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## State of natural gas resource base on the territory of Nizhneye Priangarie (lower Angara region)

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### Abstract

There are about  $6 \times 10^{12} \text{ m}^3$  of free gas potential resources concentrated in the Earth entrails of the Nizhneye Priangarie territory [L.L. Kuznetsov, A.A. Kontorovich, Proceedings of the All Russian Conference on Geology and Oil/Gas Potential and Prospects of Development of Oil and Gas Fields in Nizhneye Priangarie, Krasnoyarsk, 1996]. Gas of fields discovered here has mainly methane composition ( $\text{CH}_4$  – 63–86%); a content of methane's homologues reaches 22%, nitrogen – 27%, carbon dioxide – 1.4%. A remarkable feature of free gas from these fields is a high content of helium, that reaches 1.1%. Resource base of the Nizhneye Priangarie is reliable fundament for gas producing industry proposed here. © 1998 Elsevier Science B.V. All rights reserved.

**Keywords:** Gas; Resource; Krasnoyarsk Kray; Nizhneye Priangarie

### 1. Introduction

According to the conception of developing of oil and gas industry in Krasnoyarsk Kray, the top-priority objects of natural gas production in the south of the Kray are the fields of Nizhneye Priangarie which lie between the Angara and the Podkamennaya Tunguska rivers – the biggest right tributaries of the river Yenisey (Fig. 1).

There is a significant natural resources potential, including hydrocarbon resources that make up more than half of the resources in Russia's east regions, which are concentrated in this rather small territory.

In geological respects this territory is attributed to the south-west part of the Siberian platform. Concerning oil/gas zoning Nizhneye Priangarie is located in bounds of two oil/gas bearing areas in Lena–Tun-

guska oil bearing province with proved oil and gas. These are the Baikitsky and Katangsky regions.

### 2. Discussion

Potential resources of free gas of Baikitsky oil/gas bearing area reach  $3.2 \times 10^{12} \text{ m}^3$ . This is one of the biggest oil/gas bearing areas of Krasnoyarsk Kray as for gas resources (Fig. 2) and the biggest one – as for oil resources. In addition, Baikitsky region is the most explored one –  $2.4 \times 10^{12} \text{ m}^3$  of the resources are attributed here to prospective localised resources ( $\text{C}_3$ – $\text{D}_2$  categories). Most of the promising gas resources (about  $2 \times 10^{12} \text{ m}^3$ ) are concentrated in traps of Nizhneye Priangarie region.

Within the Baikitsky oil/gas bearing area, the Yurubchen–Tokhomo zone of oil/gas accumulation with gigantic oil and gas resources, which area makes up

