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# The Hydrocarbon Potential of Yakutia is a Real Basis for Export Supplies of Oil and Gas to the Asia-Pacific Export Countries

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**Abstract.** The article contains of the history of exploration for oil and gas in Yakutia from the 1930s to the present. Issues related to the discovery of deposits and the creation of a resource base in eastern Russia under various geological conditions are considered. The oil exploration program in Siberia was developed in 1932-34. When analyzing the history of oil and gas exploration work carried out in the Republic of Sakha (Yakutia), with a certain degree of conditionality, a number of stages are distinguished that differ in the prevailing directions of the location of the work, their volume, methodology and peculiarities of integration (1933-1955; 1956-1971; 1972-1984; 1985-1992; 1993 and to the present). During these years, the following most significant geological results were recorded. In the early 30s, the first oil was obtained in the middle reaches of the river. Lena, in the valley of her right tributary of the river. Tuolba. In 1956, the first Ust-Vilyuiskoye gas field was discovered in Yakutia. The initial geological resources of hydrocarbons in prospective areas of Western Yakutia are 24 billion tons, including 10.4 billion tons of oil (2.6 billion tons of recoverable), free gas of 12.1 trillion cubic meters; gas dissolved in oil, 0.8 trillion cubic meters tons; condensate 0.7 billion tons. The predominant part of the initial geological resources of hydrocarbon gas is concentrated in the Vilyui and Nepa-Botuoba oil and gas regions. The situation with the development of proven reserves of oil and gas and the prospects for their further expansion are covered. The data obtained, together with the materials of the work of past years, convincingly indicate that the republic's subsoil has the largest oil and gas potential, capable of further accelerating the growth of the raw hydrocarbon base and the discovery of new large fields, including oil in fundamentally new areas.

## 1. Introduction

The Republic of Sakha (Yakutia) is generally recognized as one of the largest mineral-raw regions of the Russian Federation. Oil and gas occupy one of the leading places in the list of mineral resources that constitute the main wealth of the depths of Yakutia. They play a major role in shaping the country's energy strategy, especially in the far Eastern Federal district.

When discussing the problems of the oil and gas industry of the Republic, it is usually meant its western part, located in the East of the Siberian platform, is usually taken into account.

The history of oil and gas works in the Republic has been going on for more than nine decades. The need to search for hydrocarbon deposits in the depths of the Siberian Platform, which, with its eastern regions, covers the whole of Western Yakutia, was first substantiated in the late twenties and early



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thirties of our century by prominent Soviet geologists, academicians A.D. Arkhangelsk and N.S. Shatskiy. The oil exploration program in Siberia was developed in 1932-34 since with the active participation of Academician I.M. Gubkin [1,2].

The methodology of the study is based on a comprehensive synthesis and analysis of all available data from different years on the socio-economic situation of the Arctic regions of the Republic of Sakha (Yakutia). The theoretical and methodological basis of the study was the work of Russian scientists on the theoretical and practical problems of the heat and power balance of the republic. To obtain the results, methods of theoretical analysis of information sources, generalization and comparison of information on the issue under study were used. Comparative and statistical analyzes are carried out. Used tabular methods for presenting research results. The research information base was made up of materials from the Government of the Republic of Sakha (Yakutia).

## **2. History and economics of exploration**

### *2.1. The first stage 1933-1955 years*

In 1936, in the basin of the Tuolba River, the right tributary of the Lena River, the first deep well was laid at the Kuchugei-Bilyakhskaya structure (Chenkyamskaya Square). The maximum flow of oil, released with water, was recorded in a subsequent well and reached 110 liters per day [1,3].

In the period from 1936 to 1955 on the slopes of the Aldan anticline and the adjacent territory of the Predpatom (Pre-Baikal) through a number of areas were covered by exploratory drilling. Oil wells have been recorded in many wells. An emergency release of gas was noted on the Russko-Rechenskaya area. However, the discovery of oil and gas during this period in the middle reaches of the Lena River did not take place.

The second direction of oil exploration, which was carried out almost simultaneously with the first, is connected with the northern regions of Yakutia. These works were carried out according to a single government program and covered vast areas of the Krasnoyarsk Territory and the Yakut ASSR, adjacent to the lower reaches of the Yenisei, Khatanga, Anabar and Lena rivers. In the Nordvik region, oil prospecting work was carried out by the Glavsevmorput Department from the beginning of the 30s to 1953. Of the many dozens of wells drilled for the purpose of the possible productivity of Permian and Devonian deposits, only 6 showed weak oil or gas shows.

