Petroleum potential of the Neocomian deposit of Nyurolsky megadepression

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Abstract. The distribution of shelf deposits and Achimovsky reservoirs of the Neocomian deposits of Nyurolsky megadepression was studied. Based on paleotemperature simulation, the values of the heat flow, distribution paleotemperatures and generation paleosource of the Bazhenov oil were received, evaluation of resources relative density distribution was performed. The areas for priority hydrocarbons exploration were proposed.

1. Introduction

Nyurolsky megadepression, confined to the southeastern part of the West Siberian plate, is the research target. Deposits of hydrocarbons (HC), which were earlier developed here, are associated to the Upper Jurassic oil and gas complexes (OGC). The aim of this work is to study the petroleum potential of underexplored Cretaceous (Neocomian) OGC.

The area under study covers two oil and gas fields - Kaymysovsk and Vasyugansk where 44 fields were discovered (figure 1a).

Source of hydrocarbon traps formation in the deposits of the Upper Jurassic and Cretaceous OGC is the disseminated organic matter (DOM) of Bazhenov formation sediments, but the intensity determinant of hydrocarbon generation at DOM catagenesis is geotemperature. According to the geothermal criterion, the balance model of oil and gas generation processes in the Bazhenov Formation [1] makes it possible to forecast center of intensive hydrocarbon formation foci from DOM: at 85 º C – migration of source rocks into major oil generation zone. .

2. Characteristics of potential petroleum area

Productive complexes are the Cretaceous, Upper Jurassic, Middle Jurassic, Lower Jurassic and Paleozoic. Togur formation (tg, J_1t) is the source rock for pre-Jurassic, Lower Jurassic and Middle Jurassic OGC. It is confined to the Nyurolsky megadepression and tapers out in the north-westward (figure 1a).

Oil source rock for Upper Jurassic and the Cretaceous OGC is Bazhenov formation (bg, J_3tt) which is regional throughout the studied area. Its thickness involves: Kaymysovsk arch – from 5 to 20 m, Nyurolsky megadepression – from 20 to 41 m, North Mezhovsky megamonocline – from 8 to 30 m, Srednevasyugan megaswell – from 9 to 19 m.

Cretaceous OGC is characterized by a complex geological structure [2], where sediments in sedimentation stages have a threefold division: Neocomian, Aptian-Albian-Cenomanian, Upper Cretaceous. Petroleum potential is associated with Neocomian sediments overlying Bazhenov formation oil source rock and overlain by mature clay deposits. Potential and oil-and-gas bearing are clinoform slope sediments (Achimovsky formations), shelf zone sediments and its edges. The

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following oil fields, average in reserves, are being developed: South Cheremshansk (index 1), South Myldzhinsk (index 2) and Myldzhinsk (index 3) (figure 1a, table 1).

