of hydrocarbon migration from the upper-Yana and Lena–Anabar basins toward the Olenek arch up the slope of the passive continental margin in the precollision time.

Conclusions

The results obtained evidence that in the north of the Siberian Platform, including the Olenek uplift and Lena–Anabar basin, there are at least three genetic naphthide families, which formed from different sources separated both in time and in space.

Oils in the central Sukhanka basin and in the Lena–Anabar basin might be localized in the Precambrian–Lower Paleozoic complex of deposits. The deposits of the Khatspyt and Kuonamka Formations and their analogs might be oil source rocks. The deposits in the zone of the Vendian and Cambrian stratigraphic discordance (analogs of the Turkut Formation and basal beds of the Kesyusa Formation) seem to be the most favorable oil reservoirs. On testing the Khastakh and Charchyk wells, inflows of formation waters (up to 659 m$^3$/day) with dissolved gas were obtained from different Vendian and

![Fig. 6. Schematic profile across the Olenek uplift and Bulkur anticline of the Verkhoyansk foredeep. 1, algal dolomites; 2, limestones; 3, clayey limestone; 4, mudstones and siltstones; 5, conglomerates and sandstones; 6, faults; 7, bitumen pools and bitumen occurrences; 8, calcite veins with bitumen.](image-url)
Cambrian horizons. Under favorable structural conditions, e.g., on the northeastern slope of the Sappyi uplift, large zones of oil accumulation are predicted in the area of wedging-out of Riphean horizons.

In the Lena–Anabar basin, on the extension of the Olenek field, oil pools that formed at the precollision stage of hydrocarbon migration are predicted in the Permian deposits.

The findings of mafitas among the Jurassic clayey strata evidence that the latter are oil source rocks, i.e., oil fields might exist in the Middle–Upper Jurassic reservoirs in the most deeply buried Lena–Anabar basin.

The exploration of fields of natural bitumens and heavy (highly viscous) oils as a new source of mineral resources should be aimed at not only the modern but also the future progress in the technique and technology of their mining and refining and at finding new ways of their use. Application of natural bitumens as an alternative to oil bitumens in the road-building sphere is the simplest and rather cheap. Examples of such an application are known in Tatarstan and Kazakhstan. The samples of asphalt concretes prepared from the Olenek field bitumens and rocks in the laboratory of the Yakutavtodor Enterprise were of high durability (Kashirtsev, 1988).

The production of hydrocarbon material and possible extraction of valuable metals (vanadium and nickel) from natural bitumens (synthetic oil) are much determined by topographic, geologic, geographic, economic, chemical, and technological factors, i.e., the infrastructure of the field regions and the world oil prices.

According to the estimates by the United States Department of Energy, the world resources of extra-heavy oils and natural bitumens amount to 585.4 bln tons, including: Canada—222.4, Venezuela—163.7, Russia—184.2, Kazakhstan—10.9, USA—5.5, and Madagascar—5.9. But only the bitumen and heavy-oil resources in Canada (32.7 bln tons) and the Orinoco belt, Venezuela (15.5 bln tons), were recognized to be of commercial value (Bragninskii, 2004). The world production of bitumens and extra-heavy oils in 2000 was 37.5 mln tons.

According to the forecast of the Canadian Association of Petroleum Producers, the production of heavy oils and natural bitumens in the nearest future can reach 200 mln tons provided that the economic situation is favorable.

In Russia, heavy oils and natural bitumens are produced on much smaller scales. In Tatarstan, the bitumen production in recent years has been 5000 (2002), 4000 (2003), 4000 (2004), 3000 (2005), and 3000 tons (2006) (Khisamov et al., 2006). At present, the works aimed at a drastic increase in the production and refining of heavy oils are performed there. In the Timan–Pechora petroliferous province, the oil production began at the Yareg field in 1932 and reached 2.954 mln tons in 2005, i.e., 14.4% of the total oil production in the province (Starostina et al., 2006).

During the planned petroleum prospecting in Arctic, natural bitumen fields in the northern Siberian Platform must be taken into account both for estimating the petroleum resources of the modern continental margin and shelf and as individual objects of commercial exploration in the future. Assessment of oil and gas resources, including giant bitumen pools, and their exploration in the framework of “The fundamentals of Russian state policy in Arctic up to 2020” have become a top-priority problem. Petroleum-refining products might be an economically feasible raw material in the eastern Russian Arctic sector to be supplied via the Northern Sea Route.

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