On the South-Tigian anticline structure, exploration was carried out from 1934 to 1952. In one of the wells located in the arch of the eastern dome, oil from Permian sandstones was obtained with a flow rate of up to 12 cubic meters per day. The well was operated intermittently for three years. The well was exploited intermittently for three years [4,5].

The lack of stable inflows of oil or gas of industrial significance led to the fact that, despite the abundant oil and gas occurrences, prospecting in the north-west of Yakutia was stopped in the early fifties.

In 1951, a group of specialists of the Yakutsk exploration drilling office under the leadership of A.K. Bobrov, on the instructions of the USSR Ministry of Geology, is preparing a prospective plan for prospecting and exploration for oil and gas in Yakutia. In this regard, the Predverhoyanskiy deflection was recognized as the most promising region. Compared with the previous work, this was a fundamentally new direction of work, which was focused on breeds of Mesozoic age.

### *2.2. The second stage 1956-1971 years*

In 1956, the first Ust-Vilyuisk gas field in the Republic was discovered. The first powerful inflows of gas from the Lower Jurassic deposits on the Siberian platform here not only confirmed the promise of Mesozoic rocks but also predetermined the final reorientation in the areas of geological exploration. Priority work was recognized in the Predverhoyanskiy trough and adjacent areas of the Vilyui syncline [1,6].

Simultaneously with these works, the adjacent territory of the Vilyui syncline was studied. In the early 60s, regional seismic surveys of the Reflected wave method in the eastern part of the syncline

on the right bank of the Vilyuy river, combined with the drilling of the Vilyuykolontovyi mapping wells, revealed a large haloform uplift, the KhapchagayMegaval, whose arched part is complicated by a number of large anticlinal structures. Entering them into deep exploratory drilling and the concentration of work at the Khapchagaysky uplift led to the discovery of a number of gas and gas condensate fields - Badaranskiy, Nedzhelinskiy, Srednevilyuiskiy, Tolonskiy, Mastakhskiy.

Since 1965, systematic seismic exploration of the territories located within the previously identified Botuobinskaya saddle (northern part of the Nepa-Botuoba anteklise) began. As a result, a number of large anticline structures of the platform type (Srednebotobinskaya, Verkhnevilyuchanskaya, etc.) were identified. In the first of them, a parametric well was drilled and the Lower Cambrian and Devonian sediments were broken down in the section. Gas inflows of varying intensity, indicating the discovery of the first field in the south-west of Yakutia, are noted.

### *2.3. The third stage 1972-1984 years*

The next stage is 1972-84. The study of the oil and gas potential of Yakutia began after the adoption of a resolution of the USSR Government on the deployment of gas exploration for gas in the Yakut ASSR. To accomplish the task of bringing the volume of explored gas reserves to 1.0 – 1.2 trillion meters by the end of 1975, work was significantly intensified, primarily on the exploration of discovered fields of the Khapchagay gas-bearing region, as well as on the search and study here new gas deposits. In this regard, the originally «Khapchagai» direction in the placement of exploration was predominant. As exploration works were carried out, it turned out that the structure of the deposits discovered here and other promising areas is much more complicated than it had been previously thought. It was envisaged, in particular, that a significant part of gas reserves would be explored in the horizons of the Upper Permian. In addition, a considerable part of gas reserves was predicted in the Lower Jurassic sediments. The results of the drilling of deep wells showed that the Upper Permian production horizons are characterized by a very complex development of reservoir rocks and significant variability of their reservoir properties. Therefore, the specific density of gas reserves within their limits is small. The assessment of the potential gas content of the Lower Jurassic deposits, which contain, as a rule, only small secondary deposits of gas in certain areas, was not confirmed either [3].

As a result, from the second half of the 70s, the more general «Vilyuisk» direction with the placement of priority objects throughout the Vilyui syncline becomes the priority. At the same time, gas and oil were also searched in other geological regions, which, in terms of volumes of work, were significantly inferior to Vilyuisky, at least until the end of the 1970s [7,8,9].

With a focus on promising deposits of the Cambrian and Vendian, oil prospecting in various volumes began to be carried out in many geological regions of Western Yakutia, in particular in its south-western, southern, western and central regions. The basis for their consistent reversal, primarily in the south-west of Yakutia, was the discovery of the above-mentioned Srednebotuobinskiy field [10].

