Fe isotope and REE signatures through a Mesoarchean carbonate platform: new data from the 2.94 Ga Red Lake Greenstone Belt (Canada)

L.A. PATRY[1]*, P. FRALICK[2], P. SANSJOFRE[3], M. HOMANN[4], C. THOMAZO[5], M. AFROZ[1], AND S.V. LALONDE[1]

[1] CNRS-UMR6538 Géosciences Océan, IUEM, 29280 Plouzané, France (*correspondence: lpatry@univ-brest.fr)
[2] Department of Geology, Lakehead University, Thunder Bay, ON, P7B 5E1, Canada
[3] Muséum National d'Histoire Naturelle, 75005 Paris, France
[4] Department of Earth Sciences, University College London, WC1E 6BS London, UK
[5] UMR CNRS/uB6282 Biogéosciences, Université de Bourgogne Franche-Comté, 21000 Dijon, France

Here we report a stratigraphic study of the iron isotope and rare earth element (REE) composition of shallow marine stromatolitic carbonates and deep-water facies (iron formation (IF) and black shales) of the ~2.94 billion-year-old metasedimentary Ball Assemblage, Red Lake Greenstone belt, Superior Craton, Western Ontario, Canada [1, 2]. This deposit is particularly unique as it represents the first significant accumulation (>200 m) of sedimentary carbonate on Earth. Over 200 samples representing multiple facies over 400 m of drill core (core NGI10-031) were analyzed for trace element and Fe stable isotope compositions using high resolution and multi-collector ICP-MS. REE systematics of chemical sedimentary facies (IF and carbonates) reveal clear seawater signatures, with upwelling of hydrothermally-influenced deep waters onto the shelf indicated by pronounced Eu anomalies. No true negative Ce anomalies are present, suggesting very low or non-existent free oxygen in the water column. However, Fe isotopes reveal active iron redox cycling, with δ^{56}Fe values ranging from -2.88 ‰ to 1.50‰ through the drill core. This large range may be explained by plume depletion of Fe via iron oxide precipitation, generating low δ^{56}Fe values in the residual Fe(II) pool. Important secular δ^{56}Fe variations observed in the carbonate package can't be explained by a Rayleigh distillation model nor by abiotic pyrite formation but are linked instead to bulk rock sulfur concentrations. It would appear that an external driver linked the Fe and S cycles and controlled $\delta^{56}Fe(II)_{aq}$ values on the platform, which we suggest may be tied to photosynthetic primary production.

[1] Corfu & Wallace (1986) *Can. J. Earth Sci.* 23, 27-42. [2] McIntyre & Fralick (2017) *Depos. Rec.* 3(2): 258–287.