Goldschmidt 2021 Abstract
https://doi.org/10.7185/gold2021.5916

Co-evolution of ocean redox, nutrient cycling and atmospheric O_2 during the mid-Mesoproterozoic

YAFANG SONG[1], FRED T BOWYER[2], BENJAMIN J. W. MILLS[1], SHUICHANG ZHANG[3], DON CANFIELD[4], LEWIS J ALCOTT[5], GRAHAM A SHIELDS[6] AND SIMON W. POULTON[1]

[1]School of Earth and Environment, University of Leeds
[2]University of Edinburgh
[3]Research Institute of Petroleum Exploration & Development, China National Petroleum Corporation
[4]Institute of Biology and Nordcee, University of Southern Denmark
[5]Yale University
[6]University College London

Presenting Author: eeyso@leeds.ac.uk

The Mesoproterozoic Era (1.6 – 1.0 billion years ago, Ga) has long been considered an interval of stasis, both in terms of environmental oxygen levels and rates of macroevolution. However, emerging geochemical evidence suggests that the palaeoredox state of the Mesoproterozoic ocean was more dynamic than previously recognized. Palaeoredox conditions exert a dominant control on nutrient recycling in the global ocean, with important implications for feedbacks on marine primary productivity and oxygenation. Despite recent efforts, the influence of Mesoproterozoic oceanic palaeoredox state on nutrient availability (in particular phosphorus), remains poorly constrained. Here, we present a new high resolution multiproxy geochemical dataset from continuous drill core of the 1.4 Ga Xiamaling Formation, deposited on the North China Craton.

The combination of iron speciation and redox-sensitive trace element data indicate a gradual transition from oxygenated bottom waters to dominantly ferruginous conditions in the middle part of the succession, followed by the development of euxinia. The uppermost Xiamaling Fm records a return to oxic conditions, mixed with ferruginous intervals. We enhance this palaeoredox record by considering the dynamics of bioavailable P through application of P speciation. These data indicate that P was efficiently trapped in sediments in association with Fe (oxyhydr)oxide minerals under oxic conditions, which limited P recycling and thus limited the extent of oxygen minimum zone conditions. A similar mechanism for P retention is invoked for the subsequent ferruginous conditions. By contrast, euxinic conditions were accompanied by moderate bioavailable P regeneration from sediments. This promoted a limited positive feedback on productivity, which led to the gradual oxygenation recorded in the upper Xiamaling Fm. Lastly, we present a biogeochemical model, ground-truthed with these new data, to explore possible variations in nutrient availability and atmospheric oxygen concentrations at 1.4 Ga.