Peculiarities in the Distribution of Hydrocarbons in Carbonate Sediments of Venda and Cambrian

Z E Ivanova¹, A I Sivtsev²
¹North-Eastern Federal University named after M.K. Ammosov, (NEFU named after M.K. Ammosov), Belinskiy, 58, Yakutsk 677000, Russian Federation
²North-Eastern Federal University named after M.K. Ammosov, (NEFU named after M.K. Ammosov), Belinskiy, 58, Yakutsk 677000, Russian Federation

E-mail: kbltblia@mail.ru

Abstract. An attempt is made to explain the features of the distribution of deposits and zones of improved reservoirs in the carbonate part of the Vendian-Cambrian oil and gas complex. The conditions of oil and gas content of the carbonate part of the section of the Nepsko-Botuobinskaya anteclise (NBA) are proposed: the formation of a fault zone with feathering cracks → circulation of aggressive solutions along them with the formation of secondary fractured-cavernous reservoirs → vertical migration and accumulation of hydrocarbons in the formed secondary reservoir. According to the presented scheme for the formation of zones of improved reservoirs, promising zones and subsoil areas within Western Yakutia are indicated.

1. Introduction
Nowadays, all balance oil reserves and two-thirds of the gas reserves of Yakutia are confined to the Vendian-Cambrian deposits (NBA) [1]. This is about 650 million tons of oil (recoverable) and more than 2 trillion m³ of natural gas. At the same time, the achieved degree of development of the predicted resources of the territory of the republic is on average 20% [2, 3].

At present, among the unsolved fundamental problems in the NBA, one can single out the peculiarities of the oil and gas content of carbonate productive horizons, which are presented in works [4-11]. In all these works, zones of improved reservoirs are associated with the formation of the primary pore space. The issues of oil-bearing capacity of NBA carbonate reservoirs remain quite controversial. The issue of reliable forecasting of zones and areas of improved reservoirs in carbonate deposits has not been resolved. Even in the most drilled Talakanskiy field, the forecasting of zones of improved reservoirs of the Osinsk iy horizon has not been finally decided. In addition to the Talakanskiy field, deposits in the carbonate part of the section of the Vendian-Cambrian oil and gas complex are known at the Verkhnevilyuchanskiy, Iktekhskiy, Otradninskiy, Srednebotuobinskiy and other fields. Recently, commercial gas inflows have been obtained in a number of areas from carbonate deposits of the Yuryakh Formation and within the Predatom regional trough that is do not have primary permeability [12].

In our opinion, the formation of significant hydrocarbon deposits in carbonate rocks of the Upper Precambrian and Cambrian is possible only in the case of the following sequence of processes: formation of a fault zone with feathering cracks → circulation of aggressive solutions along them with
the formation of secondary fractured-cavernous reservoirs → vertical migration and accumulation of hydrocarbons in the formed secondary reservoir.

The decisive role of secondary changes leading to an improvement in the reservoir properties of carbonate reservoirs of the Nepsk-Botuobinsk antecline is considered in [13-15].

A promising direction of prospecting for oil deposits above high-amplitude basement ridges also fits the above sequence of processes. It is generally accepted that due to the difference in the compaction of terrigenous rocks directly above the high-amplitude protrusions of the basement and along the periphery, fractured reservoirs are formed in the overlying carbonate horizons that are capable of retaining hydrocarbons under favorable conditions (Figure 1) [16-19].

![Figure 1. Schematic diagram of the formation of deposits above the basement ledges in the carbonate section.](image)

Due to the compaction of terrigenous rocks above the high-amplitude basement ledges, anticlinal traps with fractured reservoirs are formed in carbonate rocks holding hydrocarbons under favorable conditions. It is on such structures, confined to high-amplitude basement projections, that the Kurungskiy gas and oil and Kyttygas oil and gas condensate fields were discovered in the license areas of OOO Taas-Yuryakh Neftegazodobycha.

From the standpoint of the above concepts, of particular interest in substantiating the zones of improved reservoirs may be the study of the features of the dynamics and composition of groundwater NBA [20].

2. Conclusions

Thus, significant accumulations of oil and gas in carbonate horizons can be expected only along the margins of negative structures, because their boundaries are usually caused by faults. This is the northwestern slope of the NBA, the near-platform wing of the Predatomskiy trough, the Vilyuchanskaya saddle. In a closer approximation, one can expect deposits in the Yuryakhskiy horizon along the western and eastern boundaries of the Central block of the Srednebotuobinskiy field, along the outskirts of the Taas-Yuryakhskiy field, etc.

Cambrian oil and gas complex has not yet been discovered. Nevertheless, it can be assumed that in the zones of junction of the Predatom trough with the Nepsk-Botuobinsk antecline, the formation of deposits is possible according to the proposed formation scheme.

