Iron-rich conditions and molybdenum enrichment in a Mesoproterozoic shelf setting: A snapshot from the Vindhyan Basin, India

S.K. SAHOO[1,*], G. J. GILLEAUDEAU[2], J.D. OWENS[3], S.W. POULTON[4], T.W. LYONS[5]

[1,*]Dept. of Geoscience, UNLV; geosks@gmail.com; (*presenting author)
[2]SESE, Arizona State University; ggillea1@gmail.com
[3]EOAS, Florida State University; jdowens@fsu.edu
[4]SEE, University of Leeds; s.poulton@leeds.ac.uk
[5]Earth Sci., Univ. of California, Riverside; timothyl@ucr.edu

Fundamental questions persist regarding the redox structure and trace metal content of the Mesoproterozoic oceans. Multiple lines of evidence suggest expanded anoxia in the deep oceans compared to today, and iron speciation indicates that anoxia was largely accompanied by dissolved ferrous iron (*i.e.*, ferruginous conditions). Still, exceptions exist—euxinic conditions have been reported from some ocean margin and epeiric sea environments, and oxic conditions were even reported in one deep basinal environment. Previous geochemical data suggest that the concentrations of redox-sensitive trace metals such as Mo were low, which could limit marine diazotrophy and place important evolutionary constraints on early eukaryotes.

Here, we present new geochemical data from the ~1.2 Ga Bijaygarh shale (Kaimur Group, Vindhyan Basin, India). This unit was deposited in an intracratonic setting near storm wave base, with open ocean connection to the northwest. Iron speciation indicates the dominance of ferruginous conditions throughout the section. Molybdenum and vanadium (V) concentrations are mildly enriched above average oxic shale, which is consistent with ferruginous deposition. By contrast, chromium (Cr) concentrations are not enriched above crustal values. Moderately positive pyrite $\delta^{34}S$ values are indicative of local sulfate limitation, and $\delta^{15}N$ values > 0 ‰ are consistent with N-fixation by Mo-nitrogenase. Together, these data depict geochemical conditions that may have been common in the Mesoproterozoic oceans—ferruginous conditions below the zone of wave mixing, muted enrichment of metals sensitive to anoxia (such as Cr), variable enrichment of metals sensitive to euxinia (such as Mo and V), and general sulfate limitation. Conditions such as this represent an important end member among the potential redox states of Mesoproterozoic seawater.