

The Comparative Analysis of oil-gas-bearing basins of East Siberia and Northern China on the example of Lena-Tungus and Tarim basins

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A complex analysis of geological-geochemical parameters accomplished by the authors indicates that both basins are similar in their geologic structure and conditions of petroleum occurrence: sub-salt Lower Paleozoic carbonates, localization within large arches, Paleozoic source rocks with sapropel-type organic matter, methane type of oils and condensates.

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The Lena-Tunguska and Tarim oil-and gas-bearing basins are highly prospective for further addition of hydrocarbon reserves of Russia (Siberia) and China. The Tarim basin (northwest China) is one of the largest oil-and gas-bearing basins in which oil fields with reserves exceeding 300 million tons have been discovered (Lunnan, Toshono). The oil accumulations are located within a large dome-like uplift; the reservoirs are fractured carbonates of the Lower Paleozoic (Ordovician). In the Lena-Tunguska basin-of-the Siberian-platform, a large Yurubchen-Tadhom zone of oil and-gas accumulation has been discovered in the sub-salt formations, with-the Yurubcheri and Omorin fields containing the aggregate reserves of more than 1 trillion m³ of gas and about 300 million tons of oil. Here, as in the Tarim basin, the hydrocarbon accumulations are mainly restricted to the fractured carbonates of the Lower Paleozoic and, to a less degree, to the Pre-Cambrian (Riphean) carbonates (cavernous dolomites).

Lena-Tungus oil-bearing basin occupies the most part of Siberian platform Crystalline fundament is of pre-Cambrian age and represented by magmatic and metamorphic rocks-granite gneiss, quartz porphyry.

Sedimentary cover-distinguishes with wide development of discrepancies, strong saliferous thickness and effusive rocks (age P3-T) as well as frozen rocks (300-450m). The most wide-spread sediments are Lower Paleozoic (mostly Pre-Cambrian and Cambrian). There are three pay oil-and gas-bearing complexes, distinguished in section: Riphean carbonate. Vend terrigenous, Cambrian carbonate. The most large oil fields were opened in Nepsko-Botuobinskays. region (Srednebotuobinskoe, Verhneviluchanskoe, Markovskoe, Yarakchinskoe etc). Most of are the gas-condensate and oil-condensate ones.

Less fields are oil ones (Bolshetirskoe, (RIPED) Nilovskoe arc.). The single commercial accumulations-HC were also revealed in Baykitskaya (Yurubchenskoe, Kuyumbinskoe) and Katanganskaya (Sobinskoe etc) regions.

Tarim oil-gas-bearing basin is situated in the North part of West China. The basement is also of pre-cambrian (Pre-Sinian) age. Sediment cover has a thickness of 10 km. In difference with Lena-Tunguz basin saliferous deposits are not widely spread here, the same is for trap intrusions. Wide diapason of oil and gas content from Sinian-Lower-Paleozoic to Cenozoic periods predetermines large potential hydrocarbons reserves. Generally four oil-gas-bearing regions with different production level ages can be clearly named: Severo-Tarimskaya (blue, Middle Paleozoic, Mesozoic), Tsentralno-Tarimskaya (lower and middle Paleozoic), Yugo-Zapadnaya (Cenozoic), Kuchayskaya (Mesozoic).

The most significant fields are: within Severo-Tarimskaya region—Huntsiyskoe, Yanchayskoe, Lunnakskoe etc; In the Tsentralno-Tarimskaya region—Tachzhun-10, Tachzhun-11 etc.; in the Yugo-Zapadnaya region —Bashitoskoe, Kekdyakskoe; within Kuchayskaya region— Itsikelinskoe.

A complex analyses of geological-geochemical parameters indicates that both basins are similar in their geologic structure and conditions of petroleum occurrence; sub-salt Lower Paleozoic carbonates, localization within large arches, Paleozoic source rocks with sapropel-type-organic matter, methane type of Oils and condensates.

The certain proximity of Lena-Tungus and Tarim basins can be found in the conditions of accumulation distribution and oil and gas bearing properties. There are some differences (modern thermal conditions) that can be used within both basins in the future explorations on new fields.

