COMPOSITIONAL FRACTIONATION DURING EXPULSION OF PETROLEUM FROM SOURCE INTO CARRIER BEDS

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Summary

The discharge of oil and gas from a source rock into adjacent carrier beds is called petroleum expulsion (Tissot and Welte, 1984). Previous research has provided clear evidence that petroleum expulsion is accompanied by substantial molecular redistribution between hydrocarbon-rich petroleum and asphaltene-/resin-rich source bitumen (e.g. Mackenzie et al., 1983; Leythaeuser et al., 1988a, b). Here, we examine the effects of petroleum expulsion using different scenarios of adjacent source rock-carrier bed couplets involving, (1) organicrich shales of the Upper Jurassic Draupne Formation and, (2) coals and shales of the Middle Jurassic Hugin Formation. The investigated scenarios comprise, (i) a high-resolution section (1 m) including a small source rock interval intercalated between two sandstone reservoir units, and (ii) a low resolution section comprising a 30 m sequence involving one shaly and two coaly source units intercalated by sandstone carrier beds. The samples were analyzed for bulk properties and molecular composition to determine the thermal maturity and expulsionrelated compositional changes. Our data from scenario (i) suggest both rich source potential (8-10 % TOC) and maturity within the oil window leading to the generation and expulsion of oils. TOC-normalized extract yields increase towards the edges of the source interval and reach highest concentrations within the sandstone carrier beds. Interestingly, this trend is accompanied by profound compositional changes, in particular increasing nC17/Pr- and TA(I)/TA(I+II)-ratios. Both ratios depend on molecular shape, with preferential expulsion of n-alkanes relative to isoprenoids and short chain compared to long chain triaromatic steroids. A similar but this time polarity-based trend was observed for the C2 dibenzothiophenes vs. C2 phenanthrenes ratio. Polar C2 DBTs are retained in the source, whereas less polar C2 phenanthrenes are expelled into the adjacent carrier beds. Since well-established discrimation diagrams involving both saturated and aromatic compounds indicate a genetic relationship between source bitumen and reservoir oil, we propose that the observed gradients are primarily controlled by selective adsorption-desorption interactions between generated bitumen and the pore surface of the source rock. In scenario (ii) the Hugin coals were found to be strongly enriched in benzo[b]carbazole, which we postulate to represent an excellent facies parameter that would be expected to be seen in partially coal-derived oils. In agreement with Isaksen et al. (1998), our results indicate that there is no or minor contribution of the Hugin coals to the oil found in the adjacent carrier beds.

References

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