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Calibrating Enhanced Rock Weathering with Os, Nd, and Si Isotopes

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Enhanced rock weathering (ERW), a negative emission technology, works to emulate and accelerate the negative feedback of the carbonate-silicate cycle. ERW involves deploying finely milled silicate rock feedstock conducive to rapid weathering, such as basalt, to select application areas. This feedstock chemically weathers and consumes atmospheric CO_2, which produces carbonate alkalinity and various dissolution products [1]. Secondary mineral formation from dissolution products may impact the efficiency of CO_2 sequestration through ERW. However, quantification of ERW feedstock dissolution and secondary mineral formation rates in comparison to natural and anthropogenic carbon emission sources remains an elusive topic in current ERW research [2]. Separating the rate of terrestrial ERW and background rock weathering requires a method of quantifying feedstock dissolution and secondary mineral formation rates. Osmium and neodymium have distinct isotopic compositions in the basaltic feedstock relative to the continental crust and therefore could be used as novel tracers to differentiate between ERW and natural rock weathering, potentially strengthening measurement, reporting, and verification (MRV) processes. We aim to employ a coupled osmium-neodymium-silicon isotope tracer method to quantify the rate of ERW and the degree of secondary mineral formation. We performed two sets of batch reactor dissolution experiments, where one set implemented an enriched $^{29}SiO_2$ tracer that tracked time-series changes in solution pH, total alkalinity, dissolved components, and select isotope ratios of Os, Nd, and Si with time. The change in dissolved silica with time reflects dissolution and secondary mineral precipitation. Combining the change in silica concentration with changes in silicon isotope ratios can quantify unidirectional dissolution and precipitation rates. Our experiments will provide a basis on the feasibility of utilizing osmium and neodymium as tracers of basalt feedstock ERW in agricultural settings. Based on the results of our experiments, we will develop a novel geochemical model that will strive to calibrate and quantify net atmospheric CO_2 capture.

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