The comparative characteristics of Lena-Tungus (Russia) and Tarim (China) basins in connection with the conditions of oil accumulations and oil-gas-bearing shows that, both basins are connected with the ancient platforms similar to each other in geological structure and accumulations distributions. However these platforms has the certain differences. Lena-Tungus oil-bearing basin occupies the most part of Siberian platform. Crystalline fundament is of pre-Cambrian age and represented by abyssal and metamorphic rocks-granite, gneiss, quartz porphyry etc. Sedimentary cover distinguishes with wide development of discrepancies, strong saliferous thickness and effusive rocks (age P3-T) as well as frozen rocks (300-450m). The most wide-spread sediments are Lower Paleozoic.

According to the available data the Cambrian sediments gave the favorable conditions for oil and gas generation and accumulation. The basic oil and gas bearing systems are connected with the Vend and Cambrian sediments. The cross section shows three productive oil-gas-bearing systems: Riphean carbonate, Vend terrigenous and Cambrian carbonate. The most large oil fields were revealed in Nepsko-Botuobinskaya region (Srednebotuobinskoe, Verhneviluyskoe, Markovskoe, Yarakchinskoe etc). Most of the fields are the gas-condensate and oil-condensate ones. Less fields are the gas-condensate and oil-condensate ones. Less fields are oil ones (Bolshetirskoe, Danilovskoe in Bashkirskaya (Yurubchenskoe, Kuyumbinskoe) and Katanganskaya (Sobinskoe etc.) regions.

The oils-mainly the light ones ($790-810 \text{ kg/m}^3$) – are primarily composed of methane HC, gases of gas-condensate deposits contains CH_4 90%, HC C₂-C₅ 9%, CO_2 0, 2-1,0%, N_2 1-1, 5%, gas-condensate ($690-720 \text{ kg/m}^3$) are mainly composed of aliphatic HC, the quantity of arene is 2-4%.

Tarim oil-gas-bearing basin is situated in the North part of West China. The basement is also of pre-cambrian (Pre-Sinian) age (Archaic-Proterozoic complex with thickness up to 10 km). Sinian-sediments (720-4000m) are GaaanbHtie for the sediment cover. In contrast to Lena-Tungus basin, the salt-bearing sediments are not widespread here (they are found mainly in the carbon rocks). The same is attributed to the trap intrusions (Table 1,2). Favorable conditions for development of the oil-gas-generation and oil-gas-accumulation processes existed not only in the Sinian-Lower-Paleozoic and Middle-Upper-Paleozoic complexes (Carbon and others) but and in the sediments of the Triassic, Jurassic and Cenozoic periods (Miocene and others), so wide a diapason predetermines big accumulations of HC raw materials. The oil-gas-bearing level is deeply differing in the structure violation zones. This fact determines the possibility of creation of secondary accumulations in upper horizons. Generally four oil-gas-bearing regions with different production level ages can be clearly named: Severo-Tarimskaya (blue, middle Paleozoic, Mezozoic), Tsentralno-Tarimskaya (lower and middle Paleozoic), Yugo-Zapadnaya (Cainozoic), Kuchaiskaya (Mezozoic).

Contrary to Lena-Tungus basin, in this one the oil fields are dominating among the revealed accumulations. The most significant fields are: within Severo-Tarimskaya region-Huntsiyskoe, Yanchayskoe, Lunnakskoe etc; In the Tsentralno-Tarimskaya region-Tachzhun-10, Tachzhun-11 etc. in the Yugo-Zapadnaya region-Bashitoskoe, Kekdyakskoe; within Kuchayskaya region-Itsikelinskoe.

Yurubcheno-Tokhom oil-bearing zone of Leno-Tunguz basin is situated within Krasnoyarsk region between Podkamennaya and Tunguzska-Angara rivers. This zone in Vendian and Riphean reservoirs concerns to the central part of Kamov arch. Within basin area Yurubchen-Tokhom zone includes Yurubchen gas-condensate and oil field. Kuyumbin oil and gas field, Omorin gas-condensate field, Tersk and Madrin productive blocks.

Table 1. The community elements of geological conditions and distribution of hydrocarbon accumulation in Lena-Tungus and Tarim basins

Geological conditions	Distribution and phase state of deposits
1.Ancient platform, pre-cembrian base	1.Presence of hydrocarbon deposits in pre-cembrian and cembrian sediments
2-Abundance of dissents	2.Considerable gas part reserves of hydrocarbon raw materials
3-Presence of magmatic (P, T) and coal-bearing (I,T)rocks in open-pit mine	3.Proximity of geochemical gas and oil index of pre-cembrian and cemrien sediments, presence of light oils in the ancient sediments which are close by their structure to gas condensates.
4.Predominance of mainly split carbonate (sea) sediments in lower paleozoi and upper pre-cembrian.	
5-Presence of region ectoplasmdonors.	

