

## Serpentinization and carbonate precipitation at the Lost City Vent Field (30N, MAR)

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The discovery of the peridotite-hosted Lost City Vent Field (LCVF) at 30N near the intersection of the MAR and the Atlantis Fracture Zone provides new opportunities to understand the links between volatiles, hydrothermal activity, serpentinization, and microbial activity in off-axis environments (Kelley et al., 2001). The LCVF, located on the dome-like Atlantis massif, hosts at least 30 carbonate-brucite structures that reach up to 60m in height. This field is distinguished from all other known marine hydrothermal systems because it (a) occurs off-axis; (b) is the first known example of seafloor vents capable of producing low Mn/CH<sub>4</sub> plumes; (c) hosts carbonate-brucite chimneys rather than sulfide deposits; and (d) is dominated by serpentinized peridotite rather than basaltic material. The rocks record multiple phases of deformation and alteration during the magmatic, tectonic and hydrothermal evolution. The peridotites are 50-100% serpentinized, characterized by poorly developed mesh textures, static alteration, and incomplete serpentine reactions. Serpentinization is dominated by lizardite, chrysotile, magnetite and/or calcite after primary olivine, and bastite, talc or chlorite after pyroxene. Multiple generations of veins and fractures are filled with talc, tremolite, chlorite and/or serpentine with late stage fillings dominated by Mg-rich calcite and/or aragonite.

Interaction with seawater during serpentinization and carbonate precipitation is supported by stable isotope analyses of carbonate. The  $\delta^{13}\text{C}$  values of well-lithified pelagic sediments and the LCVF carbonate vent structures reflect a marine source of carbon and ambient temperatures of precipitation. In contrast, carbonate veins in the peridotites show a large range of isotopic compositions. Samples with the most negative  $\delta^{13}\text{C}$  values (-6 to -1 permil VPDB) commonly have negative  $\delta^{18}\text{O}$  values (-20 to -7 permil VPDB), which suggests a <sup>13</sup>C-depleted C-component (possibly CH<sub>4</sub>) in the fluids and precipitation up to 50-200C. Our studies suggest that this new class of hydrothermal system is vastly different from basaltic environments. Serpentinization may not only control CH<sub>4</sub>-contents, fluid compositions and carbonate precipitation, the exothermic nature of serpentinization may provide a large component of heat to drive hydrothermal flow; and thus may play a fundamental role in thermal and chemical exchange between the lithosphere and hydrosphere.

### References

Kelley D.S. et al. (2001). *Nature* **412**. 145-149.

## S-Fe-Mn biogeochemistry of temperate intertidal sediments of the North Sea

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The isotope biogeochemistry of the sulfur cycle was studied in sandy, silty and muddy tidal sediments of the German Wadden Sea (North Sea). Sampling sites include organic matter (OM), metal (Fe, Mn) contents and permeability, reflecting different hydrodynamic regimes. The study focusses on the seasonal dynamics on biogeochemical reactions in the C - S - Fe - Mn cycles. Main interest was the activity of sulfate-reducing bacteria in relation to the development of stable isotope (S, O) signatures in different sulfur species (e.g., SO<sub>4</sub>, AVS, pyrite, S<sup>0</sup>, organic S) and metal cycling. Special attention has been paid to the influence of temperature (T) and OM load as process-controlling variables in the upper 10 cm of the sediment.

In OM-rich sediments, T controlled the microbial activity, which led to a significant discrimination of S isotopes between the inorganic S fractions and dissolved porewater SO<sub>4</sub>. AVS, SO<sub>4</sub> and S<sup>0</sup> reflect bacterial metabolism and re-oxidation of sulfur compounds, but pyrite compositions are additionally superimposed by transport processes. Due to the typically low OM contents, depth-integrated sulfate reduction rates in the sandy sediments were much lower and controlled by the availability of reactive OM besides T. The observed temporal decoupling of the sulfur isotopic composition of metastable from stable sulfur compounds in sandy sediments indicates that temporal disturbances as anoxic sediment surfaces („black spots“) will not be preserved in the sedimentary record. S cycling is closely coupled to the reduction potential for metal(oxyhydr) oxides.