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Seismic stratigraphy, formation history and gas potential of the Nadym–Pur interfluve area (West Siberia)

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Abstract

The study presents a seismic and geological characterization of the Meso-Cenozoic sedimentary cover of the Nadym–Pur interfluve area and discusses the morphology of the Jurassic and Aptian–Albian–Cenomanian sedimentary complexes, formation history of structures, and geologic processes responsible for the formation of Cenomanian gas accumulations.

Keywords: reflector; seismic sequence; Cenomanian; tectonics; gas potential; structure; trap; pool; field

Introduction

The study area is located in the north of West Siberia in the Yamal-Nenets Autonomous District in the western part of the Nadym–Pur interfluve area and comprises the Nadym and Gubkinskii petroleum regions of the Nadym–Pur petroleum area (Fig. 1).

The study area is the host to the giant Medvezh'e, Yubileinoe, and Yamsoveiskoe gas fields confined to anticlinal structures with high vertical closure. Major reserves of the Nadym–Pur petroleum area are associated with the Cenomanian sand horizon (PK_1) underlying the Kuznetsov regional seal. The main commercial production from the Medvezh'e, Yubileinoe, and Yamsoveiskoe fields is from the underlying Aptian–Albian reservoirs and Neocomian shelf sandstone beds. The Bathonian Horizon J_2 and Achimov sands beds are major producing zones at the Yubileinoe field and Yamsoveiskaya prospect, respectively.

Despite the fact that the Medvezh'e, Yubileinoe, and Yamsoveiskoe fields are oil-gas-condensate fields, they produced almost entirely nonassociated gas, which accounts for 99.6% of total hydrocarbon reserves, whereas dry gas reserves of the Cenomanian reservoirs account for 94.8% of total gas reserves and 94.4% of total hydrocarbon reserves of these fields. Oil and condensate production from the Neocomian and Aptian–Albian sands (bed J_2) accounts for 0.04% of total hydrocarbon reserves.

Seismic and geological characterization

The largest oil and accumulations in the West Siberian petroleum province are found within sedimentary megacomplexes overlain by laterally persistent shale horizons, acting as megaregional seals (Gurari et al., 1968; Karogodin, 1974; Kazarinov, 1958, 1963; Kontorovich et al., 1975). Three petroleum-bearing megacomplexes can be recognized and correlated regionally in the Mesozoic–Cenozoic sedimentary fill of the basin: Triassic–Jurassic ($T_{2\text{-}3}$–J), Neocomian (Berriasian–Lower Aptian) (K_1), and Aptian–Albian–Cenomanian (K_1–K_2). These megacomplexes containing important oil and gas accumulations become progressively younger from south to north. In the south of the study area, in the Tomsk and Novosibirsk regions, Jurassic, and especially Upper Jurassic rocks are of particular interest in terms of hydrocarbon potential. In the central part of the study area (including the Khanty-Mansi Autonomous District), the main oil-and-gas prospective target is the Neocomian (Berriasian–Lower Aptian) megacomplex, whereas the major hydrocarbon potential

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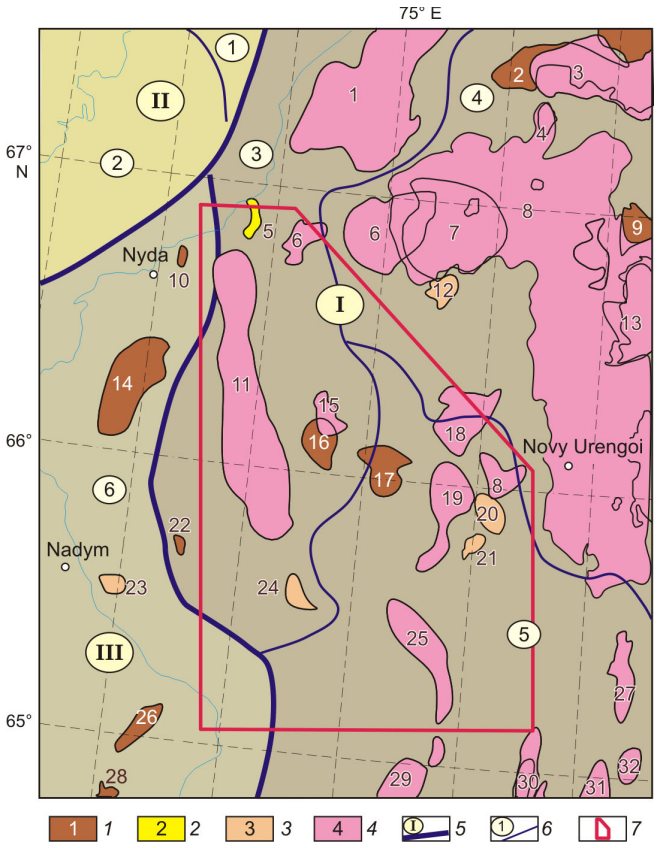

