Geophysical Research Abstracts
Vol. 14, EGU2012-3598, 2012
EGU General Assembly 2012

Geochemical Aspects of Formation of Large Oil Deposits in the Volga-Ural Sedimentary Basin

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The study of the rocks domanikoid type in the territory of the Ural-Volga region has an almost century-long history, beginning with the first studies of A.D. Archangelsky in the late 20's of last century. But nevertheless the question of the source of oil that formed the industrial deposits of Volga-Ural oil and gas province (OGP), where Romashkinskoye oil field occupies a special place, remains unresolved and topical.
According to the sedimentary-migration theory of origin of oil and gas, it is supposed that the primary source of hydrocarbons in this area are the deposits of domanikoid type that contain a large ammount of sapropel organic matter (OM). Semiluki (domanik) horizon of srednefranski substage of the Upper Devonian is considered to be a typical domanikoid stratum. Investigation of the OM of the rocks and oils of the sedimentary cover on the basis of chromato-mass spectrometry method allows us to study the correlations between rock and oil and to assess the location (or absence) of the sources of hydrocarbons in the Paleozoic sedimentary cover.
The results of geochemical study of dispersed organic matter (DOM) of rocks from Semiluksky horizon of the Upper Devonian and of the oil from Pashiysky horizon of the Middle Devonian form the basis of this paper.
The objectives of this study were the following: to determine the original organic matter of the rocks, which would indicate the conditions of sedimentation of the supposed rock-oil sources; the study of chemofossils (biomarkers) in oil from Pashiyskiy horizon; and the identification of genetic association of DOM rocks from Semiluksky horizon with this oil on the basis of the oil-DOM correlation. The study of biomarkers was carried out with the help of chromato-mass spectrometry in the Laboratory of Geochemistry of Fossil Fuels (Kazan Federal University).
In this study we used several informative parameters characterizing the depositional environment, the type of source OM and its maturity: STER / PENT, hC35/hC34, GAM / HOP, S27/S28/S29 (steranes), DIA / REG, Ts / Tm, MOR / HOP, NOR / HOP, TET / TRI, C29SSR, C29BBAA, C31HSR, S30STER, TRI / PENT, TRI / HOP.
Comparison in the rock-oil system was performed primarily according to the parameters indicating the depositional environment of the source rock that contains syngenetic DOM – according to the coefficients that determine lithological conditions for the formation of the supposed oil-source bed strata (DIA / REG, Ts / Tm, NOR / HOP, TRI / HOP and STER / PENT).
Biomarker ratios indicate a different type of sedimentation basins. Sediments, which accumulated DOM from Semilukskiy horizon, can be characterized by low clay content, or its absence, that is consistent with the carbonate type of cut of the horizon. The bacterial material that was accumulated under reducing conditions of sedimentation appeared to be the source of syngenetic OM. Chemofossils found in oils from Pashiyskiy horizon are typical of sedimentary strata that contain clay - for clastic rocks, which in the study area are mainly represented by deposits and Eyfel Givetian layers of the Middle Devonian and lowfransk substage of the Upper Devonian.
The study of correlations obtained for the different coefficients of OM and oils showed that only the relationships between Ts/Tm and DIA/REG and between NOR/HOP and TRI/HOP are characteristic of close, almost similar values of correlation both for the dispersed organic matter and for oil. In all other cases, the character of the correlation of OM is significantly different from that of oil.
The differences in values and ranges of biomarker ratios as well as the character of their correlation indicates the absence of genetic connection between the oil from Pashiyskiy horizon for the dispersed organic matter from Semilukskiy horizon. This conclusion is based on the study of five biomarker parameters (DIA/REG, Ts/Tm, NOR/HOP, TRI/HOP and STER/PENT).
The research results described in the article clearly indicate the need for further studies of geochemical features of the organic matter of the Paleozoic mantle rocks and the underlying sedimentary and crystalline complexes of Precambrian.