Conductive cooling and microbial carbon transformations in diffuse hydrothermal fluids at Loki's Castle

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Loki's Castle is a bare-rock sediment-influenced hydrothermal system at 2310m depth on the ultraslow spreading Arctic mid-ocean ridge [1]. Besides focused "smoker" vents (306–316°C), cooler diffuse fluids of putative high-temperature origin emanate from a large peripheral area called the Barite Field (BF) [2]. In 2017–2018, isobaric gas-tight samples of paired endmember smoker and diffuse BF fluids were collected with realtime temperature measurements for the first time and analysed for diverse dissolved gases, major/minor elements, total alkalinity and $pH_{(25°C)}$.

Compared with near zero-Mg high temperature fluids, diffuse BF fluid (15–16°C) collected in 2017 shows consistent elevated Mg (36.7–37.4 mmol/kg), as well as SiO_2, K and Na concentrations indicating an endmember fluid content of *ca*. 30%. Modelled isenthalpic mixing between the high-temperature fluid and seawater thus reveals this fluid has undergone extensive conductive cooling from in excess of 100°C. Partial removal of Ca, Sr and SO_4, near-quantitative removal of H_2 and CH_4, as well as strong enrichments in H_2S and total alkalinity in the fluid implies a complex fluid evolution involving anhydrite precipitation, followed by pronounced chemolithoautotrophic microbial activity in the subseafloor. These chemical trends, combined with the presence of anaerobic methanotrophic archaea (*e.g.* ANME-1) previously identified in the BF area [2], indicate subseafloor sulfate-driven microbial anaerobic oxidation of methane. Additionally, ethane, propane and CO are also evidently consumed (relative to conservative dilution trends) in the 15–16°C fluid, most likely by microbial processes. Cooler, more diluted BF fluid samples (<4°C) collected in 2018 show variable degrees of *n*-alkane consumption, but generally similar chemical trends. Potential causes of such extensive cooling will be discussed, but collectively these physical, chemical and microbiological observations point to a highly unusual diffuse hydrothermal ecosystem.

[1] Baumberger et al.(2016) *Geochim. Cosmochim. Acta* 187, p156–178 [2] Steen et al.(2016) *Front. Microbiol.* 6, 1510.