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BioMetArchive - Subsurface biosphere metagenomics along the 1 Ma sedimentary archive of ferruginous Lake Towuti, Indonesia.

FATIMA RUIZ-BLAS[1], JENS KALLMEYER[1], CYNTHIA HENNY[2], JAMES M RUSSELL[3] AND AURELE VUILLEMIN[1]

[1]GFZ German Research Centre for Geosciences
[2]National Research and Innovation Agency
[3]Brown University

Presenting Author: fatima.ruizbl@gmail.com

Lake Towuti, Sulawesi, Indonesia is a stratified ferruginous system whose deep basin experienced dynamic redox conditions, resulting in variable iron oxide and organic matter inflows over geologic time. As wet and dry periods alternated during the Late Quaternary, sediment accumulated, archiving paleoenvironmental conditions while feeding microbial life with ferric and organic substrates. However, changing geochemical conditions during sediment burial select for specific groups of microorganisms that remain metabolically active long after their entombment, altering the primary genomic record.

In 2015, the ICDP Towuti Drilling Project retrieved a stratigraphic archive spanning the last 1 Ma of climatic and depositional history. Drilling involved the use of a contamination tracer to ensure that samples were not contaminated by foreign microorganisms via the drilling fluid. Sediments were sampled on site in an anaerobic chamber providing aseptic conditions and protective atmosphere. Our prime objective is now to determine how sedimentological and geochemical conditions select for specific microbial assemblages at the time of deposition and trace them through the 1 Ma stratigraphic sequence. Our hypotheses are the following: Microbial compositions initially arise from past lacustrine conditions and deposited substrates, which are partially recorded in sedimentary DNA; the changing geochemical conditions during burial select for specific metabolic features that shape the subsurface biosphere in deep sediments of Lake Towuti.

Extractable sedimentary DNA will be used to characterize microbial populations in terms of abundance, diversity and metabolic functions. We will establish the phylogenetic distribution of microorganisms and integrate genomic data with already existing environmental and geochemical datasets to identify parameters that control microbial community composition over time. Through metagenomics we will identify which microbial taxa and metabolic features are involved in the major biogeochemical cycles and organic matter remineralization throughout the sediment sequence. Finally, we will reconstruct the corresponding metabolic pathways that can drive efficient redox cycling and organic matter remineralization in ferruginous sediments. The sediment's ferruginous conditions predominantly select for fermentative Bathyarchaeia. Metabolic features assigned to this phylum relate to sulfur transformation, acetogenesis and methanogenesis, suggesting that the cryptic biogeochemical cycles that they drive may represent modern analogs to early life's metabolic processes in ancient ferruginous systems.