Fig. 1. Fragment of petroleum zonation map of West Siberia. *1*, oil; *2*, gas; *3*, gas-condensate; *4*, oil-gas-condensate fields; *5*, boundaries of petroleum areas; *6*, boundaries of petroleum regions; *7*, study area. Fields: 1, Yamburgskoe; 2, Olikuminskoe; 3, Severo-Urengoiskoe; 4, Piricheiskoe; 5, Tanusalinskoe; 6, Zapadno-Pestsovoe; 7, Pestsovoe; 8, Urengoiskoe; 9, Severo-Samburgskoe; 10, Sandibinskoe; 11, Medvezh'e; 12, Yuzhno-Pestsovoe; 13, Samburgskoe; 14, Lenzitskoe; 15, Yuzhno-Padinskoe; 16, Vostochno-Medvezh'e; 17, Zapadno-Yubileinoe; 18, Severo-Yubileinoe; 19, Yubileinoe; 20, Vostochno-Yubileinoe; 21, Urkainsko-Yubileinoe; 22, Zapadno-Medvezh'e; 23, Nadymskoe; 24, Pangodinskoe; 25, Yamsoveiskoe; 26, Lutseyakhskoe; 27, Sterkhovoe; 28, Srednenadymskoe; 29, Severo-Komsomol'skoe; 30, Severo-Gubkinskoe; 31, Zapadno-Tarkosalinskoe; 32, Dremuchee.

of its northern and Arctic regions is associated with the Aptian–Albian–Cenomanian megacomplex.

The Turonian–Maastrichtian and Cenozoic depositional megacomplexes form the topmost part of the sedimentary fill. The Turonian–Maastrichtian complex was found to incorporate the Gaz-Sale sand member and a package of Santonian sand beds with commercial hydrocarbon accumulations in the northeast of West Siberia and one sand horizon with a rich gas potential in the Medvezh'e field of the Nadym–Pur interfluve area.

The Paleozoic depositional complexes of the West Siberian province can be regarded as a separate exploration target.

All of the Mesozoic–Cenozoic depositional megacomplexes are controlled by regional top seals, including the Bazhenov Formation and its time equivalents (Upper Jurassic, Volgian-lowermost Berriasian) for the Triassic–Jurassic megacomplex, the Koshai (Neite) member (Lower Cretaceous, Aptian) for the Neocomian megacomplex, and the Kuznetsov Formation (Upper Cretaceous, Turonian) for the Aptian–Albian–Cenomanian megacomplex. The Turonian–Maastrichtian complex is overlain by the Talitsa Formation shales of Early Paleocene age.

All of these megaregional seals are composed of transgressive marine shales, regionally persistent in thickness, which were deposited over extensive areas of West Siberia during a period of tectonic quiescence. As a result of their anomalously low acoustic properties, these regional marker seals can readily be tied to continuous and highly energetic reflectors (Table 1, Fig. 2).

Six seismic megasequences bounded by regional seismic markers were recognized in the Mesozoic–Cenozoic sedimentary fill of the basin: Triassic, Jurassic, Neocomian (Berriasian–Lower Aptian), Aptian–Albian–Cenomanian, Turonian–Maastrichtian, and Cenozoic (Fig. 2, Table 2). Each of the megasequences was divided into a number of complexs based on the presence of both zonal and local shale seals associated with seismic markers (Kontorovich, 2009; Kontorovich et al., 2001).

In the study area, all seismic markers and seismic megasequences of the West Siberian geosyneclise are recognized within the Mesozoic–Cenozoic sedimentary fill (Fig. 3).

Paleozoic seismic megasequence (basal sequence). In the study area, the Paleozoic section penetrated by two wells (Medvezh'ya-1001 and Yubileinaya-200) consists mostly of Devonian limestones.

The Paleozoic rocks are overlain in most areas of the West Siberian petroleum province by Jurassic or Triassic formations. The Triassic complex is characterized by a bipartite