On the Issue of Isolated Well Productivity in a Number of Areas of the Republic of Sakha (Yakutia)

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Abstract. A brief analytical review of isolated industrial inflows of oil and gas in a number of areas of the Republic of Sakha (Yakutia): Buyaginsky, Kederginsky, Russkorechensky and South Tigyansky. The recorded industrial inflows were suggested to be confined to zones of "flower-type" discontinuous violations. In all the considered areas, promising structures are or were located in zones of subhorizontal tectonic compression and shear stress. As an example, the features of the oil and gas potential of the Yuzhno-Tigyansky heavy oil field are considered in more detail. The model of the "flower type" structure and its isolated industrial oil flow in the South-Tigyansky area. Based on the proposed model of oil and gas potential of the areas, the conclusion is made about the direction of geological exploration in the "flower" structures to the lower potentially feeding areas of the subsurface.

1. Introduction
Currently, large-scale geological exploration for oil and gas is being carried out by subsurface users on the territory of South-Western Yakutia. Traditionally, a certain amount of seismic exploration is carried out on licensed areas to identify perspective structures and a couple of wells are drilled. The results of well testing will show whether to continue work, or to return the licenses. However, there are areas where industrial inflows of oil and gas were received only in isolated wells out of a number of drilled exploration wells (Buyaginsky, Kederginsky, Russkorechensky and South Tigyansky).

Consideration of the conditions for obtaining industrial inflows and possible reasons of its absence in neighboring wells will allow us to get closer understanding of the features of oil and gas potential of promising territories and increase the efficiency of geological exploration.

2. Problem statement
The first industrial gas inflow on the territory of Yakutia was received on the North-Western slope of the Aldan anteclise from well No. 1 on Russkorechenskaya area in 1953. An emergency release of natural gas with an estimated flow rate of up to 100 thousand m³/day was obtained presumably from the Riphean deposits. After casing and cementing the well, retesting failed. The disappearance of gas inflow from the well was explained by the following possible reasons: the formation of hydrates in the...
bottom-hole zone of the formation, the production of a small amount of gas, the degassing of a heavy oil deposit, and the deep penetration of cement into the bottom-hole zone of the formation. The drilling and testing of wells doubles (Russkorechenskaya 2 and 3) did not yield any results.

In 2019, Rosneft drilled the Srednelenskaya No. 1-p search well in the immediate vicinity of the Russkorechenskaya well No. 1. The well turned out to be "dry" in all the three explored objects.

On the Buyaginskaya area, which is located on the North-Western slope of the Suntar uplift in the zone of junction with the Ygyattinskaya depression, an industrial inflow from the terrigenous harystan productive horizon was obtained from well No. 664 with a flow rate of up to 332.7 thousand m3/day. In the other 3 wells (Nos. 661, 662, 663), the harystan horizon was not distinguished at all. At the same time, in well No. 662 which is above the section, gas inflow of 29.2 thousand m3/day was obtained from the Osinsky horizon during tests in the column and 6.5 m3/day of oil in the open trunk from the interval of occurrence of the Yuryakh, kudulakh and uspun formations. The conclusion was made about the complex structure and limited hristoskova horizon.

A similar situation is observed in the Kaderginsky structure, which is located on the North-Eastern side of the Berezovsky trough. Out of the 6 exploration wells, only one produced an emergency gas flow rate of 2,047.4 thousand m3/day from the I-Icher horizon. The well was liquidated as an emergency one. In other productive wells, the flow rates from the ichersky horizon are insignificant: 432 (doubler 431) – 37.75 thousand m3/day, 438 – 80 thousand m3/day, 435 – 5.27 thousand m3/day.

It is very likely that the high flow rate (2,047 thousand m3/day) obtained in well No. 431 from the metegero-icher complex of deposits with a small effective thickness (3.2-8.4 m) and not outstanding FES (KP – 8-14%) was due to the connection of another large drained volume through discontinuous faults.

3. Experimental part

A peculiar oil-bearing capacity is established within the South Tigyansk heavy oil field, where only one R-102 well has produced an industrial inflow of oil.

The South Tigyansk field is located within the Anabar-Khatanga saddle (the Western border of the Leno-Anabar trough). The Deposit is confined to the eponymous brachianticlinal the crease of sub-latitudinal strike. Its size in the lower Cretaceous deposits is 19×6 km, and its amplitude is 700 m. The hinge of the fold forms two domes – the Western and Eastern, separated by a saddle, while the Eastern dome is about 200m higher than the Western one. The section opened by deep drilling in the field is represented by the upper Paleozoic-lower Mesozoic complex of terrigenous deposits. In the undiscovered part, the development of a rather powerful terrigenous-carbonate middle Paleozoic (up to 1 km), carbonate lower Paleozoic (up to 1.3 km) and Precambrian cover is expected.