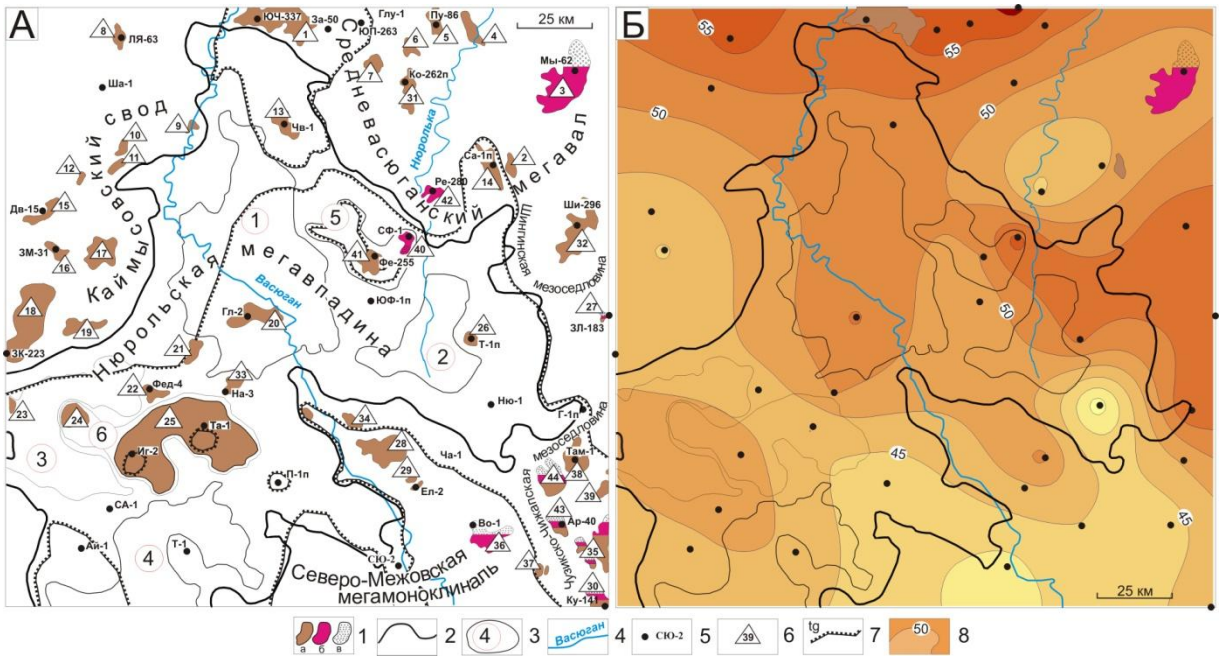


Figure 1. Tectonic map of Nyurolsky megadepression petroleum potential: (a) distribution of heat flow density from bottom of sedimentary mantle (b). 1. fields: a – oil, b – condensate, c – gas; 2. of Nyurolsky megadepression border 3. – structure of III order and its number: 1 – Kulan-Igayskaya depression, 2 – Tamradskaya depression, 3 – Osevoy syncline, 4 – Tamyansky syncline, 5 – Festival bar, 6 – Igolsko-Talovoye dome–shaped uplift; 4 – river system; 5 – well log where paleotemperature modeling was performed; 6 – field arbitrary number; 7 – Togur formation distribution zone border; 8 – isoline values of calculated heat flow density, mWt/m^2. Map (b) shows the field of Cretaceous deposits in OGC.

Table 1. Characteristic features of Nyurolsky megadepression field and framing structures with Cretaceous oil and gas complex deposits

Field	Number (Figure 1a)	OGC	Phase	Horizon, layers
South Cheremshansk	1	Cretaceous	Oil	A_{2-7}, A_{9-10}, B_{4-10}, B_{12-13}
			Gas	A_{2-7}, $B_{0,\ 4-13}$
South Myldzhinsk	2	Cretaceous	Oil	$B_{9\ -13}$
			Gas	$B_{9,\ 10}$, B_{11-12}, B_{13}
Myldzhinsk	3	Cretaceous	Gas condensate	A_{2-7}, $B_{0,\ 4-10,\ 12,\ 13}$
		Upper Jurassic	Gas condensate	J_1

3. Research methodology

Thickness of shelf deposits and Achimovsky reservoirs is the summing of homogeneous sediment thicknesses of 7 cyclites in the Neocomian sedimentation basin.

Thermal history matching of Bazhenov formation sediments was performed by computer paleotemperature modeling [3]. Paleotemperature calculating scheme consists of two stages. The first stage of "observed" temperature T_i distribution in the well includes the calculation of the heat flow q through the surface of the underlying formation, i.e. the solution geothermic inversion . In the second

stage the value q, is used in forward solution, i.e. – immediate calculation of temperature U in given points of sedimentary sequence Z at predetermined geological time t.

To estimate the relative density distribution magnitude of generated Bazhenov oil resources,the conditional integral index R was calculated by the formula [4]:

$$R = \sum_{i=1}^{20} (U_i t_i \cdot ¿10^{-2}) \quad ¿. \quad , \qquad (1)$$

where U_i – calculated temperature of oil generation, ^{o}C; t_i – tduration of oil generation, millions of years; number of time intervals i = 1, ..., 20, defined by the number of suites during their formation stages.

