Geophysical Research Abstracts
Vol. 20, EGU2018-18484, 2018
EGU General Assembly 2018

Free oxygen and microbial activity in Mesoarchean oceans: a sequence stratigraphic case study of the iron-rich units of the Witwatersrand-Pongola basin of southern Africa

Albertus Smith (1,2) and Nicolas Beukes (1,2)

(1) DST-NRF Centre of Excellence for Integrated Mineral and Energy Resource Analysis, Department of Geology, University of Johannesburg, Auckland Park, 2006, South Africa, (2) Paleoproterozoic Mineralization Research Group, Department of Geology, University of Johannesburg, Auckland Park, 2006, South Africa

The approximately 2.98 to 2.91 Ga lower Witwatersrand and upper Pongola Supergroups of southern Africa show a strong litho- and sequence stratigraphic correlation, indicating these sequences were deposited in different parts of the same basin. A major part of this correlation include Fe-rich units, which include some of the oldest Superior-type iron formations (IFs) and Fe-rich mudstones. Correlation of these units indicate that some IFs were deposited across the entire basin, marking major transgressions, whereas other iron formations were limited in their depositional extent. Many of these Fe-rich units show a variety of characteristics that strongly suggest low concentrations of free oxygen played a role in their deposition approximately 500 Ma prior to the Great Oxidation Event (ca. 2.4-2.3 Ga). The lines of evidence include: Mo isotope systematics; lateral depositional facies variations in Fe and Mn contents; small-scale erosional unconformities marked by Mn-enrichment capping iron formations; a lack of sedimentological evidence that Fe oxidation occurred in the photic zone in micritic IFs; distinct Fe isotope sources for shallower granular IFs and deeper water micritic IFs; and Mn-rich carbonate concretions depleted in heavy C in Fe-rich mudstones. The petrographic and geochemical characteristics also show direct and indirect evidence that microbial activity likely caused the oxidation and precipitation of Fe and Mn in these units, with all Fe- and Mn-rich carbonates sourced from organic carbon and microstromatolites occurring in granular IFs. The Fe- and Mn-oxidizing bacteria that most likely mediated these processes would have required low concentrations of free oxygen.