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Characterization of diagenetic siderites formed in recent and ancient ferruginous sediments of Lake Towuti, Indonesia.

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Authigenic minerals in lacustrine settings can be formed in the water column and within the sediment, abiotically and/or triggered by biological activity. Such minerals have been used as paleosalinity and paleoproductivity proxies, reflecting trophic state, and/or early diagenetic conditions. They have also been considered as potential biosignatures of past and present microbial activity.

Here we present a study from Lake Towuti, a deep tectonic basin in Sulawesi, Indonesia. Its geographic position makes it a prime location to record paleoclimatic changes in the tropical Western Pacific warm pool in its sedimentary sequence. The ultramafic rocks and surrounding lateritic soils in the catchment area supply considerable amounts of iron and other metals to the lake. These elements further restrain primary productivity along with the development of specific microbial metabolic pathways involved in early diagenesis. Lake Towuti is stratified with anoxic conditions below 130 m, allowing metal reduction processes to take place in the hypolimnion. The extreme scarcity of sulphate and nitrate/nitrite make Lake Towuti's bottom waters a modern analogue for the Archaean Ocean. It was therefore chosen as a drilling target by the International Continental Drilling Program (ICDP).

In May to July 2015, the Towuti Drilling Project recovered a total >1000 m of sediment core from three drilling sites, including a 114 m long core drilled with a contamination tracer dedicated to geomicrobiological studies. Heavy mineral fractions were extracted from core catcher samples and siderite crystals ($FeCO_3$) were selected from different depths. Characterization of their habitus was achieved via SEM and TEM imaging. Preliminary results show that siderites grow from amorphous into nanocrystalline phases and form twinned aggregates developing into mosaic monocrystals with depth. Gradual filling of vugs and microporosity were observed along with inclusions of magnetite nanocrystals.

Work in progress includes parallel $\delta^{13}C$ measurements on bulk organic matter (OM) surrounding the minerals and on the siderites themselves to trace organic to inorganic carbon transfer associated with microbial respiration of OM and infer possible relationships to methane oxidation processes. Analysis of $\delta^{56}Fe$ compositions will complement this dataset to highlight the role of dissimilatory Fe (III) reduction in siderite formation. We hypothesize that sedimentary siderite is formed by precipitation from pore water due to saturation resulting from microbial OM and iron respiration processes. A similar approach will be applied to vivianite crystals ($Fe_3(PO_4)_3 \cdot 8H_2O$) that were found concomitantly with siderite in sedimentary horizons intercalated with tephra layers.