4. Research results

The development of Neocomian sediments in Nyurolsky megadepression were identified and defined, as well as its positive framing structures (figure 2). The maximum thickness of shelf sediments (over 80 m) are mapped in the north-eastern part of the megadepression, the Achimovsky (80 m) – in the north-eastern slope of Kaymysovsk arch. Instead of Achimovsky formations one can observe a large "bay" in the south-western part of the studied area and “horseshoe” zone to the east.

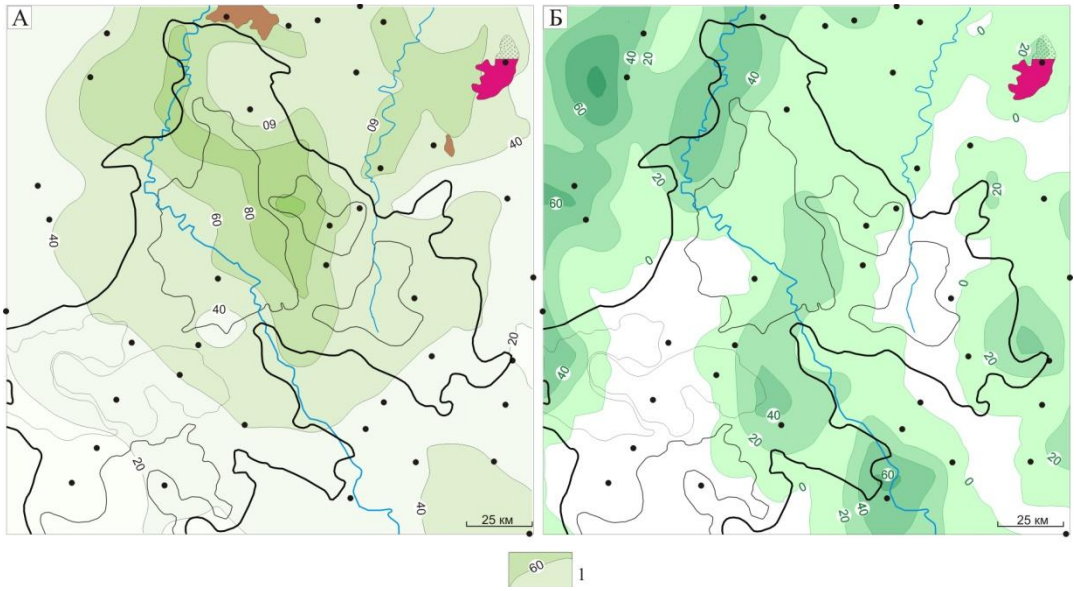


Figure 2. Contour maps of cumulative thickness of (a) shelf deposits and (b)Achimovsky deposits Hydrocarbon fields with commercial deposits in (a)shelf reservoirs and (b) Achimovsky deposits are shown; 1 – isopachytes. The remaining symbols are indicated in figure 1.

