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Methanotrophy and sulfate reduction at the interface between Mediterranean seawater and the MgCl2-dominated Kryos brine basin

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The Kryos brine basin is located at ∼3000m water depth in the Eastern Mediterranean Sea. The anoxic brine originates from subsurface Messinian evaporites and is dominated by very high concentrations of MgCl2-equivalents (∼5M), making this environment challenging for live. The strong density difference between the brine and the overlying Mediterranean seawater impedes mixing, and the seawater-brine interface is thus characterized by a strong redox gradient. In the redoxcline, we observed sharp sulfate, sulfide and methane concentration gradients, from seawater background concentrations to high concentrations in the brine (∼150 mM sulfate, ∼250 μM sulfide, ∼50 μM methane). Right at the interface, under micro-oxic conditions, we determined methane oxidation rates of up to 60 nM/day, and sulfate reduction rates of up to 15 μM/day. Our findings of 13C-depleted biomarkers typical for aerobic methanotrophs (diplopterol, fatty acid C16:1ω8) indicate an aerobic mode of methane oxidation independent of sulfate reduction. Below the interface (within the anoxic brine), the presence of both methane and sulfate would make the anaerobic oxidation of methane with sulfate (AOM) thermodynamically feasible. However, while sulfate reduction rates were very high (500 μM/day), methane oxidation rates were not detectable suggesting inhibition of AOM. In the brine, we detected high concentrations of an unusual fatty acid (10Me-C16:0) indicative for sulfate reducing bacteria, which might be responsible for the high sulfate reduction rates. In addition, we also found archaeal lipids (archaeol, PMI) moderately depleted in 13C. Considering the absence of AOM activity, these lipids suggest a methanogenic, rather than methanotrophic origin of the archaea within the brine. All these results provide new and exciting insight into life in an extreme environment.