New Data on Thermal History and Source Rock Development in Complex Rift Basins (Northern Upper Rhine Graben, SW Germany)

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ABSTRACT

The Upper Rhine Graben (URG) in SW-Germany, a classical hydrocarbon province, is part of the European Cenozoic Rift System. Rift graben development has led to a complex basin fill of terrestrial and marine deposits providing several reservoir and source rock units. Source rocks are restricted to the pelitic units of marine transgressive intervals. Although TOC is similar in the different source rock units, kerogen composition and therefore hydrocarbon potential, differs significantly. In general two types of source rocks are identified. Transgressive marine intervals during high rift tectonic activity with high subsidence and therefore high terrestrial input from the graben shoulders led to terrestrial dominated, mainly gas-prone source rocks. Even in the maximum transgressive interval (Rupel clay) high rift tectonic activity led to mainly gas-prone kerogen instead of mainly oil-prone kerogen as proposed before. In contrast, marine transgressions in times of low rift tectonic activity and therefore low subsidence and terrigenous sediment input led to the deposition of mainly marine-brackish derived, oil-prone kerogen, as expected for marine intervals. Kerogen composition also shows minor differences due to different structural positions. Thus organic matter accumulation and kerogen composition is strongly influenced by rift-related tectonic activity and less by sea-level variations, which differs clearly from previous models. For a better understanding and modelling of the petroleum system in the northern URG the palaeothermal history was studied by integrated maturation analysis of several wells across the study area. Most wells show almost vertical maturation trends, untypical for burial controlled maturation but clearly indicating secondary thermal overprint. This is related to long-lasting, very hot hydrothermal fluid systems, well known from the URG, which were mainly concentrated along reactivated fault zones. Therefore, maturation is mainly influenced by tectonically controlled distribution of hydrothermal systems and not by basin subsidence. This is confirmed by the uniform maximum maturation in the early oil-window in all wells, despite the different burial depths. Thus minor hydrocarbon generation can be expected only from oil-prone source rock units. Hence, the development of the depositional setting, kerogen composition, thermal maturation and hydrocarbon potential is directly linked and mainly controlled by the dynamics of the rift system.