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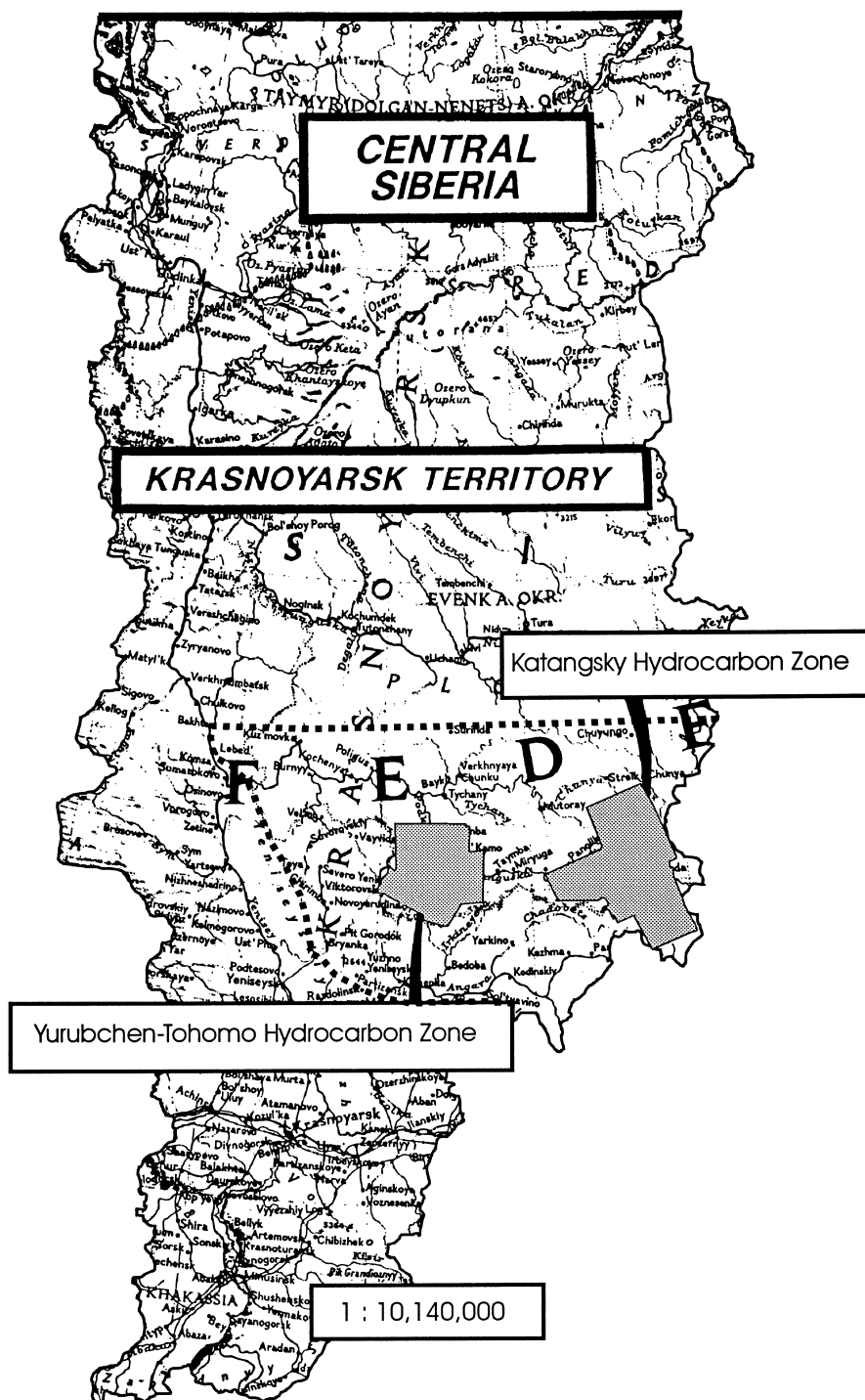


Fig. 1. Geography and administrative location of Nizhneye Priangarie territory: (■■■■■) boundary of Nizhnee Priangarie.

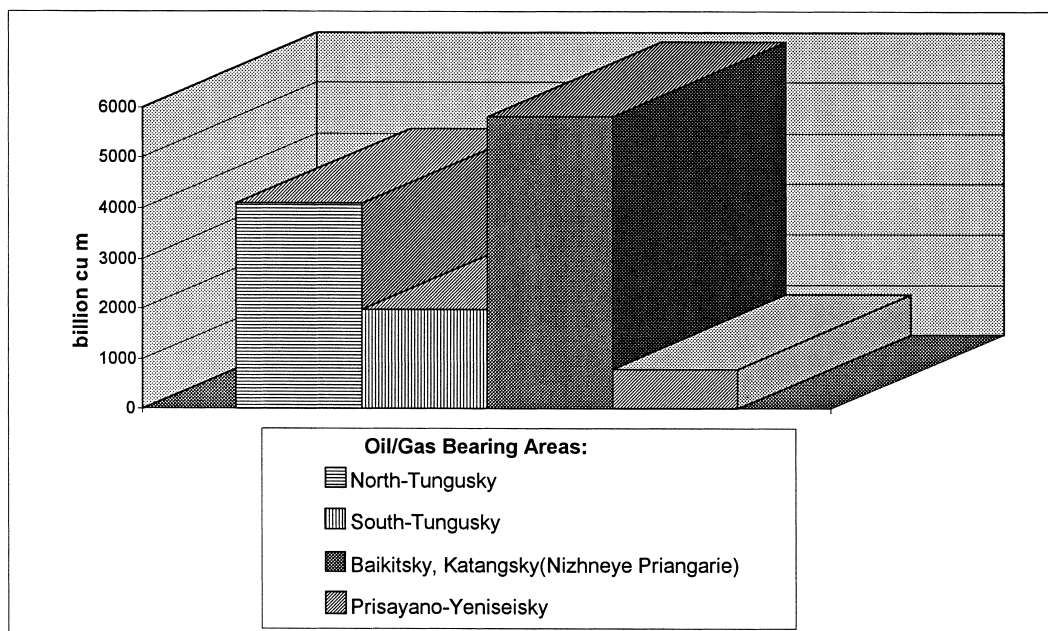


Fig. 2. Distribution of free gas potential resources in principal oil/gas bearing areas of Krasnoyarsk Kray.

