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Climate induced metal enrichment in sediments of ferruginous Lake Towuti, Indonesia

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Lake Towuti (2.75^o S, 121.5^o E; 560 km^2, 205 m WD) is a tectonic, ferruginous, and hyposulfidic lake in central Sulawesi, Indonesia. The region's tropical climate causes intense chemical weathering and fast denudation of the ultramafic bedrock surrounding the lake supplying metal rich lateritic weathering products to the lake. Lake Towuti is thermally stratified, with anoxic conditions below ∼140m water depth, that promote reductive dissolution of metal oxides in its bottom waters and surface sediments. The upper 90m of the water column mix during the dry season due to evaporative cooling of the surface waters.

We infer that the burial efficiency of redox sensitive metals is closely linked and sensitive to the climatically controlled mixing state of Lake Towuti. Indeed, results from our piston cores covering the past 30 kyr document that the concentration of individual redox-sensitive metals in Towuti's sediments is higher during the dry MIS 2 compared to the wetter Holocene, likely as a result of better preservation of metal oxides in a well-oxygenated water column and surface sediment. Highest enrichment factors for redox-sensitive metals are, however, associated with a ∼1cm thick oxide layer occurring at the transition from the wet, early- to the drier, mid-Holocene around 8.5 kyr BP. Enrichment of metal oxides in this layer can not entirely be explained by better preservation alone. CT and SEM analysis on the respective layer reveal the abundance of amorphous Fe/Mn- oxide nodules, indicative for diagenetic formation of these phases in pore spaces. We interpret this oxide layer as a buried redox front that formed close to or at the sediment water interface during a phase characterized by a well-ventilated water column and relatively constant and low sedimentation rate. Based on the position of the oxide layer just ∼10 cm above a turbidite deposit we infer that the time required for the formation of the oxide layer is in the order of less than ∼300 years. Preservation of the oxide layer is likely a result of a rapid change in sedimentation rate and/or mixing state of the lake.