In 1974, joint studies of scientific and industrial organizations of the Yakutsk Autonomous Soviet Socialist Republic, the Irkutsk Region and the Krasnoyarsk Territory with the leading participation of Siberian Research Institute of Geology, Geophysics and Mineral Resources, which is the leading sectoral institute in the east of the country, were first allocated to the Nepa-Botuoba anteklise and the same name oil and gas region. In the north, the Botuobinsky saddle, which was previously distinguished here, became part of it. Within anteklizi directly in Yakutia, a number of gas condensate and oil and gas fields were discovered: Verkhnevilyuchanskoe, Vilyuisko-Dzherbinskoe, Irelyaskoe, Tas-Yuryakhskoe, Nizhnekhamakinskoye, Iktekhskoye, Talakanskoe [11].

After a long break, work was resumed in the Predpatom (Pre-Baikal) marginal trough, including its western (Nepa-Dzherbinsk depression) and eastern (Berezovskaya depression) branches. In the west of the trough three parametric wells were drilled (Mukhtuyskaya, Nizhnepeleduyskaya, Parshinskaya) and searched for the Hotogo-Murbay structure. The gas field of the same name was discovered in the last area in the terrigenous sediments of the vendian.

In the Berezovskaya Basin located within the large Bysakhtakh anticline, gas inflows from vendian sediments were obtained, indicating high prospects for gas-bearing area. Exploratory drilling was carried out at the Kederginsky structure, where in a number of wells semi-industrial gas inflows from carbonate sediments of the lower-middle Cambrian were recorded, indicating the presence of a small gas reservoir of complex structure.

Expansion of geological exploration in Western Yakutia and the focus of these works in search of large oil and gas accumulation zones predetermined a repeated surge of increased attention to the petroleum potential of the Lena-Anabar trough. Dia-Appal and Charchyk parametric wells were drilled here, revealing sediments from the Mesozoic to the Riphean. The most promising horizons, from which intensive inflows of stratal water with dissolved hydrocarbon gas in the Charchyk well, are confined to the Vendian section.

Continuous prospecting and exploration at the Srednebotuobinskoe field allowed by 1985 to almost completely complete the exploration of this largest accumulation of hydrocarbons. It is noteworthy that its study began with a focus solely on gas, and ended with the submission to the State Reserves Committee of materials on gas, condensate, oil and associated components in the form of helium and rare-earth hydro mineral resources.

### **3. Postsoviet time explorations**

#### *3.1. The fourth stage 1985-1992 years*

The beginning of the next - the fourth stage (1985-92) of the study of the oil and gas potential of Yakutia is timed to the time when the search for gas in the Mesozoic sediments in the Vilyui syncline was almost completely completed. Geological exploration in this period was focused mainly on the study and prospecting of the early Early Paleozoic and Late Precambrian strata.

In the Vilyuisk Oil and Gas Region (OGR), single wells continued exploration of previously discovered Andylakhsky and Nizhnetyukyansky gas fields. The Ulakhan-Tyuert Reservoir Type Anomalies (RTA), which is a continuation of the eastern pericline of the Middle Tung structure, received a flow of gas from the Permian sediments.

In order to study the structural features of the Predverhoyanskyy deflection, the Prilenskaya and Alysardakh parametric wells were drilled first on the platform platform deflection, the second within the frontal zone of regional thrust. There are numerous, gas shows.

In the Lena-Anabar trough deep drilling was carried out on the Ust-Olenek and Hastakh structures, as well as within the limits of the Boer non-anticlinal trap. In each case, one well was drilled. Despite the presence in the section of Mesozoic and Upper Paleozoic sediments, the search for oil and gas was focused on the deeper horizons of the sedimentary cover (lower Paleozoic, Precambrian). Positive results are not received.

In the West Vilyui Oil and Gas Region (OGR), the study of promising areas located within large depressions (the Ygyattinskaya, the Kempendyai) with a multi-tiered tectonic structure continued. In the Kempendyai depression, the focus was on studying the petroleum potential of subsalt deposits on its northwestern side. Atyakhskaya and Eseleyskaya parametric wells are drilled here. In the first of these, gas flow from the near-bottom part of the section was noted and the Abnormally High Reservoir Pressure (AHRP) was recorded.

