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Prospects of using passive seismic in the Novy Port oil and gas condensate field, Russia

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SUMMARY

This paper considers the prospects of conducting the supplementary exploration in the north part of the Novy Port oil and gas condensate field. There may be two ways to completely explore this field. The first way includes drilling a significant number of exploration wells based on available data. The second one requires the passive seismic surveys and drilling a small number of exploration wells with the aim of confirming the obtained results. These wells can be used as the production ones later. Such an approach will significantly reduce the financial burdens and increase reliability of received geological information. There are many advantages of using the passive seismic in the Novy Port oil and gas condensate field.

Introduction

Nowadays, Russian oil companies put the primary importance on the fields located in the Far North of Western Siberia due to the depletion of vital petroleum resource bases in the Volga-Ural region and the middle riverbed of the Ob River. One of the largest arctic fields in Russia is the Novy Port oil and gas condensate field.

The Novy Port field is located in the Russian North on the Yamal Peninsula, 120 km north of the rural locality Yar-Sale, and 30 km away from the Gulf of Ob River (fig. 1a). This field was discovered in 1964 and put on stream in 2014. The 2D seismic surveys stretched 1139 linear km, and the 3D ones covered 616 km^2.
There are 19 producing formations to define in the geologic cross-section of the field. The Novy Port field was assessed to have 5,27 billion barrels of original oil-in-place, with about 2,69 billion barrels recoverable. The estimated gas-in-place is 252 billion m^3, and condensate-in-place is 17 million tonnes [1]. Gazpromneft-Yamal LLC is currently operating in this field.

From the geological point of view, the southern and northern parts of the Novy Port licensed sector are well-understood not at the same level. The south part has been investigated by well drilling comprehensively, and in the northern one, in contrast, only few exploration wells are drilled. Therefore, the geology of the north part cannot be modelled accurately (fig. 1b).

