Trace element behaviour and the export of organically-bound dissolved iron at cold seeps

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We report on trace element data (Fe, Mn, Ba, U, REE) for seawater samples collected by submersible above methane seeps in the Gulf of Guinea (Regab pockmark). Our aim was to investigate the behaviour of trace elements during fluid seepage. Dissolved (<0.45 μm filtered samples) and total dissolvable (unfiltered samples) concentrations were determined over ~50 m long vertical transects above the seafloor.

We show that substantial amounts of Fe and Mn are released into seawater during seepage of methane-rich fluids. Mn is exported almost quantitatively in the dissolved form. Although a significant fraction of Fe is bound to particulate phases, the dissolved iron pool still accounts for approximately 20 percent of total iron flux at vent sites (mean Fe_{DISS} ~34 ± 5 nmol/kg). This dissolved Fe fraction also appears to remain stable in the water column. In contrast, there was no evidence for any significant benthic fluxes of pore water REE, Ba and U associated with fluid seepage at the studied sites.

Overall, the absence of any dissolved REE and Ba enrichments in bottom waters at Regab clearly indicates effective removal of these elements in sub-surface sediments. Most likely, precipitation of authigenic mineral phases at cold seeps (carbonate, barite) represents a net sink for these elements. While Mn appears to behave near-conservatively during fluid seepage, the observed relative stability of dissolved Fe in the water column above Regab is best explained by complexation with strong organic ligands, as reported previously for submarine hydrothermal systems. Considering the ubiquitous occurrence of methane vents at ocean margins, cold seeps could represent a previously unsuspected source of dissolved Fe to the deep ocean.