Conventional and unconventional petroleum systems in the Ukrainian Dniepr-Donets-Basin: A comprehensive source rock study

David Misch, Doris Gross, Reinhard F. Sachsenhofer, Achim Bechtel, Reinhard Gratzer

Montanuniversitaet Leoben, Dept. Applied Geosciences and Geophysics, Leoben, Austria; e-mail: david.misch@unileoben.ac.at

In Ukraine hydrocarbons are produced mainly in the Dniepr-Donets Basin (DDB). While reservoirs are predominantly located in the Upper Visean and Lower Permian, a multitude of potential source rock units exists in the Devonian and especially the Carboniferous succession (*e.g.*, Upper Visean "Rudov Beds"). In an attempt to evaluate their contribution to the charging of conventional oil and gas deposits, oil/gas-source rock correlation was performed based on biomarker and carbon stable isotope data. Furthermore, pyrolysis gas chromatography was used to define the hydrocarbon potential of the potential source rock intervals. The majority of investigated oil and gas/condensate samples could be correlated either to a (Upper) Visean or a Serpukhovian source, while Devonian rocks were not identified as a major source in the NW DDB, despite their relative importance in the neighbouring Pripyat Trough. Furthermore, organic geochemical data clearly points to mixing of different oil families in the NW DDB. Additional contributions of Tournaisian, as well as Bashkirian and Moscovian (partly coaly) units were determined especially for the central and SE DDB (*e.g.*, giant Shebelinka field). Due to their proven importance as a source for conventional oil/gas deposits in the NW DDB, Upper Visean Rudov Beds might also be considered a target for shale gas/oil production. Unconventional production requires certain quality parameters to be met, and preferably lateral continuity. Clearly, Rudov Beds show sufficient TOC contents and thickness over a wide lateral area, including main parts of the NW and central DDB. Nevertheless, organic petrographical and organic geochemical data point to a facies zonation with the oil-prone facies being restricted to the so-called Srebnen Bay in the NW part of the basin, whereas a strong terrestrial input at the basin margins and in the central part clearly reduces the generation potential for liquid hydrocarbons in these areas. Target maturity for shale oil (>0.8 %Rr) and shale gas (>1.2 %Rr) production is reached at great depths only (>4.5 km and >5.5 km, respectively), and kinetic experiments do not point to earlier generation, *e.g.*, due to the presence of type II S kerogen. The low thermal maturity, confirmed by the presence of expandable clay minerals to depths >5 km, is referred to a low Mesozoic heat flow that also agrees with 1/2-D thermal modelling results. The mineralogical composition of Rudov Beds varies strongly in both lateral and vertical directions, challenging the previously established facies zone concept. A substantial fraction of samples from the basinal (siliceous), as well as the majority of samples from transitional (calcareous) and marginal (clayey) facies zones do not meet the desired cut-off of >60 wt.% brittle minerals (quartz, feldspar, pyrite, etc.), due to high clay mineral contents. Kaolinite contents up to 80 wt.% where determined even for samples from the basinal facies. Furthermore, a strong diagenetic overprint resulting in authigenic (carbonate) cement phases was observed for many samples. These are considered to have an important influence on the overall mechanical properties, limiting their predictability by bulk mineralogical data.