Developing Rhenium Isotopes as a Paleoredox Proxy

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Rhenium (Re) concentrations have been used as a paleoredox proxy to track *local* suboxic and anoxic marine redox conditions. However, Re isotopes have the potential to also identify *global* changes in marine redox. This application is possible because (i) the residence time of Re in the oceans is longer than the oceanic mixing time, and (ii) there is incomplete Re removal to suboxic sediments, facilitating potential isotope fractionations which reflect global redox. Because Re geochemistry is sensitive to suboxic, Fe-reducing conditions, Re isotopes are likely well-suited to trace oxygenation relevant for the evolution of early aerobic life.

To test the hypothesis that Re fractionates during episodes of transient oxygenation, we present the first Re isotope data from the Mt. McRae Shale drill core collected in Western Australia. Prior work on these ~2.5 Ga black shales provided the widely-cited evidence for a transient “whiff” of atmospheric O_2 at least 100 Myr prior to the Great Oxidation Event, including a large transient increase in the Re concentrations of these shales.

We measured the Re isotopic composition (presented as δ^{187}Re) of samples before, during, and after the “whiff” of O_2. The new Re isotope data indicate that there is a shift in the δ^{187}Re composition of sediments to lighter values, coincident with the increased Re concenrtations and total organic carbon concentrations during the “whiff” interval. Our work demonstrats that there was active geochemical cycling of Re in Archean seawater which resulted in measurable Re isotope variation—this could be consistent with other proxies that indicate weakly oxygenated seawater conditions were already common in the Archean surface ocean. These results demonstrate that incorporation of Re into sediments fractionates Re isotopes from seawater. As a result, global changes in Re burial can be detected by measuing Re isotopes in ancient marine sediments. Ongoing work at ASU is focused on developing the potential of the Re isotope paleoredox proxy.