3. References

[1] Sitnikov V S, Pavlova K A, Sevost’yanova R F 2018 Oil potential of the central part of the western Yakutia Geologiya nefti i gaza (Geology of oil and gas) 6 63-72
[2] Pakhomov A A 2017 Western-Yakutian oil and gas cluster: analysis, assessment and prospects of development Nauka v tsifrakh (Science in numbers) 1(2) 43-47
[3] Sal’va A M 2014 The state and prospects for the development of the oil and gas industry of the Republic of Sakha (Yakutia) Science Time 7(7) 355-367
[4] Burova I A 2010 Carbonate reservoirs of the Vendian-Lower Cambrian oil and gas complex of Eastern Siberia Neftegazovaya Geologiya, Teoriya i practika (Oil and Gas Geology, Theory and practice) 5(2) http://www.ngtp.ru/rub/4/23_2010.pdf

[5] Cherepanov E N 2018 New model of formation of the early Cambrian carbonate petroleum reservoirs in the Nepsko-Botuobinskaya antecline Geologiya nefti i gaza (Geology of oil and gas) 3 75-87

[6] Gubina E A 2014 Forecast of Vendian-Lower Cambrian carbonate reservoirs of oil and gas in the central part of the Nepa-Botuoba antecline based on the model of their formation (Doctoral dissertation) (St. Petersburg)

[7] Archegov V B 2010 Structure, petroleum potential and control factors of hydrocarbon accumulation zones in ancient complex of siberian platform Oil and Gas Geology. Theory and practice 5(3) http://www.ngtp.ru/rub/4/41_2010.pdf

[8] Berzin A G, Marsanova M R, Tretyakov M F, Berzin S A 2019 Activated fault tectonics and formation of hydrocarbon deposits in the sedimentary-natural basin in the south of the Siberian platform Exploration and protection of mineral resources 2 11-19

[9] Kaichev N F, Kolesov V A, Kvachko S K, Musin R A 2016 Lithogenesis role in formation of zones with improved reservoir properties of subsalt carbonate sediments of Vendam and lower Cambrian (Eastern Siberia) Bulletin of the Perm National Research Polytechnic University. Geology, oil and gas and mining 15(20) 216-231

[10] Loshkareva V A, Postnikova O V, Kitaeva I A 2018 Mechanism of formation of primary porosity in Vendian-Cambrian biocenoses Trudy Rossiiyskogo gosudarstvennogo universiteta nefti i gaza imeni I.M. Gubkina (Proceedings of the Russian State University of Oil and Gas named after I.M. Gubkina) 4(293) 7-16

[11] Ponomarenko A S 2020 Deposits' geology of carbonate reservoirs of the Nepa-Botuobinsky antecline The Eurasian Scientific Journal 6(12) https://esj.today/PDF/16NZVN620.pdf

[12] Safronov A F 2006 Zones of oil and gas accumulation in the northeast of the Nepa-Botuobinskaya antecline Geology, geophysics and development of oil and gas fields 7 18-25

[13] Morozov V P, Kol'chugin A N, Kuznetsov V G 2015 On some specific forms of leaching of carbonate rocks Lithology and minerals 6 576

[14] Postnikova O V, Kitaeva I A, Repina M O, Omelchenko O V 2012 Influence of secondary transformations on the formation of reservoir properties of the Osinsky horizon of the Nepsko-Botuobinsky antecline Territory Oil and Gas 11 24-27

[15] Ponomarenko A S 2020 Geology of carbonate reservoirs of the Nepa-Botuoba antecline Bulletin of Eurasian Science 6 https://esj.today/PDF/16NZVN620.pdf

[16] Lazeev A N, Gaiduk A V, Gnutova E N, Nikitin Yu I, Popov V G, Streltsov T M, Fishchenko A N, Khairullina E A 2016 Geological exploration works of PAO NK «Rosneft». Results, achievements, plans (Geology of oil and gas) 5 75-84

[17] Gaiduk A V, Filichev A V 2018 Influence of the basement paleorelief on the formation of hydrocarbon deposits in the Vendian-Early Cambrian sedimentary cover of the Siberian platform Modern methods of studying and developing the bowels of Eurasia Proceedings of the International Geological and Geophysical Conference 229-234

[18] Gribovskaya N P 2019 Prospects for the Yuryakh horizon within the basement ledges Theory and practice Rosgeologia In search of new discoveries Materials of the fourth scientific and practical conference 15-16

[19] Dolgova Ye I, Chirgun A S, Gaydud A V, Perevozhikov S N 2021 Search for missed deposits at the Srednebotuobinskoye field in Eastern Siberia Oil industry 5 80-84

[20] Chistyakova N F, Dravante V V, Sivtsev A I 2020 Features of the brine water composition of the vendian - lower cambrian middle Botuoba oil-gas-condensate field during the catagenesis time Oil and gas geology. Theory and practice 15(3) http://www.ngtp.ru/rub/2020/30_2020.html