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The oil and gas contents of the Lower Jurassic and Achimovka reservoirs of the Nyurol'ka megadepression

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Abstract

The paper describes Lower Jurassic (horizons J_{16} and J_{15}) and Achimovka (Neocomian clinoforms) reservoirs in the area of the Nyurol'ka megadepression and its framing (42,000 km^2). The total thicknesses of seven Achimovka sedimentary cycles are mapped. The thermal history of the Togur and Bazhenov parental sediments in the sections of 39 deep wells is reconstructed by paleotemperature modeling. The geotemperature criterion is used to identify paleosources of oil generation, starting from the Jurassic. The distribution of the relative density of the resources of the generated Togur and Bazhenov oils is estimated and shown on sketch maps. The Lower Jurassic reservoir is divided into zones depending on the distribution of the relative density of the Togur oil resources, and the Achimovka reservoir, of the Bazhenov oil resources. The priority oil search zones are proposed.

Keywords: Lower Jurassic reservoir; Achimovka reservoir; thermal history of parental sediments; density of oil resources; Nyurol'ka megadepression

Introduction

The study area (42,000 km^2), located on the southeastern West Siberian Plate, includes the Nyurol'ka megadepression and its framing structures (Fig. 1). As in whole West Siberia (Brekhuntsov et al., 2011), the lower part of the Mesozoic section—Lower Jurassic sediments—is poorly studied here. The lower part of the Cretaceous section—Neocomian, Achimovka sediments—contains commercial hydrocarbon pools in almost entire West Siberia, except the southeast (Kurchikov and Borodkin, 2011).

The study area is an area of the current oil industry in the Tomsk Region (Fig. 2*A*). The growth and development of the resource potential of this territory are among the priorities of the Tomsk petroleum industry. Evidently, this is the most resource-saving and cost-effective work. Such an approach to the planning of prospecting and exploration works was suggested by Academician V.A. Obruchev (1939).

The pools developed in the study area mainly belong to the Upper Jurassic petroleum complex (PC). The oil fields, including the largest ones, are confined to anticlinal structures. However, the bank of anticlinal structures is almost exhausted now. The high density of seismic prospecting does not leave a chance for discovering new pools in the anticlinal structures or, consequently, any considerable enlargement of the base for exploration and recovery in this PC. Therefore, along with the detection of nonanticlinal prospecting objects in the Upper Jurassic Vasyugan Formation (Kontorovich et al., 2011), the geological exploration works are aimed at prospecting for, and exploration of, hydrocarbon pools in complicated traps confined to the Lower Jurassic and Cretaceous (Neocomian) PCs.

The current prognostic studies are concerned with a great-depth Lower Jurassic series (horizons J_{16} and J_{15}) (Lower Jurassic reservoir) and a Neocomian Achimovka clinoform member (Achimovka reservoir).

Previously, the objects in the Lower Jurassic and Cretaceous PCs were of little interest (hard to detect) because of the complicated traps, and the low resistivity of the Neocomian productive beds was a serious obstacle to their identification in the section (Tishchenko, 2004). Present-day high-resolution seismic prospecting and new techniques for interpretation of GIS data eliminate these problems (Kontorovich, 2007; Mel'nik, 2012). The question arises which parts of the study area are of the highest priority for exploring and developing the Lower Jurassic and Cretaceous PCs. The present study is an attempt at answering this question.

The studies include paleotectonic reconstructions and paleotemperature modeling, mapping of sources of intense generation of Togur and Bazhenov oils, analysis of distribution

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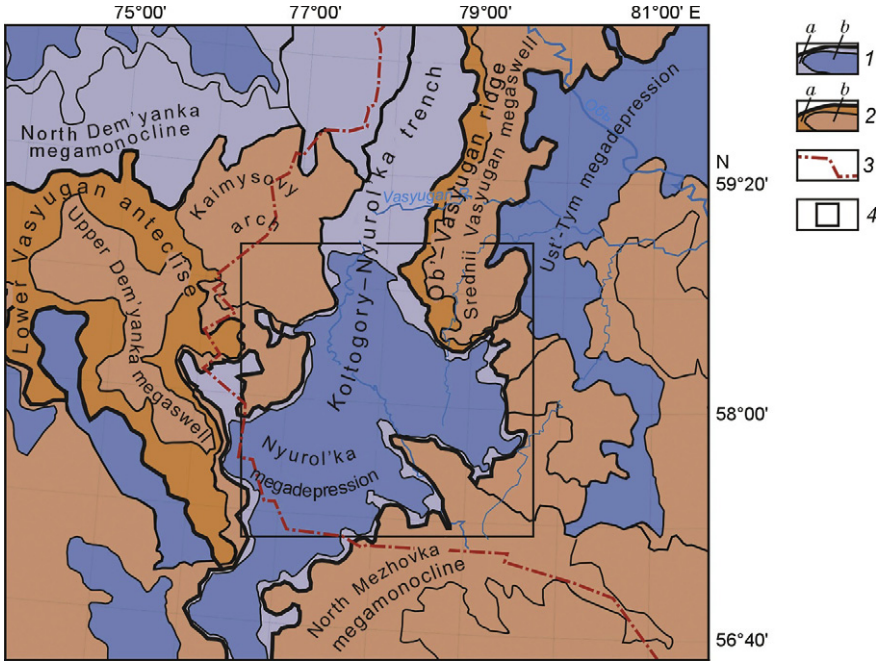

