

B2, OR NOT B2, THAT'S THE QUESTION – ON THE EXISTENCE OF AN OCCLUDED BITUMEN-PHASE

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A non-extractable bitumen phase can in some cases remain after exhaustive solvent extraction of powdered sedimentary rocks. This adsorbed or occluded bitumen is only recoverable after the digestion of carbonates and/or silicates, and has been termed bitumen 2 (Smith et al., 1970), or B2 (as opposed to freely extractable B1). The nature and recoverability of B2 have received much attention given that its non-recoverability during conventional solvent extraction has been interpreted as implying a certain protection from external contamination, which would mean that B2 might represent an original and syngenetic hydrocarbon phase even in samples that have otherwise been affected by contamination (e.g. Sherman et al., 2007; Waldbauer et al., 2008). Yet other colleagues and studies have suggested that B2 more likely represents an artefact of incomplete extraction.

We studied multiple, sequentially extracted B1 phases as well as B2 from organic-rich sediments deposited in Eocene Lake Enspel (Germany). The uppermost part of this lacustrine succession was capped by a mafic lava flow, resulting in a natural maturation sequence over uniform depositional facies: over ~70 cm of stratigraphy, the thermal maturity ranges from 0.3 to 1.07 %R_o. In terms of source rock evaluation this would span from an immature state to beyond the oil window. A high abundance of extractable organic matter led us to sequentially use multiple techniques: samples were first extracted by ultrasonic agitation in dichloromethane/methanol (ULTRA), followed by multiple sequential extractions using pressurized automated solvent extraction (ASE). Subsequently, rock powders were acid digested (carbonates and silicates removed with HCl_{aq} and HF_{aq}) and re-extracted with DCM (ultrasound) to yield B2.

Many unexpected and highly relevant observations will be discussed in the presentation. For one, both extract yield and composition vary strongly between sequentially extracted free bitumen phases, as well as with thermal maturity. This compositional heterogeneity of bitumen implies that analyses on non-exhaustively extracted samples may be mildly to strongly skewed. Bitumen 2 systematically differs in terms of its composition, exhibiting a different primary organic matter input, a higher thermal maturity and enhanced clay-catalysed diagenetic reactions (e.g. sterane dia/regular ratio). The key conclusion is that B2 indeed represents a separate organic phase, thereby pointing to significant bitumen heterogeneity on a small spatial scale. The suspected separately observed signatures of primary producers, plant cuticles/macerals and detrital organic matter will be discussed in detail.

While our results open more questions than they answer, they are highly significant in suggesting the co-existence of different non-mixed pools of organic matter that can tentatively be attributed to different sources. Hypothetically, these sources (detrital vs. cuticle vs. water column vs. sediment) might be teased apart by detailed sequential bitumen

extractions, once the complexity of bitumen localization and recovery, as well as possible catalytic processes, are fully understood.

References

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