ASSESSING THE EFFECTS OF THERMAL MATURATION ON BIOGENIC AND ABIOGENIC ORGANIC MATERIAL

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Organic matter in Archean or, potentially, extraterrestrial materials may reveal the existence of (early) life, but it is typically difficult to discriminate whether such organics derive from biological or non-biological sources (e.g. Lindsay et al., 2005; Van Kranendonk, 2011; Westall et al., 2015). In particular, postdepositional alteration of these (bio-)signatures over geological timescales make an assignment of their origin problematic (e.g. Brocks and Summons, 2003; Peters et al., 2005). Experimental maturation studies provide the opportunity to observe molecular changes under controlled temperature and pressure regimes and could thus help in the interpretation of the underlying processes.

Here we report on abiotic synthesis experiments to produce Fischer-Tropsch-type (FTT) organic material under hydrothermal conditions (Fischer and Tropsch, 1926; McCollom et al., 1999). In a second step, the FTT organics and a biogenic reference material (Green River Shale kerogen, Eocene) were experimentally maturated in gold capsules (e.g. 300°C, 1 d to 200 d, 2 kbars) to assess the molecular alterations and the stability of individual compounds during the maturation processes. Vitrinite reflectance was determined by parallel maturation of lignite reference samples. The maturation products of the FTT- and Green River Shale samples were analysed using gas chromatography-mass spectrometry (GC-MS) and pyrolysis-GC-MS, respectively.

Abiotic synthesis products show a variety of aliphatic hydrocarbon compounds, e.g. *n*-alkanes, *n*-alkanols, *n*-alkanoic acids (see also McCollom et al., 1999; Rushdi and Simoneit, 2001) and a number of methyl-branched compounds that have not been reported so far from FTT processes. All compounds do not show any chain length preferences. Maturation of these FTT organics resulted in an overall decrease of functionalised alkyl chains and, simultaneously, in an increase of aromatic hydrocarbons, while *n*-alkane patterns remained largely unchanged.
The immature Green River Shale initially showed a "biological" odd-over-even predominance for *n*-alkanes, and abundant sterane and hopane biomarkers (Mißbach et al., 2016 and references therein). With increasing thermal stress, sterane and hopane biomarkers decayed and disappeared completely in a maturity range corresponding to 1.38 - 1.83% R_O (Mißbach et al., 2016). Likewise, the odd *n*-alkane predominance progressively decreased, and the distributions of the remaining *n*-alkanes were no more distinguishable from those of the FTT samples beyond this point. Furthermore, the experiments allowed to track the effect of thermal maturation on some biomarker ratios that are commonly used for paleoreconstructions (pristane/phytane, pristane/n-C_{17}, phytane/n-C_{18}, total steranes/hopanes; Mißbach et al., 2016).

The discrimination of biogenic and abiogenic organic matter is still a central problem in geo- and astrobiology. We demonstrate that abiogenic FTT-processes can indeed produce a variety of linear-, branched-, and functionalized organic compounds that in many respects resemble biologically produced organic matter. Likewise, defunctionalisation and aromatisation reactions during maturation tend to make the molecular frameworks of biotic and abiotic organic matter essentially similar and thus, unspecific. It is therefore crucial to determine the distinct characteristics of biological organic matter that may remain even after strong alteration. The data obtained here contribute to a solid experimental fundament needed for the interpretation of organic signatures in Archean rocks and, potentially, extraterrestrial materials.

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