



## Microbe-metal associations in hydrothermal sulfidic sediments.

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Prokaryote metabolism in metalliferous sediments is enhanced at the limit of oxygen penetration into the sulfidic sediment pile. Sulfidic substrates may provide a significant energy source in the deep sea. These two hypotheses have previously been tested on a site by site basis by coupling microbial measurements to measurements of solid substrate and associated fluids. These studies rarely integrate these disparate approaches because the scale of sampling and the sensitivity of current techniques is only now at the level where interdisciplinary studies are possible.

Sulfidic sediments were collected by submersible from the periphery of the active TAG hydrothermal mound from areas of diffuse fluid flow. Samples were taken above, within and below the active redox front identified from visual inspection of the core (goethite-atacamite-sulfide boundary) and ITRAX analysis. Biomarker, microbiological and trace element partitioning data were carried out to gain new insights into the fate of trace elements and the role of microbes in these settings.

At the top of the core, above the sulfide layer, members of Beta-, Gammaproteobacteria and of the Cytophaga–Flavobacterium–Bacteroides (CFB) were found. CFB are considered to play a key role in the degradation of organic matter. *Marinobacter articus* was found but was more abundant in the sulfide layer than above or below. The layer was dominated by Gammaproteobacteria, mostly *Marinobacter articus*. There was a higher diversity below the layer with members from Delta- and Gammaproteobacteria as well as Actinobacteria. Archaea could only be identified in the sulfide layer, an observation which was supported by biomarker analyses of minor archaea. The n-alkanes showed an even-over-odd predominance. Their presence in the sedi-

mentary organic matter therefore may be of bacterial origin or of diagenetic alterations of fatty acids. Squalene was found in high concentrations and could, together with the even-n-alkane-predominance point to transformation processes under strong reducing conditions.

Elements that are remobilised during redox/pH changes (Cu, Zn, Co, Ag, Se and Pb) showed significant mobilisation at the redox front associated with the alteration of the sulfides. Cu and Fe association with primary and secondary sulfides was quantified through the redox front. As, Se and Mo were primarily (>95%) associated with primary sulfides, whereas Pb and U show significant association with secondary sulfides. Overall, the combined data showed clearly that there are mobilisation processes going on at the redox front which are co-incident with enhanced biomarker content. Sequential leaching of the solid phase allowed insights into the different reaction pathways of redox sensitive elements.