Paper Number: 1827

PETROLEUM SYSTEM MODELLING OF THE EAST BARENTS SEA BASIN

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In 2011-2014 VSEGEI carried out a multi-client Project “Basin analysis and petroleum systems modelling of the Eastern Barents Sea”. Its main peculiar features were the compilation of a large body of geophysical, geological data, their reinterpretation, obtaining new analytical data (including organic geochemical, thermochronological and isotopic methods) and computer modelling to analyze the basin burial history and evolution of petroleum systems.

Rock-Eval pyrolysis and vitrinite reflectance data were used to estimate potential source rocks (SR) in terms of their quantity, quality and thermal maturity. The four most prominent source rock intervals were distinguished – Upper Devonian (Domanik) marine facies (Type II kerogen), Upper Carboniferous – Lower Permian marine carbonate-terrigenous rocks Type II-III), Low-Middle Triassic shales (Type III) and Upper Jurassic black shales (Type II). The Paleozoic rocks are usually overmature, Triassic SR are in the oil window, and Cretaceous ones are immature as a rule.

Numerical uplift/erosion estimating was the important part of the Project. As a results magnitude assessment of exhumation for 23 boreholes on the Barents Sea shelf have been obtained using compaction trends together with vitrinite data [1]. These estimates were spread for the whole basin area using seismic velocity dataset. According to available data, there is the only principal stage of uplift. For the first time the evaluation of the uplift onset was performed based on apatite fission track analysis (13 samples from the Fersmanovskaya-1 borehole) – it clearly shows that the accelerated cooling caused by uplift began at 60 Ma [2].

1D burial modelling were made for 14 offshore deep wells. These models were applied mainly for the calibration of the temperature history. Then, based on the available seismic and geological data, 3D model of the sedimentary cover was constructed; it included not only geometry but also the assessment of hiatuses, erosion, generalized lithology and organic matter characteristics.

Modelling of four major source rock units were carried out (for Triassic SR two possible scenarios of migration were under consideration). The change of maturity in time, a volume of expelled oil and gas, the rate of their expulsion and other parameters were evaluated. The next stage of modeling deals with the analysis of migration and accumulation of the expelled hydrocarbons. As a result, the most general features of petroleum systems in time and space were outlined. Potential traps, hydrocarbon accumulations and the probability of their preservation were distinguished for each petroleum system. Upper Devonian SR reached the oil window in the end of Permian and were overmature already for the most of basin to the end of Triassic. The oil accumulations of this age could be preserved only in the marginal parts of the basin. The peak hydrocarbon generation of the Upper Carboniferous – Lower Permian SR was in Triassic, the modelled accumulations (gas mainly) distribution are similar to the previous system. The Triassic petroleum system has long and the most complicated hydrocarbon generation history with several phases of acceleration and termination, the peak generation occurred in the Late Cretaceous and ceased abruptly with the Paleocene uplift onset. Upper Jurassic black shales are the best source rock, however they are immature.

The project has been supported by Oljedirektoratet, Statoil AS, Concedo AS; Detnorskeoljeselskap AS, Total E&P Russie, Wintershall Holding GmbH and Lukoil Overseas North Shelf AS.

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