The highest efficiency was obtained during geological exploration in areas located to the including the administrative border of Yakutia. A whole range of new fields was discovered here. The industrial productivity of some of them was established first during the exploration of previously isolated objects of anticlinal type: East Talakanskoe, Tumpuchikanskoe, Alinskoe.

In the late 80s - early 90s, Yakut geologists and geophysicists (Matveyev V.D., Shabalin V.P., Sitnikov V.S, Serezhnikov V.G., Soloshchak M.M. and others) carried out joint research to substantiate and comprehensive analysis of available materials on the structure and oil content of ancient sedimentary strata. For the first time in the republic a number of large non-anticlinal traps were identified. The identified promising sites are located mainly in the south-west of Yakutia and in

some other geological areas. The exploratory drilling at one of these Non-Anticlinal Traps (NAT) led in 1989 to the discovery of the Chayanda oil and gas condensate field [1].

### *3.2 The fifth stage 1993 year to the present*

The total area of potential oil and gas-bearing territories of Western Yakutia exceeds 1.5 million km<sup>2</sup>. The initial geological resources of hydrocarbons in prospective areas of Western Yakutia are 24 billion tons, including 10.4 billion tons of oil (2.6 billion tons of recoverable), free gas of 12.1 trillion cubic meters; gas dissolved in oil, 0.8 trillion cubic meters tons; condensate 0.7 billion tons [12].

The predominant part of the initial geological resources of hydrocarbon gas is concentrated in the Vilyui and Nepa-Botuoba oil and gas regions. Gas contains significant amounts of condensate. In the south-west of the Republic, the presence of oil rims with large oil reserves is characteristic of many hydrocarbon gases confined to the ancient layer. Also noteworthy is the presence in the gas in the south-west of Yakutia an associated component of helium in abnormally high concentrations, far exceeding industrial conditions [13,14].

To date, total gas reserves in categories C1 and C2 in the Republic of Sakha (Yakutia) are in the amount of more than 3.0 trillion cubic meters, more than 30 hydrocarbon fields have been discovered.

In recent years, the annual levels of oil and gas production in the Republic, which previously differed sharply from each other, have become significantly closer and comparable [15,16]. Oil is produced in the mode of implementation of the ESPO oil and gas megaproject. Every year, up to 10 million tons of oil is sent to the main oil pipeline. Currently, there is almost no oil refining in the Republic.

The annual level of gas production in the Republic for many years did not exceed 2.0 billion cubic meters, condensate – 70 thousand tons. After the completion of the main gas pipeline "Power of Siberia", gas production in Yakutia increased sharply, and deliveries to China began.

## **4. Conclusion**

A major reserve for the further expansion of oil and gas reserves and the consistent development of the resource base in the Republic are primarily [5]:

- promising little-studied areas of the Nepa-Botuoba oil and gas region;
- possible discoveries as a result of revision and reinterpretation of materials from previous years and return to previously abandoned areas with new scientific concepts and modern technologies of work;
- areas with potential productivity of analogs of the Vendian and Cambrian horizons, as well as fundamentally new horizons in the section of the Lower Paleozoic and Riphean in the adjacent territories of Predpatomskiy and West-Vilyuyskiy oil and gas regions;
- certain prospects for the discovery of new oil fields, along with the Nepa-Botuoba oil and gas region, are associated with other oil and gas regions, primarily on the slopes of the Aldan antecline. Of particular interest is its northeastern slope, complicated by the Aldan-Maya depression, as well as the adjacent parts of the large Yakut mega-arch. The hydrocarbon potential of large depressions in the north-east of Yakutia, the high oil and gas potential prospects of the Laptev Sea and East Siberian Sea shelf, as well as numerous and diverse sources of unconventional hydrocarbon raw materials not considered yet. This is the largest reserve for a more distant future [4,5].

In conclusion, it should be noted that insufficient research into the characteristics of oil and gas potential and the comparative assessment of hydrocarbons in the continental and marine territories of the planet contribute to periodic spikes in disseminating in scientific publications and through the media unfounded pseudoscientific predictions about the future depletion of oil reserves and resources on our planet, already in the short term. It does not take into account the known data that the crust of the planet, especially in the part of plates, platforms and marginal deflections, is literally saturated with oil and gas. At the same time, the maximum prospects for a further increase in the resource base will be associated with marine shelf areas. A significant role in the future will also be played by unconventional sources of hydrocarbons [3].

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