Fig. 1. Sketch map of the study area (based on the tectonic map of the Jurassic structural stage from (Kontorovich, 2002)). *1*, superorder depressions (*a*), depressions of rank I (*b*); *2*, superorder uplifts (*a*), uplifts of rank I (*b*); *3*, southwestern border of the Tomsk Region; *4*, outline of the study area in the Nyurol'ka megadepression.

of the relative density of the oil resources in the Lower Jurassic and Achimovka reservoirs, and the subsequent zoning of these reservoirs by potential.

Previously, the sources of generation of Bazhenov and Togur oils in the Nyurol'ka megadepression were considered in (Isaev and Fomin, 2006). The difference between the present and the previous works consists in the tenfold larger study area. Also, the methods (Isaev et al., 2009) have been refined: The mathematical thermodynamic model now includes the secular variation in temperature on the Earth's surface (boundary condition) and the paleotemperatures of determinations of vitrinite reflectance as "observed" ones.

Brief geological and structural summary of the region

The Nyurol'ka megadepression, an isometric depression of rank I, complicates the southern part of the Koltogory–Nyurol'ka trench (Fig. 1).

The megadepression is complicated by structures of lower ranks (Fig. 2*A*), including elements of rank III: Kulan-Igai and Tamrad basins, Axial and Tamyanskii troughs, Festival'nyi swell, and Igol–Talovaya domal upwarping. The depression is bounded by the eastern slope of the Kaimysovy arch in the northwest and by the Srednii Vasyugan megaswell in the northeast. It joins the Shinginskaya and Chuzik–Chizhapka mesosaddles in the east and southeast and the North Mezhovka megamonocline in the south. In turn, the structures of ranks I, II, and III are complicated by local folds of rank IV. The surface of the roof of the Jurassic sediments in the Nyurol'ka megadepression is localized at an elevation of –2660 m below sea level, and the basin area is 20,150 km^2.

Petroleum potential of the region

Most of the study area is located within the Kaimysovy petroleum-bearing region. The productive complexes are Cretaceous, Upper Jurassic, Middle Jurassic, Lower Jurassic, and Paleozoic. Fourty-nine hydrocarbon pools are localized in the study area (Fig. 2*A*).

The principal source rocks for Lower Jurassic and Paleozoic reservoirs are the Togur Formation (J_1t_1) with disseminated organic matter of the mixed type. Its distribution in the Nyurol'ka megadepression is limited by depressed relief, wedging out toward the surrounding uplifts and crystalline-basement highs. The high content of C_{org} (up to 10%) and catagenesis of disseminated organic matter to the stage MC_1^1–MC_1^2 determine its regional oil-generating potential (Fomin, 2011; Gurari and Ekhanin, 1987; Kontorovich et al., 2009).

The Lower Jurassic PC combines the horizons $J_{17–16}$ of the Urmanskaya Formation (J_1h-p) and J_{15} of the Salatskaya Formation (J_1t_2–J_2a_1), in which the pools are related to structural–lithologic and tectonically shielded traps (Surkov, 2005). According to (Resolution, 2004), the Urmanskaya Formation accumulates in the Hettangian–Pliensbachian, which corresponds to the start of formation of the sedimentary cover. When the sediments of the basal horizon J_{17} are reduced, the basement is in direct contact with the overlying sediments of the Upper Urmanskaya Subformation (horizon J_{16}). When the Urmanskaya sediments wedge out completely, the basement rocks are adjoined by the rocks of the Salatskaya Formation, whose sandy varieties are combined in the horizon J_{15}. The hydrodynamic combination of the horizons J_{15} and J_{16} often gives rise to a single pool (Table 1).