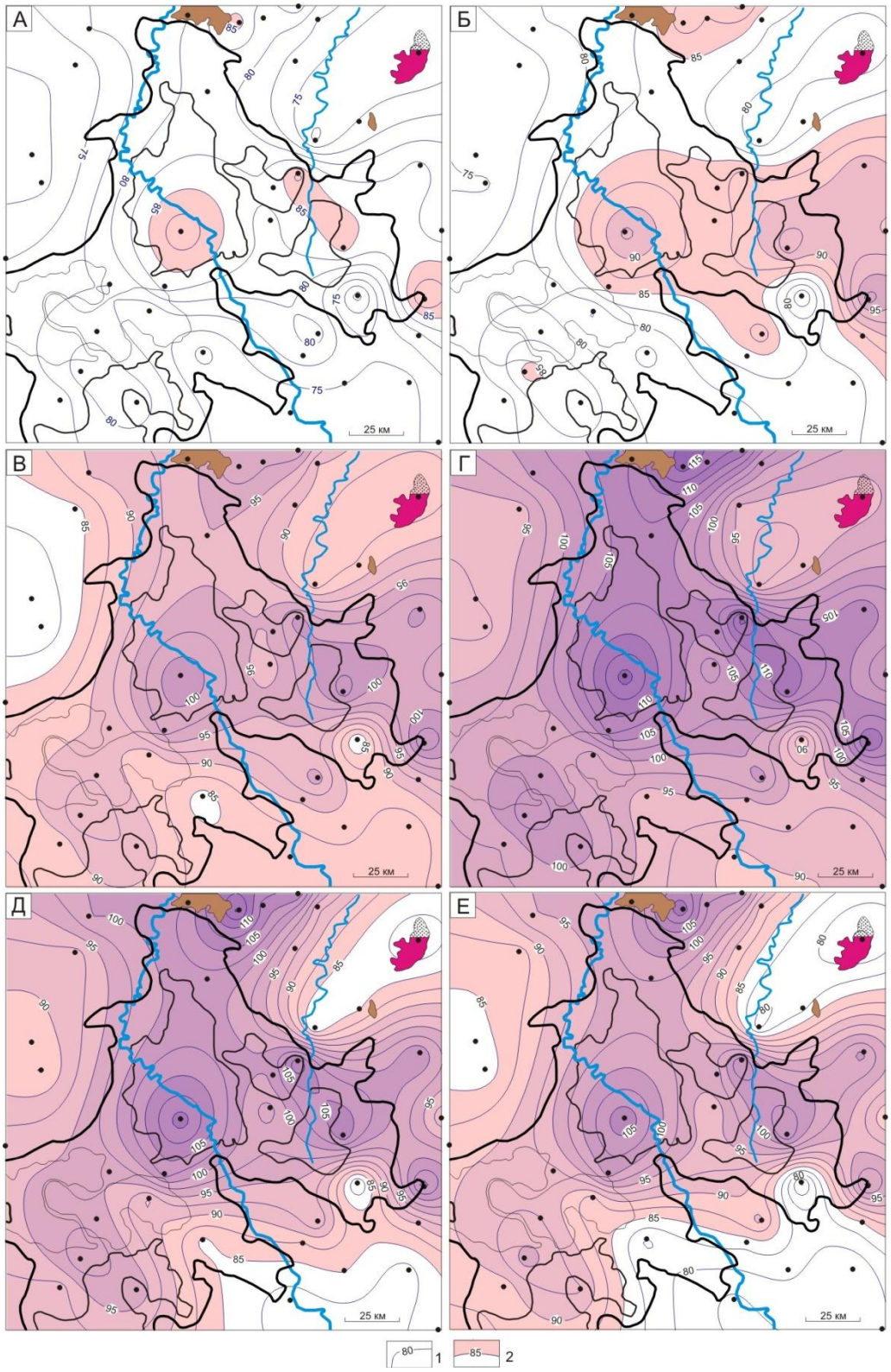


Figure 3. Contour maps of geotemperature distribution and source location position intensive generation of Bazhenov oils (a) 91.6 million years ago ; (b) 86.5 million years ago; (c) 61.7 million years ago; (d) 37.6 million years ago; (e) 24.0 million years ago and (f) present day. 1 – isotherm, °C; 2 – source contour. The remaining symbols are indicated in figure 1.

Paleotemperature simulation was carried out for 39 well logs (figure 1a). The following references were used formation temperatures measured during well testing and paleotemperatures recalculated from vitrinite reflectivity values .

According to heat flow values of geothermic inversion from 39 well logs, ***the contour map of heat flow density distribution values*** was plotted (figure 1b). As a result of forward solution the paleotemperatures were determined in Bazhenov formation sediments at starting/completion time of each suite formation. Figure 3 shows the contour maps reflecting the dynamics of the thermal history of Bazhenov sediments.