The industrial oil and gas potential of the South Tigyansk Field is associated with deposits (horizon) of the roof part of the nizhnekozhevnikovskaya formation of the lower Permian. Productive horizon XI with a total thickness of 70-90 m lies in the depth range of 1580-1720 m. The maximum inflow of 15.3 m3/day of oil was obtained in the R-102 well laid on the Western dome. The same well produced a gas inflow of up to 1,445 m3/day. In other wells on the Western dome, the flow rates vary from 0.1 to 2 m3/day. On the Eastern dome, oil inflows do not exceed 0.3 m3/day. The oil density is high – from 0.930 to 0.970 g/cm3, with an average of 0.950 g/cm3 [1].

In [1], it was concluded that the increased flow rate of the R-102 well is due to deep recharge of the Deposit according to the established discontinuity from the subsalt middle Paleozoic deposits. Prospects for oil and gas potential of the middle Paleozoic deposits within the Anabar-Khatanga saddle are substantiated in [8, 9]. The presence of discontinuous faults in the area of the R-102 well, including overburden, was discovered by the latest seismic surveys in 2012 (figure 1, A).
Figure 1. Seismogeological section along the section of profile 050311 on the Western dome of the South Tigyan structure.

Legend: deposits: 1 – upper Jurassic-lower Cretaceous, 2 – lower - middle Jurassic, 3 – medium-verkhnetarasovka, 4 – upper Permian-lower Triassic, 5 – Nizhnetagilsky Suite lower Permian, 6 – section of upper Carboniferous-lower Permian (custosa Suite), 7 – Ordovician-lower Carboniferous, 8 – Vendian-lower Cambrian, 9 – Riphean; 10 – basement; 11 – faults; 12 – indices of the reflecting horizons; 13 – borehole; 14 – area of transition fault on reset.

This discontinuity for the Western dome has the form of a Central or axial discharge to the middle of the deposits bounded by reflecting horizons VII and VIB (middle Carboniferous – tustakh formation of the lower Permian). However, it is Central only in the middle and upper Paleozoic deposits of the Western arch, and in the Riphean and lower Paleozoic layers it shifts to the southern periphery of the fold. Vertical movement of layers is 100-200 m. Figure 1 (A and B) shows that the discontinuous violation takes the form of a surge from a depth of 2.4 km. From the interval of occurrence of the productive horizon XI in the South direction, an additional discontinuous violation (upswing) appears, where the plane of the displacer is inclined to the South, and the upswing amplitude is small – 30-40 m. This discontinuous violation of the North-Western strike does not complicate the Eastern dome of the South Tigyan area. In addition, numerous sliding mirrors and crushing zones are found in the core material descriptions, which indicate subhorizontal movements. Here, a complex of discontinuous violation creates a "flower-type" structure.
4. Conclusion

Apparently, in all the considered areas, there is a deep (extra-reservoir) recharge of the opened productive intervals. As we know, Kederginsky and Russkorechenskaya areas are located in the zone of active tectonic movement influence. Currently, tectonic activity is recorded in the Baikal reef zone (BRZ) due to increased seismicity. At the same time, based on the analysis of the focal mechanisms of earthquakes, it was found that compression forces in the BRZ prevail from the middle course of the Olekma river to the East [13-16, 21]. Under compression conditions, so-called “flower” structures can be formed that permeate the section with discontinuous violations similar to a flower (figure 1). It should be noted that the territory of the junction of the North-Western slope of the Aldan antecline and the Berezovsky trough is permeated by a swarm of dikes of the middle Paleozoic age of the North-Eastern strike. Compression could contribute to the formation of "flower" structures.

Active tectonic processes are not currently established on the territories of the Buyaginskaya and South Tigyansk areas, but they occurred in the recent geological past [3]. These processes may also have caused a peculiar redistribution of hydrocarbon accumulations in the section and in the plan.

If we imagine that modern search operations within the South Tigyansk area were carried out without drilling in the area of the R-102 well, but only in other areas, the subsoil user would most likely have handed over the license back.

In the indicated geological and tectonic representations for the discovery of large deposits, exploration work should be directed and focused on the search for lower feeding horizons using the morgt-3D technology at the search stage. Territories with potential development of "flower" structures within the Republic of Sakha (Yakutia) include the North-Western slope of the Aldan antecline, the pre-Atomic (NYU-Djerba and Berezovskaya deflections), the pre-Verkhoyansk and Leno-Anabar deflections.

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