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Production and Destruction of Novel Organic Species during simulated Hydrothermal Alteration of Seafloor Sediment

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Hydrothermal alteration of sedimentary organic matter is a fundamental process generating dissolved organic molecules in sediment-influenced hydrothermal ecosystems. Production of organic species other than simple hydrocarbons and some organic acids [1,2] remains largely unconstrained, however. To address this, we conducted two time-series experiments using a Au-TiO_2 apparatus to investigate NSO-production during hydrothermal seawater-sediment interactions at 250–360ºC (35 MPa). The experiments heated two differing sediment types with similar wt.% organic carbon over several months - Arctic Mid-Ocean Ridge terrigenous sediment (KNIP) and Guaymas Basin diatomaceous ooze (GUAY). Both were progressively heated to 250ºC and 330ºC at similar seawater/sediment ratios, with GUAY heated further to 360ºC while KNIP was cooled to 250ºC, simulating conductive cooling of an organic-rich fluid.

Time-series measurements showed major element, gas and dissolved organic carbon (DOC) concentrations generally followed trends observed in previous studies at comparable conditions [1,2]. We observed remarkably similar trends for NSOs in both experiments. CH_3SH rapidly increased to mmolar concentrations at 250ºC, vastly outpacing CH_4 production in the earliest stages. CH_3SH concentrations then decreased at 330–360ºC, but increased again slightly in the cooled 250ºC KNIP experiment. This implies CH_3SH production exceeds destruction at moderate temperatures over several months - a trend reversed at higher temperatures. C_2–C_5 carboxylic acid concentrations behaved similarly, rapidly increasing at 250ºC and 330ºC, then decreasing at 360ºC (GUAY), and stabilizing in the cooled 250ºC phase (KNIP). Formate abundance was temperature dependent, evidenced by lower, but identical, abundances in both 250ºC phases in KNIP relative to the higher concentration 330ºC phase. Despite bulk DOC and total dissolved nitrogen concentrations reaching 10s of mM at 250ºC, solid-phase extractable DOC decreased rapidly with increased temperature in both experiments. Ongoing analysis of alcohols, $\sum NH_4^+$, amino acids, structural characterization of DOC and mineral alteration products will also be presented. Our results demonstrate complex but common trends for diverse NSO-organics during hydrothermal sediment alteration, with important implications for how these species respond to varying thermal maturation extents and timescales in natural systems.

[1] Seewald *et al*. (1990) *Applied Geochemistry*, 5(1-2), 193-209

[2] Kawagucci and Seewald (2019) *Geochemical Journal,* 53(4), 281-291