Origin of Natural Gas in the Polish Outer Carpathians

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Abstract

The Outer Carpathians belong to the largest petroleum provinces of Central Europe. They are part of a young Alpine orogenic belt having a nappe-thrust structure. The Polish Outer Carpathians include several structural units. Oil and gas fields occur in Silesian, Skole, Sub-Silesian, and Dukla units.

The main objective of this study is determining the origin of natural gases associated and non-associated with oil accumulated in the Upper Cretaceous - Lower Miocene sandstone reservoirs based on the results of analyses of molecular and stable isotope compositions. The gases were analyzed for molecular and stable isotope compositions as follows: hydrocarbon and non-hydrocarbon components, $^{12,13}C$ in CH_4, C_2H_6, C_3H_8 and CO_2, $^{1,2}H$ in CH_4, and $^{14,15}N$ in N_2.

Fifty natural gas samples from sandstone reservoirs, including two samples from two fields of the Skole Unit, thirty six samples from seventeen fields of the Silesian Unit, five samples from two fields of the Sub-Silesian Unit, and seven samples from four fields of the Dukla Unit were collected in the study area.

Gaseous hydrocarbons accumulated in the Silesian, Skole, and Dukla units of the Outer Carpathians are genetically related to thermogenic and microbial processes. Thermogenic gas from the fields within Skole and Sub-Silesian units and a few fields within the Silesian Unit was generated at a maturity level of 0.7 to 1.0% Rr from mixed Type-II/III kerogen in the Oligocene Menilite Shales. Gases accumulated in the Dukla Unit were generated during both high-temperature and low-temperature thermogenic processes from mixed Type-II/III kerogen of the Menilite Shales. The microbial methane component has been generated during microbial carbon dioxide reduction from organic matter within the Oligocene Menilite beds in the Skole, Silesian, and Dukla units and Oligocene-Lower Miocene Krosno Beds in the Silesian Unit.

Carbon dioxide originated both from thermogenic and microbial processes.

Molecular nitrogen was mainly generated during thermal transformation of dispersed organic matter of the flysch strata, and partly from thermal destruction of NH_4-rich illites.

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