New Data on Organic Geochemistry of Paleozoics of West Siberia

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The geochemistry of the organic matter of the Paleozoic rocks of the south and southeast parts of West Siberia has been studied extensively. Information has been gathered also on the Middle Ob, Krasnoleninsk arch, and individual exploration areas of the central and north of the platform. Most of the wells penetrated just the upper part of the Paleozoics. Only in a few wells has it been possible to trace variations in geochemical parameters of organic matter with depth.

A broad program of geochemical studies was used to assess the oil-gas prospects of the Paleozoics in the study area: content of organic carbon, its genetic type, catagenesis of this organic matter, pyrolysis of kerogen, and bitumen content of the rocks.

The Paleozoic sediments were deposited under a wide range of litho-facies, climatic, and tectonic conditions, as reflected in the significant variations in geochemical parameters. For example, content of organic carbon ranges from 0.01 to 10-11 percent. Shales carry the greatest amount of organic matter; average organic carbon content, is 2.1 percent. Value for marls is 0.54 percent, and for limestone - 0.37 percent. These values indicate that content of organic carbon in the Paleozoic sediments exceeds substantially Clarke levels. The organic matter is a finely dispersed mixture of lower and higher plants residue. Sapropelic material usually predominates in the carbonate rocks, and humic in the clastics.

Content of bituminous components in the rocks is small, ranging from hundredths to thousandths of a percent. This is apparently the result of significant alteration of the organic matter of the Paleozoic sediments. For example, at high stages of catagenesis after loss of volatiles the bitumoids gradually harden, converting to practically insoluble material. Tars predominate at 36-53 per cent. Oils and asphaltenes are subordinate. The low content of hydrocarbons and dominance of asphalt-tar components indicate a syngenic-residual character of the bitumoids.

 Ninety Paleozoic samples were investigated using the Rock-Eval method to estimate their residual oil-generating potential, quantitative expression of which is the hydrogen index. The pyrolysis data confirm that a decrease in hydrogen content in kerogen is due to generation of hydrocarbons during catagenesis of organic matter. The greatest change in the chemical composition of the kerogen takes place after the peak of the main phase of oil formation, when the residual oil-generating potential is sharply reduced and further maturity of the organic matter generates only gas. In the final stages of apo-catagenesis the value of the hydrogen index approaches zero.

Catagenesis of the organic matter is very important in assessing the oil-gas prospects of sedimentary basins. This determines the beginning and attenuation of processes of generation of oil and gas and their localization in the oil and gas windows. Cores of carbonate and clastic rocks from 60 areas of West Siberia were studied. Stage of catagenesis was determined from vitrinite reflectance, and pseudo-vitrinite for the carbonates. The level of maturity of the organic matter was found to be in the range from MK-3 to AK-3. See figure 1. The lowest maturity at MK-3 is in the Vartov, Nikol, and Noyab areas of the Ust'-Tym depression in thin Permo-Carboniferous sediments that rest discordantly on Lower Carboniferous. The latter are in the AK-1 stage, which passes gradually to AK-2 in the Middle Devonian.

Catagenesis at the MK-4 stage has been determined in five exploration areas. The middle part of this stage has been established in the Komsomol and Strezhev areas of the Nizhnevarrov arch and its upper part in the Van'yegan area. A transition to the MK-4 stage is found in the Novogod and Zapadno-Vengapuyakutin areas.

The AK-1 stage has been reached in several areas. In the Middle Ob region the lower part of this stage is found in the Verkhnekolik "yegan, Koshil, Soviet, and Ledov areas, and the middle-upper part in the Ledyan, Matyushkin, Poluden, Severo-Tarkhov, Severo-Var'yegan, Verkhnekaral'kin, Gromov, and other areas. (Figure 1). Disseminated organic matter is within the AK-1 stage in several areas of Krasnoleninsk arch (Lovin, Yelizarov, Srednenazym, and Talin) and also in the central and eastern regions of the West Siberian platform - Salym, Nadym, Kysom, Yuzhno-Russkaya, Yutymal, and Komsomol.

Pre-Jurassic rocks are close to metamorphic grade over a considerable part of the study region. The level of maturity is generally at AK-3, rarely AK-2. A broad zone at the AK-2-AK-3 stage is recognized in the south extending completely over the Paydugin and Aleksandrov mega-arches as well as the intervening Ust'-Tym depression - except for the Upper Paleozoic sediments. Maturity is at a similar level in the northeast part of the Kaymyskov arch (Ozerrnaia, Vesen, Aerosymsicheskaia areas). See figure 1. A comparatively large zone of high catagenesis is present in the Nizhnevarrov region, including the Tyumen, Yershov, Samotlor, Agan,