The first oil generation source emerged 91.6 million years ago (at the end of the Pokursky suite formation $K_{1\text{-}2}pk$) in the southern part of Kulan-Igayskoy depression, in the eastern parts of the Festival bar and the Tamratskoy depression, in the joint depression zones with positive framing structures (figure 3a). In 5 million years (at the end of the Ipatovskaya suite formation K_2ip) the sources combined, embracing the central and eastern part of the studied area (figure 3b). Over the next 25 million years (at the end of the Gankinskaya suite formation $Pg_1\text{-}K_2gn$) the sources continued generating and their size increased (figure 3c). Maximum heating of the sedimentary thickness was during the Chegan formation ($Pg_{3\text{-}2}hg$) 37.6 million years ago (figure 3d). Figure 3e (end of the Nekrasov suite formation Pg_3nk) illustrates the starting period of sedimentary thickness cooling caused by climatic condition changes in the Oligocene, which continues till now (figure 3f). Relative Bazhenov oil density distribution of shelf deposits and Achimovsky reservoirs (figure 4) was plotted.

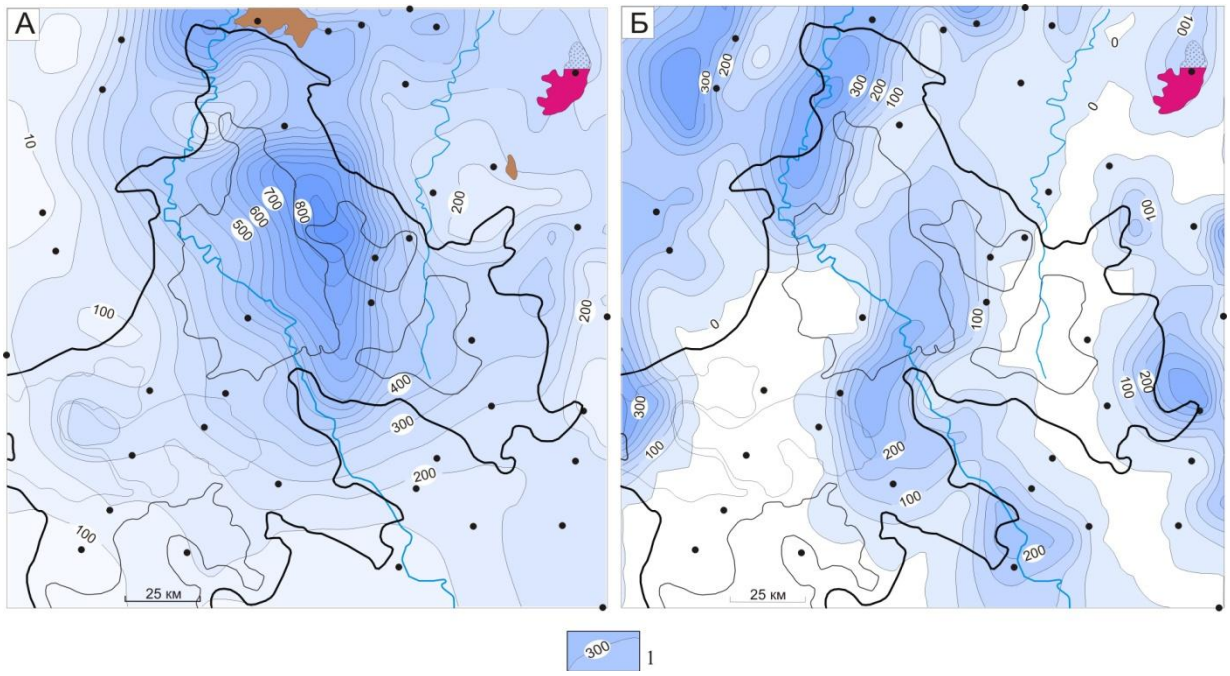


Figure 4. Contour maps of relative density distribution of oil resources in (a) shelf sediments; (b) in Achimovsky deposits of Nyurolsky megadepression. 1 – isopachytes of relative density values, c.u. The remaining symbols are indicated in figure 2.

5. Conclusion

The integrated investigation approach of the territory (analysis of the geological structure, allocation of intensive generation zones and oil migration) allowed evaluating the prospects of Achimovsky (clinoform) and shelf reservoirs of Neocomian Nyurolsky megadepression. The zoning of the reservoirs by the relative resource density defines the priority prospecting targets in Lower Cretaceous sediments. This zone includes the western part of the Festival bar and the south-eastern part of Kulan-Igayskoy depression.

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