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BIOMARKER AND ISOTOPE GEOCHEMISTRY OF THE LACUSTRINE WEALDEN FACIES IN THE LOWER SAXONY BASIN (L. CRETACEOUS, GERMANY)

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Abstract

The Lower Cretaceous (Berriasian) Isterberg-Formation (German Wealden) in the Lower Saxony Basin (LSB) is in terms of its hydrocarbon potential one of the most prolific geological deposits in Germany. It is regionally considered as potentially significant "unconventional" hydrocarbon (HC) resource (Bruns et al., 2016) although the high clay contents in the shales are presumed to negatively affect the recovery of shale oil or gas. The respectively most prolific parts of the Isterberg-Formation belong to the ostracod zones "Wealden 3 and 4" and mainly consist of organic matter with lacustrine Type I kerogen and hydrogen indices of up to 900 mg HC g^{-1} TOC (Berner et al., 2010; Zink et al., 2016). From detailed studies of a core from the central basin it is known that the facies reflects frequent changes in the abundances of aquatic and terrestrial organic matter (Berner et al., 2010) and also encompasses periods of marine ingressions. During the main period of shale (and thus source rock) accumulation (Wealden 3–4), however, the situation in the central basin is considered relatively stable. Lateral changes of the depositional environments during that time interval are also known (Elstner and Mutterlose, 1996). Abundant coal seams, intercalated with sandstones, are described from the eastern part of the basin (Deister-Formation). Despite this general knowledge, a detailed characterisation of the biomarker distributions and stable carbon isotopic signatures for the regionally different settings during Wealden 3–4 is lacking.

We here present new data from more than 30 drill sites from throughout the basin. The aim of our study was (i) to identify general organic geochemical proxies for the Wealden shale facies and (ii) to find facies-specific differences within the more than 280 km wide basin. Simple biomarkers appropriate to identify Wealden shale organic matter were not found, but certain biomarker ratios and stable carbon isotope signatures of saturated and aromatic fractions appear to be indicative. For instance, both acyclic isoprenoid/*n*-alkane ratios (e.g., pristane vs. nC_{17}) and sterane/hopane ratios are generally low and differ from ratios from e.g. Posidonia shale samples. Moreover, a lack of isorenieratane in Wealden shales was observed, while this component appears to be widespread in Lower Jurassic Posidonia shales (and petroleum). Data on gammacerane (expressed as gammacerane/hopane ratio) and the relative proportions of C_{30}-desmethyl sterane, which were found to be relatively low in the lacustrine Wealden shales, have shown to be useful for a differentiation. We also found lateral differences in biomarker compositions for the Wealden basin. Especially, a relative increase in C_{29}-desmethyl steranes towards the more terrestrially influenced eastern part of the basin nicely reflects published paleo-reconstructions (Elstner and Mutterlose, 1996). However, with regard to the still limited data in certain areas, our results demonstrate that the clay-rich Wealden source rock facies extends the central basin further to the East than previously thought. We consider our data crucial for a better understanding of facies transitions (Wealden 3–4) and thus for a better localisation of the central basin facies. Moreover, a better knowledge of Wealden Shale organic geochemistry can help to identify source rocks of the petroleum reservoirs occurring throughout the basin, and to correlate natural and potential future accidental petroleum leakages in the LSB.

References

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