Geochemical evidence for ferruginous marine conditions following the Paleoproterozoic demise of iron formation deposition

C. LI[1]*, N.J. PLANAVSKY[2], G.D. LOVE[3], T.W. LYONS[3], C.T. REINHARD[4], L. FENG[5], J. HUANG[6], Q. ZHANG[5] AND X. CHU[5]

[1]BGEG, China University of Geosciences, Wuhan 430074, China. (*correspondence: chaoli@cug.edu.cn)
[2]Yale University, New Haven, CT 06520, USA
[3]University of California, Riverside, CA 92521, USA
[4]California Institute of Technology, Pasadena, CA 91106, USA
[5]IGG, Chinese Academy of Sciences, Beijing 100029, China
[6]University of Science and Technology of China, Hefei 230026, China

In order to improve our understanding of ocean chemistry and biogeochemical cycling following the termination of Paleoproterozoic iron formation deposition (~1.85 Ga), we conducted a Fe-S-C-Mo geochemical study of the ~1.65 Ga Chuanlinggou Formation, Yanshan Basin, North China. Our results suggest that dominantly ferruginous conditions prevailed below the surface mixed layer with no evidence for discernible episodes of intermediate euxinic waters in the continental rifting Yanshan Basin, apparently independent of the local organic carbon content or the extent of basin connectivity with the open ocean. However, coupled carbonate associated sulfate (CAS) and pyrite S isotope systematics suggest significant diagenetic sulfate reduction. This relationship implies that the lack of euxinic conditions observed were linked to insufficient rates of water column sulfate reduction rather than complete sulfate limitation. Importantly, these data provide an excellent framework for assessing the controls on local euxinia in terms of rates of sulfide production, as controlled by local organic C and sulfate availability, and in the face of the buffering capacity of a broadly ferruginous deep ocean. Lastly, despite evidence for mudstone deposition under anoxic conditions, the observed sedimentary Mo enrichments are not significantly higher than crustal Mo levels (0-6 ppm ppm/wt.% for average Mo/TOC, with most values <1 ppm/wt%), consistent with the notion of low Mo mass accumulation rates in anoxic waters where Fe(II) is in excess of sulfide. Our findings thus support an emerging picture for the mid-Proterozoic ocean chemistry with deep waters that were dominated by ferruginous conditions.