about 6000 km<sup>2</sup>, has been discovered and is being explored. It includes two gas/condensate/oil fields: Yurubcheno–Tokhonskoe and Kujumbinskoe. Both the fields are being prepared for their development. In bounds of these fields most of the reserves of free gas of commercial categories (C<sub>1</sub>+C<sub>2</sub>) are prepared amounting to  $710 \times 10^9$  m<sup>3</sup>. Free gas forms gas caps of oil pools. It is remarkable that these pools are connected with most ancient sedimentary rocks in the earth crust – dolomites of Rifean age. There has so far been only one commercial hydrocarbon accumulation which was discovered on the Earth in the Rifean rocks. Reservoir rock in these pools is fractured dolomite with caverns developed along the fractures, that gives a large capacity and good filtration properties.

The similar reservoir is in dense Upper Cretaceous limestone of oil fields in Grozny oil bearing region where oil flow rates reach 2500 m<sup>3</sup>/d and in limestone of some oil fields in Iraq and Iran (specifically in Ain-Zala and Karandry fields average oil flow rates are 400 ton/d and 135 ton/d, correspondingly) [2].

Free gas of the fields in Yurubchen–Tokhomo zone contains 76–86% of methane (Table 1). Content of methane's homologues reach 22%, about 16% of

which are ethane and propane. Non-hydrocarbon components are represented by nitrogen (3–12%), carbon dioxide (up to 1.4%), hydrogen (0.01–0.6%).

Free gas of the fields in the Yurubchen–Tokhomo zone, as in the neighbouring Katangsky zone, is noticeable by its higher content of helium, which reaches a concentration of 1.8%. No gas and oil/gas fields with such high helium content has so far been discovered in Russia. In West-Siberia oil/gas bearing province the helium concentration in free gas is not more than 0.02% (Gubkinskoe). The biggest gas fields in USA Hugotone and Panhandle (Paleozoic deposits) contain about 1% of helium. Although in some fields of USA the helium concentration is higher (Red-Rock – 8.3%, Hogback – 7.2%), the main helium reserves of USA is concentrated in Hugotone and Panhandle fields because of their considerable free gas reserves [3]. In this respect, even with average helium concentration – 0.5%, Yurubchen–Tokhomo and Katangsky zones, where there is about  $5.0 \times 10^{12}$  m<sup>3</sup> of free gas, may be considered as the main objects of helium reserve concentration in Russia.

To the South of the Yurubchen–Tokhomo zone the large Nizhneangarsky gas bearing region has been

Table 1  
Characteristic of free gas in the fields of Nizhneye Priangarie

Field (productive deposits)	Gas composition (vol%)								
	Methane	Ethane	Propane	Butane	Pentane+ higher	Helium	Carbon dioxide	Nitrogen	Hydrogen
Yurubchen–Tokhomo (Vendian–Rifean)	76.0–86.0	5.0–9.0	0.8–4.0	0.5–1.8	0.1–0.9	0.15–1.1	0.1–1.1	5–12	0.01–0.6
Kujumbinskoe (Rifean)	77.0–80.0	4.0–11.4	3.3–4.5	1.3–3.5	0.2–2.8		0.63	3–7.8	Not found
Sobinsko–Paiginskoe (Vendian)	62.7–65.8	4.6–5.0	1.7–2.1	0.6–0.9	0.5–1.0	0.13–1.8	0.03–0.2	23–26	Not found
Omorinskoe (Vendian)	76.9–77.4	6.96–7.20	2.8–2.9	1.7–1.9	0.6–0.7	0.2	0.0001–0.001	9.7–9.9	0.16–0.18
Agaleevskoe (Vendian)	69.0–80.0	0.5–3.0	0.05–0.3	0.004–0.3	0.01–0.2	0.4–0.5	0–0.3	15–27	Not found

