Biogeochemistry of sediments from ferruginous Lake Towuti

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Lake Towuti is a tropical 200m deep tectonic lake, its catchment is mainly composed of ophiolitic rocks and lateritic soils, leading to a high flux of iron oxyhydroxides-oxides into the lake, thereby scavenging most of the bioavailable phosphorus and driving the lake towards oligotrophic conditions. The water column is anoxic below 130m water depth and has high concentrations of dissolved iron, promoting the biological and abiotic formation of authigenic iron minerals in the water column and the sediment. These minerals have the potential to record paleoclimate and diagenesis and provide a unique opportunity to develop better understanding of metabolic diversity and activity of microbial communities in metal-rich subsurface sedimentary environments. From May to July 2015, the International Continental Scientific Drilling Program (ICDP) retrieved sediment cores from three drill sites, including a 114 m long core for geomicrobiological studies (TDP-1A) drilled with a contamination tracer.

We analyzed pore water concentrations of dissolved ions and quantified total microbial abundance. Additionally, authigenic minerals like siderite ($FeCO_3$) and vivianite ($Fe_3[PO_4]_2 \cdot 8H_2O$) were recovered from 50 distinct layers and investigated to infer mineral formation and recording of microbial processes. SEM and TEM imaging of the siderites show that they grow from micritic phases into mosaic monocrystals with increasing burial depth. Green rust and magnetites (Fe_3O_4) are interlaced within siderites, suggesting successive diagenetic phases related to iron reduction. The concomitance of vivianites argues for accumulation of dissolved iron and potentially methane in the anoxic bottom water. We observe contrasting siderite-rich intervals that lack vivianite, which point toward bottom water oxygenation with increased burial of amorphous Fe^{3+}. Our results show that the lake has experienced significant changes in bottom water oxygenation and a complex diagenetic history.