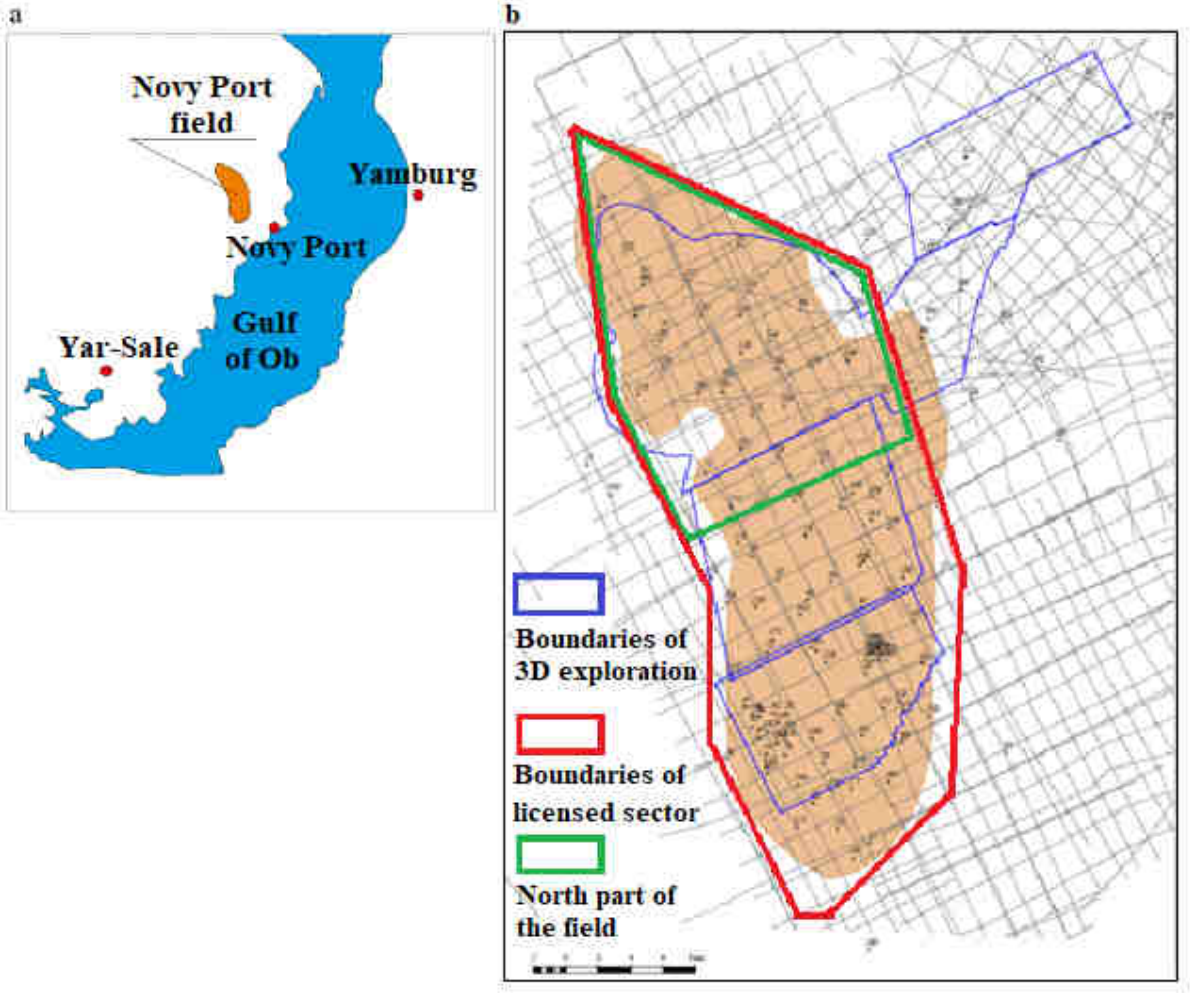

Figure 1. *Maps of a – the field location, b – boundaries of geological exploration in the Novy Port field*

To model the accurate geometry of the Novy Port oil and gas condensate field is hampered by geological complexity, heterogeneity of rock matrix in permeability and porosity, high facies' changes of rock layers, and lithotypical variation of mineral composition and types. Another severe problem is the inability to detect fluid contacts properly. These issues have resulted in the difficulty of identifying hydrocarbon-saturated zones and incorrect estimation of oil reserves.

Detailed exploration of the north part will require a large number of prospecting and exploration wells to be drilled in case of being conducted by analogy with the south part. Most of these wells will be empty and waste both time and financial resources. A new approach is needed to deal with these issues during the geological exploring process in the northern part of the Novy Port field.

Performing sequence of the works in the south part of the Novy Port field that had already been implemented:

1. Conducing the repeated 2D and 3D seismic surveys to confirm seismic models of reservoirs that were available at that time. However, the data obtained from exploring in such a way had fallen short of expectations due to the absence of methodology that could be used to interpret the complications occasioned by gas caps and free gas.

2. Conducting the repeated tests of exploration wells that had already been drilled with the aim of defining a type and degree of oil saturation in reservoirs as well as their productivity.

3. Drilling of new exploration wells to confirm the boundaries of oil-saturated zones in reservoirs and estimate the hydrocarbon reserves.

4. Performing a set of geophysical surveys of wells to distinguish the lithological cross-section, determine the petroleum reservoirs, and define the volumetric parameters.

5. Further development of hydrocarbon deposits.

Method

Supplementary exploration of the north part may be significantly reduced in capital costs by using passive seismic.

Passive seismic is a microseismic infrasound exploration technique of finding hydrocarbons used to discern promising geological structures. The main passive seismic feature is a specific nature of the low-frequency seismic signals, carrying valuable geological information in the subsurface. These signals are produced by oil- & gas-bearing reservoir, rather than reflected or refracted by the layer's surface. 3D seismic is applied to detect geological structures, having good prospects, while the passive one confirms the existence of hydrocarbons with precision [2].

Passive seismic is proposed to be used in combination with the traditional methods of exploring the structure of producing formations in order to forecast the hydrocarbon presence in the subsurface. Such an approach will provide reducing financial and time expenses for drilling the empty wells and increasing the quantities of resources. This technology can be successfully applied in complex geological and geographical conditions. Deposits, having small purely hydrocarbon-saturated zones, small-sized petroleum reservoirs, and thin oil rim reservoirs may be accurately discerned and mapped, based on data obtained from passive seismic surveys.

All types of passive seismic give the chance of success for well drilling up to 85% in identifying and delineating the oil & gas deposits. If applied this technology in the process of supplementary exploring the licensed sector of the Novy Port field, hydrocarbon-saturated zones may be forecast with saving finance instead of expenses for empty well drilling. Furthermore, the quantities of original

oil-in-place will be increased through the discovery of new hydrocarbon deposits and companion faults.

