Transient ocean oxygenation at 850Ma recorded in δ^{98}Mo of microbial carbonates

E.M. O'SULLIVAN*[1], T.F. NÄGLER[1], M. WILLE[1], B.S. KAMBER[2] AND E.C. TURNER[3]

[1]University of Bern (*correspondence: edel.osullivan@geo.unibe.ch)
[2]Queensland University of Technology
[3]Laurentian University

The link between the Neoproterozoic Oxygenation Event (NOE, ca. 850-550Ma) and the emergence and diversification of complex metazoans is highly debated. Competing evidence from geochemical and palaeobiological data as well as estimates of the minimum oxygen requirements of early animals puts into question whether oxygen availability was truly a limiting factor for the emergence of life. Reconstruction of the environmental conditions at the beginning of the NOE (850-700Ma) is vital to elucidating this relationship. Here we use Mo isotopes and YREEs of key sedimentary archives to evaluate the changing redox conditions of the ocean at ca. 850Ma.

We analysed the major and trace element, and Mo isotopic compositions of shallow water microbial carbonates and deep water shales from the ~850Ma Little Dal Group to provide an estimate for the ocean water δ^{98}Mo at this time. Previous studies of Precambrian black shales and carbonates have indicated that the δ^{98}Mo of Proterozoic ocean water remained stable at ~1.2‰ between 1700 and 600Ma, consistent with relatively oxygen-depleted waters, increasing only towards modern values of 2.3‰ at around 600Ma associated with the expansion of oxic water masses.

Our microbial carbonates indicate a maximum δ^{98}Mo estimate of 1.63‰ for open ocean water at ~850Ma. This value is up to 0.4‰ heavier than other estimates for Neoproterozoic seawater before the onset of "Snowball Earth" glaciations. These heavier values might indicate that a short-term increase in oxygen occurred at this time. As the Little Dal Group was deposited in an intracontinental basin in the interior of Rodinina during the initial stages of breakup, the increase in oxygen is interpreted to reflect a bloom in primary productivity associated with increased nutrient delivery to the ocean at this time. Our results add new constraints on the timing and temporal extent of the NOE, and may help identify possible triggers and feedbacks associated with the emergence and diversification of complex metazoans.