Integrated Stratigraphic and Petroleum System Modeling Study of the Southern Upper Rhine Graben

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Abstract

The Upper Rhine Graben (URG) is a Tertiary rift located between the Vosges (France) and Black-Forest (Germany) Variscan units as a part of the European Cenozoic Rift System (ECRIS) which crosses Western Europe from the Mediterranean Sea to the North Sea over more than 1000 km. Recent URG structuration started during the Tertiary with a major WNW-ESE extension (Eo-Oligocene) followed by a sinistral strike-slip during Miocene. Its evolution is closely related to the Paleozoic inheritance and Permian highs and troughs structuration. These crustal discontinuities fragmented the URG into several opposing tilt sub-basins separated by wrench faults. Between those periods of active structuration, Triassic and Jurassic sediments are deposited during a relative tectonic quiescence onto the Western European Platform.

Active petroleum system in the URG is known since the 15th century. Most of the hydrocarbon production took place in Pechelbronn Field until 1968. Hydrocarbon accumulations are found in the Dogger "Grande Oolithe" Formation and in Oligocene syn-rift clastics reservoirs and overlying thick Tertiary shales. Associated evaporates act as a regional seal. Hydrocarbon generation is linked to the presence of Liassic source rocks (e.g. Sinemurian shales and Toarcian "Schistes Cartons").

In this study we focused on the southern part of the URG between the cities of Colmar and Belfort (France) and Basel (Switzerland) to assess the maturity of Jurassic source rocks and evaluate the distribution of Meso-Cenozoic reservoirs within Mulhouse Potash Basin to the North and the Dannemerie Basin and Altkirch-Basel titled-block array to the South. To that aim an integrated workflow combining well-data synthesis and correlation, seismic interpretation, field work, forward stratigraphic modeling (DionisosFlow(r)) and thermal basin modeling (TemisFlow(r)) was used.

Tertiary sequences were investigated through stratigraphic modeling in order to provide 3D spatial distribution of the distinctive sedimentary facies, predicting occurrences of the potential Tertiary reservoir/seal couplets.

Petroleum system modeling was carried out on two 2D sections integrating previous results. Thermal and maturity calibration were obtained by modeling the whole lithosphere and heating caused by Tertiary rifting events. The calibration also highlights the importance of hydrothermal circulation in the generation of hydrocarbons that migrates to known accumulation of Staffelfelden.