

Petroleum Geological Evaluation of the Western Black Sea: A Large-scale 3D Petroleum System Model

A. K. Uffmann, E. Iwaniw, C. Holley, and M. O'Neill

ABSTRACT

The Black Sea is considered to be a truly frontier region with few exploration wells drilled, especially in the deep waters. Discoveries in recent years have heightened interest in this region despite its challenging deep water environment and, at times, difficult geopolitical situation. Recent exploration efforts have focused on the shelf areas of the western Black Sea, in the waters off Ukraine, Romania and Bulgaria focusing on targets ranging from Pliocene to Jurassic in age, but much of the region still remains untested and unknown.

The scope of this comprehensive study was to gain an understanding of the regional tectonic and stratigraphic evolution of the Black Sea region as a whole. Extensive regional studies beginning with gravity and magnetic interpretation, seismic interpretation, palaeogeographic mapping and correlation of the stratigraphy across all the sub-basins were used to evaluate the regional petroleum plays with the aid of basin modelling. The Western Black Sea region can be subdivided into a series of platforms and sub-basins which are separated by structural elements such as the North Dobrogea Orogen and major fault systems. The Western Black Sea Basin is characterized by high sedimentation rates from the Paleocene/Eocene to Recent and the base of the Mesozoic succession reaches depths of more than 14 km east of the Histria Sub-basin.

Black shale intervals are known in the Oligo-Miocene Maikop Formation which is a widespread source rock in the Black Sea region and has good oil source potential. Towards the West, the Maikop Formation and its equivalents follow a westerly trend of decreasing source quality, but the underlying Eocene section is organic rich in some drilled locations (e.g. well Arkhangelska-1). Moreover, Cenomanian-Turonian and Tithonian black shales are known from several wells and are assumed to be present elsewhere in the study area. In addition to thermogenic degradation of organic matter, gas in the Histria Sub-basin (e.g. Lebada Field) is most likely to be of biogenic origin.

To analyse the burial and thermal history of the region a large-scale 3D petroleum system model of the Western Black Sea region was built (PetroMod® suite software). Hydrocarbon generation from different source rock intervals (thermogenic and biogenic) was calculated and drainage areas, migration pathways and possible accumulations were computed. In addition, multiple faults were taken into account since these also control migration.

The oils of the Western Black Sea Basin are considered to have been mainly generated by Late Jurassic and Cretaceous source rocks, while the Oligo-Miocene Maikop Formation equivalent source rocks are widely immature and limited to biogenic gas generation in the central study area.

In summary, it is shown that generation and migration of hydrocarbons has taken place since the Late Eocene and is still continuing. High losses of hydrocarbons were detected during the simulation because of the lack of compacted seal lithologies and other traps. The simulation results indicate that huge hydrocarbon potential still exists, especially in the Maikop Formation and in Holocene sediments. Both are rich in TOC and they are probably a copious source for biogenic methane.