Table 2. The difference elements of geological conditions and distribution of hydrocarbon accumulation in Lena-Tungus and Tarim basins

Indexes	Lena-Tungus basin	Tarim basin
1.Intensity of trap magmatism	Cinsiderable (stratum and secant intrusions of the traps)	Little
2.Distribution of permafrost zones	Yes	NO
3.Age of the sediments of the main oil-gas-bearing complexes	R, V, Cl	0, C, T, I
4.Gas-bearing level	R3-C	PR3-N
5.Age of the most considerable carbonate-salt-bearing thickness	Cl	C (check)
6.Correlation of the potential reserves of oil and gas, oil/gas	<1	>1
7.Predominant character of the fields	One-two-stratum	Multi-stratum

Kuyumbin oil and gas field has a gas pool in Riphean carbonaceous deposits with initial gas flow rate of 200 000 cub.m. Riphean thickness varies from 0 to 1090 m. Erosional surface depth of Riphean deposits changes from 2145 to 2340.

Omorin gas-condensate field is situated within Krasnoyarsk region between Podkamennaya and Tunguska-Angara rivers. Tectonically it concerns to south-western Kamov arch slope. It yielded gas and condensate at 150000 cub.m from Vendian deposits from 2568-3014 m interval. Yurubchen field Pay zones are terrigenous and carbonaceous deposits of Riphey and Vend. Four oil-gas-conkensate pools were discovered within this field. Riphean deposits occur at 22-323 m depth.

Tarim basin-is one of the largest and least explored basins of continental part of China. Most commercial oil and gas fields were discovered in 10 systems-Sinian, Cambrian, Ordovician, Devonian, Carboniferous, Triassic, Jurassic Creta-ceous and Tertiary. More than 20 wells yielded commercial oil and gas from Cambrian and Ordovician deposits on Tabey and Central uplifts and shows their high prospectivity.

Yakia oil and gas field. Pay zones are Cambrian-Ordovician carbonates, occurring at 5363-5392m. Cretaceous sandstones are proved to be a gas-bearing. Lunnan oil field, opened in 1988 concerns to anticline on Lunnan uplift. Lunnan 1 well has proved the productivity of Ordovician dolomites at depths of 5039-5300 m. The Lunnan 8 well tested Ordovician dolomite from 5179-5266 m and obtained high flow of oil (0,856 g/cub.com) and gas. Cretaceous deposits at 4740-4887 m interval are also productive. Sangtamu oil field was discovered in 1991. Triassic reservoir is of 8 m thick and occurs at 4700 m.

Jiefangqudong oil field was discovered in and anticline trap. Oil and gas were obtained from three separated Triassic sandstones. Average productive layer has a gas cap. Jilake condensate gas field is lies 40 km south-west of the Lunnan field. The reservoirs are Triassic and Carbonaceous sandstones. Yaha condensate gas field is located in the central part of Tabey uplift. The discovery well has tested Eocenic sandstones and obtained gas and condensate flows at 5451-5455 m.

Table 3. The comparison of natural gases and densities of oils of pre-Cembrian and Cembrian sediments of Lena-Tungus and Tarim basins

Region	Gas content, %							Oil density kg/m ³
	C ₁	C ₂	C ₃	C ₄	SC ₅₊	CO ₂	N ₂	
Tarim basin								
Severo-Tarimskaya Sq. Yakela Well sha-7	87,7	2,8	1,5	0,8	0,3	0,2	6,7	792
Lena-Tungus basin								
Baykalskaya, Yurubcheno-Takhomskiy region	79,5	7,5	2,0	1,3	0,3	0,5	8,5	801

Conclusions

The certain similarity can be found between properties of oils and gases of both basins. Oil are primarily light, density-792-805kg/m³ (see Table 3). The compound of gases and oils of Cembrian dolomites (well Sha-7, Yakela sq) are very close to gases of pre-Cembrian Yurubcheno-Takhom zone of Lena-Tungus basin (the absolute domination of CH₄ with comparatively small quantity if the homologus CO₂ and N₂). Therefore, from and hand the certain proximity of Lena-Tungus and Tarim basins can be found in the conditions of accumulation distribution and oil and gas bearing properties (Table 1). But from the other hand there are some differences (modern thermal conditions) that can be used within both basins in the future explorations on new fields.