discovered, where the most of free gas potential resources of Vendian sandstones are concentrated. It is being explored in the Agaleevskoe gas condensate field. It is connected with the large anticlinal trap – the Agaleevsko–Kodinsky swell, where, from the estimation of KRIGMR experts [1], there is about  $1.0 \times 10^{12}$  m<sup>3</sup> of gas. Gas, here, in contrast to the fields of Yurubchen–Tokhomo and Katangsky zones, is connected with gas/condensate pools, but not with gas/condensate/oil pools. That is why the fields of Nizhneangarsky region are considered as the main object of gas extraction not only in Nizhneye Priangarie, but on the whole Krasnoyarsk Kray. Recovery of resource base in the gas producing region, which has been proposed here, is possible owing to such big promising traps as Ilbokichskaya, Beryambinskaya, Kolymovskaya, etc. located within 20–50 km from Agaleevskoe field and they probably form a common zone together with it. Both Agaleevskoe field and the promising traps are located along the Angara river on its right bank. An object kept in reserve for recovery of gas resources in this region is also Rifean carbonate rocks, that are insufficiently explored yet, but are productive in the neighbouring Kamovsky dome.

As it follows from first analyses the free gas from Agaleevskoe field contains 70–80% of methane, and its high molecular homologues (including hexane) not more than 4%. Non-hydrocarbon components are represented by nitrogen (15–27%), helium (up to 0.5%) and carbon dioxide (up to 0.3%).

Potential resources of free gas in Katangsky oil/gas bearing area, located East from Baikitsky, are  $2.3 \times 10^{12}$  m<sup>3</sup>. Prospective localised gas resources of this zone, connected with Vendian sandstones, are

small – not more than  $260 \times 10^9$  m<sup>3</sup>. They are concentrated mainly in one large trap – Lakurskaya ( $252 \times 10^9$  m<sup>3</sup>), that lies 30 km North–West from Sobinsko–Paiginsky oil/gas/condensate field. Free gas reserves of commercial categories (C<sub>1</sub>+C<sub>2</sub>) in this field are about  $170 \times 10^9$  m<sup>3</sup>. The field is prepared for development. Increasing of commercial reserves is possible owing to resources of Vendian reservoirs in the known traps as well as owing to potential resources, from which only about 13% are transferred into prospective resources and reserves.

A gas potential of Rifean reservoir as well as of carbonate Cambrian reservoirs are poorly explored and not realised at all. Taking into consideration an availability of the prepared Sobinsky and Paiginsky fields in the Katangsky region, the Sobinsky as well as Nizhneangarsky areas are top-priority objects of gas production in Nizhneye Priangarie.

As a characteristic of free gas in the Sobinsko–Paiginsky field, as, probably, in the whole Katangsky zone, the content of methane ranges from 63% to 66%. Amount of methane's homologues ranges from 7% to 9%. Ethane content is up to 5%, propane – 2%, butanes – 0.9%, pentanes+higher – 1.0%. Non-hydrocarbon gases are represented by nitrogen – 23–26%, helium – 0.13–1.8% and carbon dioxide – 0.03–0.20% (Table 1).

In addition to the free gas of gas/condensate/oil fields in Nizhneye Priangarie, it may be supposed, based on the estimation of Trofimuk [4] that when recovering oil, up to  $200 \times 10^9$  m<sup>3</sup> of dissolved gas would contain up to 68% of methane, about 30% of its homologues, up to 3% of nitrogen and carbon dioxide, and 0.02–0.04% of helium.

### 3. Conclusion

1. The potential resources of free and dissolved gas in Nizhneye Priangarie reach about  $6 \times 10^{12} \text{ m}^3$ . About 50% of them are attributed to prospective resources ( $C_3$ – $D_2$  categories). Gas reserves of commercial categories ( $C_1$ + $C_2$ ) on the fields make up  $710 \times 10^9 \text{ m}^3$  and about half of it are prepared for commercial development.
2. Significant resources of free gas, mainly methane with content of methane's homologues up to 16%, and dissolved gas, one third of which is represented by heavy fractions from ethane to hexane, create a reliable resource base for forming a gas producing industry in the Kray and favourable prospects for development of oil and gas-chemical industry.

3. A high content of helium in free gas of the largest fields in Nizhneye Priangarie allows to consider this region as a main region of concentration of helium resources and reserves in Russia.

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