Integrated Petroleum System Study of Dnieper-Donets Basin: What is the Depth Limit of Future Discoveries?

Ivan Karpenko[1]

[1]Naftogaz of Ukraine, Kyiv, Ukraine.

ABSTRACT

Dnieper-Donets basin (DDB) is a major petroleum province in Eastern Europe. Aulacogene deepens from 6 to 20 km and predominantly filled with Paleozoic sediments affected by salt tectonics. DDB is a mature basin with over 200 fields under development that also holds significant potential: 14bn boe of undiscovered resources and 3.4bn boe of prospective resources associated with 150 identified prospects, 40% of which are high-risk prospects located 5-7 km deep. In order to understand evolution of petroleum system during syn-rift and post-rift stages and to evaluate deep and ultradeep prospects, 1D, 2D and 3D petroleum system modeling (PSM) are being applied. Proper PSM requires advance study of petroleum system elements (PSE). Pre-modeling studies were devoted to petrographic analysis of Paleozoic organic-rich and coal samples, kerogen content was estimated using well logs from 70+ boreholes, also all discovered hydrocarbons accumulations within the study area were analyzed. Source rocks analysis has supplemented previous studies about multi-source petroleum system: several minor organic-rich oil-prone formations and major organic-lean gas-prone horizons in Famennian-Mississippian section, and predominantly gas-prone coal beds in Pennsylvanian section. Heat flow trend was determined using 1D modeling of 53 wells, which were calibrated with vitrinite reflectance values: estimated heat flow at the rate of 70-80 mWm2 during Devonian rifting decreased stepwise to 30-40 mWm2 in Cenozoic. Two 3D models were developed: first model of shallow sub-basin area aimed to correlate simulation results with known discovered oil and gas fields, second model aimed to study deep basin area. Forecasted oil and gas accumulations, obtained as a result of 3D modeling of shallow sub-basin area, well correlate with known discovered fields: 70% of predicted accumulations corresponds to real data, 88% of predicted oil-to-gas charge ratios corresponds to real data. 3D simulations of deep paraxial aulacogene area together with several 2D models of regional cross sections have indicated possible deep and ultradeep wet gas accumulations under the thick regional carbonate platform and gas-charged traps on the flanks of salt domes. Deep structures and areas, which were insignificantly affected by Early Permian halokinesis, hold significant potential for further discoveries within deep paraxial part of Dnieper-Donets basin.