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Basin Modelling of a Regional Transect in the Western Black Sea

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SUMMARY

With the exception of the shelf area, the Western Black Sea Basin (WBSB) is still considered a frontier basin, with very little data available in its central part. With the help of 1-D and 2-D basin modeling, based on the interpretation of a large data base of seismic lines and wells (on the Bulgarian shelf), a model is proposed for the petroleum generating system of the WBSB. The maturity of the considered source rocks and possible accumulations in theoretical reservoirs are discussed.

Introduction

In any underexplored deep water basin one of the key risk reducing methods is basin modelling, a technique used for the understanding the physical and chemical processes that trigger oil and gas generation in sedimentary basins. It allows a reconstruction of the burial and temperature history of a sedimentary basin through time and the understanding of source rock maturation and hydrocarbon expulsion and migration.

With the exception of the shelf area, the Western Black Sea Basin (WBSB) is still considered as a frontier basin, with very little data available in its central, deep water part. Therefore, the deep structure and stratigraphy of the basin centre were interpreted primarily using reflection seismic data. In this study a model was developed for the petroleum generating system in the WBSB using 1D and 2D basin modelling. This model was based on the interpretation a large data base of seismic lines and wells available to OMV and Petrom in the WBSB. Publicly available data geological and geophysical data from Bulgaria and Turkey were also incorporated into the basin modelling.

The WBSB is considered to be a Cretaceous extensional basin with a sedimentary cover up to 14-16 km thick containing Cretaceous syn-rift and Cenozoic post-rift sediments (e.g. Georgiev, 2012). Pre-rift Paleozoic sediments on the Bulgarian shelf encountered by the three wells were also taken into consideration. The main source rocks investigated are Carboniferous, Jurassic (shelf only), Lower Cretaceous, Eocene and Oligocene (for the self and the deep water basin). The maturity of the predicted source rocks and the possible accumulations in several potential reservoir units were analysed.

Method

The model was made with the PetroMod software. Well calibration was used for the 1D simulation of the burial and thermal history on the shelf. A heat flow model was constructed based on vitrinite reflectance and temperature measurements in several wells assuming 60 mW/m² on the Bulgarian shelf and 40 mW/m² in the deep water basin. Since the regional composite seismic section did not cross the shelf areas the basin modelling transect was extended to go through the calibration wells.

The resulting geological section was used for the 2D simulation, further constrained by data from published literature data and also by the boundary conditions determined from the 1D simulations. The result was a migration and trapping history in a series of theoretical reservoirs on the basin flanks.

Results

Regarding maturity, presently the top of the oil window is at around 4,000 m and the top of the wet gas window is modelled at around 9,000 m (Figure 1). For the shelf area the source rocks are mostly immature with transformation rates below 50%, with the exception of the Jurassic source rock which is in the early oil window with over 50% transformation. The Carboniferous source rock sequence is in the late oil to wet gas window with almost 100% transformation. The Jurassic and the Carboniferous source rocks have a different burial history and were modelled as such. These potential source rock units were considered in the basin modelling due to their very good potential seen in some of the wells.

For the deep water basin the source rocks are in the oil window at present. The Oligocene Maykop interval is mostly in the early oil to main oil window with over 50% transformation in the deeper parts. The predicted Eocene source interval is in the main to late oil window with somewhat higher transformation ratios. The assumed Lower Cretaceous source is over-mature or in the dry gas window at present with almost 100% transformation rate.

The model yielded many possible accumulations in the theoretical reservoirs, with a main migration pathway to the flanks as seen in the accumulation pattern in Figure 1.

Figure 1 The 2D model with a maturity overlay and the theoretical accumulations of biogenic gas (on the shelf) and oil (over Polskov high and the Turkish slope) The three wells are represented with dotted lines on the Bulgarian shelf.

Conclusions

The results of the basin modelling are encouraging as to the unexplored deep water parts of the WBSB. In particular, the most important source rock interval, the Oligocene to Lower Miocene Maykop interval appears to be in the oil window at present. Future work is planned to address the purely biogenic kitchen(s) in the WBSB which will require the use a very different basin modelling approach.

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