Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.31088

Rhenium isotopes as a novel tracer of oxidative weathering and carbon cycle feedbacks in geological time

MADELEINE STOW[1], ALEXANDER J. DICKSON[2], MATHIEU DELLINGER[3], VICTORIA ALCOCK[1], WENHAO WANG[4], JULIE PRYTULAK[5] AND **ROBERT HILTON**[1]

[1]University of Oxford
[2]Royal Holloway University of London
[3]CNRS - Université Savoie Mont Blanc
[4]University of Vienna
[5]The University of British Columbia

The release of CO_2 from the oxidative weathering of rock-derived organic carbon (OC_{petro}) is now recognised as a major flux in the geological carbon cycle. However, it is difficult to quantify how this flux has changed through Earth's history, making it difficult to assess carbon cycle-climate feedbacks. Due to the close association between the trace element rhenium (Re) and OC_{petro}, Re isotopes (^{185}Re and ^{187}Re, reported in delta notation, δ^{187}Re) are a promising system to provide a novel tool to quantify oxidative weathering. In modern weathering environments, δ^{187}Re values decrease in weathered residues as Re and OC_{petro} are lost, possibly due to the preferential oxidation of isotopically heavy Re bearing phase(s). This releases Re with higher δ^{187}Re values to the dissolved load of rivers. Rivers are the main source of Re to the oceans, and therefore if past changes in oxidative weathering intensity and flux alter global river δ^{187}Re values, any seawater shift in Re isotopic composition may be recorded in the authigenic component of marine sediments.

To explore the magnitude of Re isotope shifts in seawater associated with changing oxidative weathering intensity on land, we use an isotope mass balance model parameterised by measured and estimated fluxes and fractionation factors. We find that increases in oxidative weathering rate can drive resolvable variation in seawater δ^{187}Re. We then investigate the sedimentary record using shales from the Llanbedr (Mochras Farm) borehole, Wales. These samples were reanalysed recently as part of the Jurassic Earth System and Timescale (JET) project, and record continuous deposition in an unrestricted, open marine setting. We focus on samples spanning the Toarcian Oceanic Anoxic Event (T-OAE). During this period, there is evidence for carbon cycle perturbations, an increased hydrological cycle and increased silicate weathering. Our new Re isotope data show shifts that are only possible with increased OC_{petro} oxidation during this period: a positive feedback in response to warming. This response is not considered in current biogeochemical models of the geological carbon cycle, and the Re isotope proxy provides a promising tool to build new datasets to uncover how this feedback responds over geological time.