Gas and Water Occurrences in the Olkha Formation in the Sayan Mountains of the Irkutsk Region

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The Olkha region in the Sayan mountains of the Irkutsk region is located in the marginal area of the Siberian platform, in the zone of intersection of the east Sayan and Baikal folded areas. The tectonic features of the region under consideration are similar to structures of the eastern Sayan mountains; but some 20-25 kilometers to the east, Baikal-type folds are developed.

The zone of intersection of these mountain structures is covered by a thick blanket of essentially undisturbed Jurassic lacustrine-continental deposits, which prevents a study of the area by the usual methods of geologic reconnaissance.

The eastern Sayan massif, bounding the Olkha region on the south, is a complex of Archean-Proterozoic metamorphic and igneous rocks, comprising granite-gneisses, ortho- and paragneisses, various crystalline schists, and quartzites. The rock series has been deformed into a series of linear folds with nearly horizontal trends and intruded by basic and silicic intrusions.

The eastern Sayan massif is a major complexly dislocated anticlinorium which was subjected to intense post-Jurassic erosion that reached the Archean rocks. A series of transgressive, slightly metamorphosed sedimentary rocks overlies an eroded and highly weathered Archean with angular unconformity, which was named the Olkha formation by M. S. Babkova and N. F. Loganov in 1951. The age of this formation was tentatively determined as upper Proterozoic, and the section was correlated with the three part Baikal complex.

The validity of this correlation has been confirmed by later investigations, particularly by a detailed geologic survey carried out in 1956. Relative to the question of their age, both the Olkha formation and the three-part Baikal complex should be assigned to the Sinian or Lower Cambrian on the basis of spore assemblages.

North of the foothills of the east Sayan mountains there is a regular sequence of younger ancient sedimentary beds - the Lower Cambrian Ushakov, Mot, and transitional beds (equivalent to the Usol beds). The Ushakov and Mot formations of the region consist mainly of sandstones and clays totalling 450 meters in thickness. The transitional formation consists of arenaceous carbonate rocks with dolomites and limestones of the Cambrian Belok series at the top.

The monoclinal structure of the region is dislocated by a system of parallel north-west-trending (Sayan-type) folds, complicated in places by faults and overthrusts. The following tectonic elements are the most distinctive: the Kuk-Yurt anticline, the Mot upwarmp, the Upper Olkha Archean ridge, the Bezymyannaya upwarmp, the Lower Bezymyannaya trough, the Goucharui trough, the Khanchin synclinal basin, and the Olkha-Shinikhta overthrust.

For purposes of detailed investigation of the profile of the Olkha formation, the East Siberian Petroleum Geology Trust drilled a borehole at the crest of the Kuk-Yurt anticline.

On the basis of data from this boring, as well as the results of the detailed geologic survey (1956), the Olkha formation is divided into three subdivisions:

1. Lower - sandy-shaly beds, consisting of alternating gray sandstones, clays, and clayey shales. Thickness about 350 meters.
2. Middle - carbonate sediments, composed of dark gray and black bituminous limestones and dolomites, frequently of algal origin. Thickness 72-80 meters.
3. Upper - arenaceous beds, composed of medium - and coarse-grained sandstones, quartzose and arkose; frequently impregnated with iron hydroxides, containing subordinate gray siltstones and micaceous shales. Thickness up to 250 meters.

The total thickness of the Olkha formation in our opinion is some 670-700 m.

During drilling of the Kuk-Yurt borehole at depths of 350 meters, saline water containing dissolved gas began to flow. Later the flow of water and gas increased noticeably, and at a depth of 450 m (which essentially corresponds to the section of the Olkha formation) maximum yield from the boring was 30 liters of water per minute. The gas was easily separated from the water and burned with a slightly yellowish white flame, without smoke or soot. During periods when drill fluids were circulating, the gas yield from the boring increased significantly.

The occurrence of water and gas is related to a zone of compact but intensely fissured and brecciated argillaceous shales and siltstones in the lower Olkha unit. Fissured rocks constitute the reservoir.

Water samples were taken at depths of 419, 436, and 450 meters. The water is clear, acrid, and highly saline (specific gravity 1.023). As the chemical analyses show, the salt content of all three samples varies very little.

The results of chemical analyses of water sample no. 3, from a depth of 450 m, are reported in Table 1.

Minor elements such as I, B, NO$_3$, NO$_2$, as well as naphthenic acids, were not found in the water.

According to V. A. Sulim’s classification, the water should be classed as a calcium chloride type, in the chloride group and the calcium subgroup. Its composition is very similar to that of Lower Cambrian waters encountered in many deep borings in the Irkutsk region (Osa, Bokhan, Tyret’, Zhigalovo, Balykhta), differing from them only in a weaker salinity and a significant content of ammonia (which is absence in the Cambrian waters of the Siberian platform).

Samples of the gas escaping from the opening of the borehole were collected at depths of 419, 436, and 450 m. Chemical analyses of the gas were made in the laboratory of the East Siberian Petroleum Geology Trust by S. A. Brivrina. The results of the analyses are given in Table 2.

The tabulated data show that the gas from the Kuk-Yurt boring is nitro-hydrocarbonaceous, with methane as the principal constituent. The heavy hydrocarbon content (from ethane to pentane) does not exceed 0.14 percent (sample no. 2).

Attention is called to the high content of hydrogen in the gases under investigation. During circulation of drill fluids, the hydrogen content decreases to 0.93-3.94 percent, but in periods when drilling is interrupted, it increases to 14.78-56.1 percent.

Samples of hydrocarbon gas from Lower Cambrian deposits, taken from borings in the Osa, Balykhta, and Tyret’ sections, according to information by S. A. Brivrina, usually do not contain hydrogen, but the amount of heavy hydrocarbons in these gases is relatively high; furthermore, they also contain higher homologs (higher than pentane).

Taking these differences into account, it is possible to assume that the chlorine-calcium waters and the gases under consideration represent the most ancient deposits in the lower Paleozoic section of the Sayan district of the Irkutsk region and that their formation was probably related to the period of deposition of the Olkha formation.

REFERENCES


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