Mo isotope analysis of the 2.7 Ga Roy Hill Shale – more evidence for Archean oxygen?

CHADLIN M. OSTRANDER[1*], MOUTUSI ROY[1], GWYNETH W. GORDON[1], STEPHEN J. ROMANIELLO[1], ARIEL D. ANBAR[1,2]

[1]School of Earth & Space Exploration, Arizona State University, Tempe, AZ, 85281
(*correspondence: *cmostran@asu.edu)*
[2]School of Molecular Sciences, Arizona State University, Tempe, AZ, 85281

Substantial evidence exists for mild atmospheric and oceanic oxygenation prior to the Great Oxidation Event (GOE, ~2.2 – 2.4Ga). The spatial and temporal evolution of oxygen before ~2.5Ga, however, remains less well constrained. Understanding the timing and tempo of Archean Earth oxidation could provide important insight into the drivers for Earth's redox revolution.

Molybdenum (Mo) is often employed as a paleoredox proxy for both atmospheric and oceanic oxygen, due to its mobilization by oxidative weathering and subsequent preferential burial in anoxic and euxinic marine sediments. The Mo isotope composition of seawater is dependent upon relative removal by oxic, anoxic and suboxic sinks and their preference to incorporate the lighter isotopes from overlying waters.

Here we have conducted Mo isotope analyses of the ~2.6 – 2.7 Ga organic-rich Roy Hill Shale from the Pilbara Craton of Western Australia in two Agouron Institute Drilling Project (AIDP) cores. Our data show the Mo isotope composition of sediments deposited under a euxinic water column in both near- and off-shore environments are heavier than crustal values.

Isotopically heavy Mo isotope compositions in euxinic sediments, and thus overlying seawater, are indicative of light isotope removal by oxic, anoxic, and suboxic sinks. Earlier studies of the nearby and slightly younger ~2.5 Ga Mt. McRae Shale also resulted in heavy values, with isotope compositions slightly heavier than this investigation. Like that study, our results are consistent with oxidative weathering of Mo and subsequent adsorption to oxide mineral surfaces, but ~200 million years earlier.