Proposed sequence of performing the works in the north part of the Novy Port field:

1. Repeated interpretation of data received from seismic surveys.

2. Conducting the repeated tests of exploration wells that had already been drilled.

3. Implementing passive seismic to model accurate reservoir geometry, advise on placements for well drilling, and correctly estimate the hydrocarbon resources.

4. Drilling a small number of exploration wells with the aim of confirming the results obtained from the passive seismic surveys. These wells can be used as the production ones later.

5. Performing the geophysical surveys of exploration wells.

6. Drilling injection and production wells based on passive seismic data. This basis will make the empty wells to be the exception rather than the rule during the drilling process. Furthermore, it may increase the efficient penetration of horizontal wellbores and help to avoid a loss of secondary wellbores due to fluid invasion.

7. To conduct repeated passive seismic surveys at intervals of 1-2 years in order to monitor the state of productive formation, identify remaining oil in a reservoir to drill a well therein. To optimize the enhanced oil recovery methods, repair and insulation operations, and matrix stimulating process with a view to achieving the highest possible recovery factor.

8. To involve in the development process the deposits of remaining oil that were detected based on passive seismic data and optimize the pressure-maintenance system.

9. Performing hydraulic fracturing in the production wells.

10. Control over the hydraulic fracturing process using passive seismic surveys.

Missed hydrocarbon deposits and companion faults, detected by using passive seismic, may result in the growth of oil reserves in the Novy Port field (table 1). The use of this exploration technology provides to prevent errors often containing in resources and reserves estimation as well as reduce the amount of exploration well drilling. Also, it is feasible to check the results of hydraulic fracturing based on data obtained from the passive seismic survey.

Table 1. *Estimation of increase in oil reserves in the Novy Port field*

Parameter name	Parameter value
Proven original oil-in-place, billion bbl	5,29
Proven recoverable reserves, billion bbl	1,81
Recovery factor, unit fraction	0,34
Estimated original oil-in-place after supplementary exploration, billion bbl	7,25
Estimated recoverable reserves after supplementary exploration, billion bbl	2,46
Expected increase in recoverable reserves, billion bbl	0,65
Estimated cost of recoverable reserves, $ billion	29,25

* at $45 per barrel

Conclusions

1. The depletion of fields in well-explored areas of Russia puts the primary importance on the fields located in the Far North, containing significant oil reserves. However, the accurate geological models of these structures are often lacking.

2. Success for exploration & production well drilling depends on accurate modelling of the reservoir geometry. Elaboration of the proper geological model provides to prevent errors in prospecting and exploration well drilling.

3. Passive seismic is proposed to be applied in the Novy Port field in order to model the geometry of the reservoir and select appropriate placements for exploration wells. These wells, in turn, can be used as production ones in further field development. Such an approach will significantly reduce the number of wells and capital costs for field development.

4. Passive seismic data will provide to prevent the errors related to incorrect estimation of probable oil resources. A profitable business plan for field development and field infrastructure may be drawn up, based on proven reserves and promising production rates of oil, gas, and condensate.

5. The implementation of passive seismic will increase oil production rates through the well drilling in highly fractured and hydrocarbon-saturated zones of a reservoir.

6. By applying passive seismic, efficient penetration of horizontal and multilateral wells may be increased that will result in reducing the number of drilled wells, hence the costs.

7. Supplementary development of the Novy Port field makes it possible to discover new deposits based on data obtained from the passive seismic survey.

8. Current infrastructure may be engaged in by timely involving new-discovered hydrocarbon deposits and companion faults into the common development process. That will significantly reduce financial expenses for its equipping.

9. Changes that occur in a petroleum reservoir during its development may be monitored with passive seismic surveys conducted at certain intervals. The data received allow the process of driving oil to the surface to be maximized, and optimize the reservoir drive mechanisms. Also, that helps to select the most rational work package for well intervention, matrix stimulation, and enhance oil recovery in the field. The volume of water pumpable into the reservoir as a pressure-maintenance system, as well as the hydraulic fracturing and different types of waterflooding, can be managed in accordance with the passive seismic information. All of the above will increase the recovery factor of the field.

References

"Tyumen Institute of Oil and Gas" JSC (2015). Addition to the technological development plan for the Novy Port oil and gas condensate field. Contract No. 2014/416-GPN-NP from 01.12.201

Sharapov, I. R., Shabalin, N. Yu. Biryaltsev E. V., Feofilov, S. A., Ryzhov, V. A. (2015). Innovative passive microseismic methods in the oil and gas industry – experience applied in Russia. Materials of the international scientific geological conference "ATYRAUGEO-2015".