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Using rhenium and δ^{187}Re to trace the fate of rock organic carbon in the Critical Zone

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The rock organic carbon (OC_{petro}) reservoir is vast and contributes to the evolution of Earth's atmospheric O_2 and CO_2 concentrations over geological timescales[1]. There is an estimated 1100 Pg C stored as OC_{petro} in the upper 1 m of sedimentary rocks at the earth surface[2]. It has been shown that in rapidly eroding environments, chemical weathering OC_{petro} can rapidly release CO_2 to the atmosphere[3], yet OC_{petro} oxidation rates are poorly constrained in settings with moderate to low erosion rates. Rhenium (Re) has emerged as a promising tracer, but we require improved constraint on Re mobility during OC_{petro} weathering.

Here we assess the fate of Re during OC_{petro} weathering in 6 well studied black shale weathering profiles [1], providing additional constraints from the rhenium isotope composition (δ^{187}Re). We find that un-weathered (unaltered) samples range in [Re] from 31 to 670 ng/g. Weathered samples have lost between 59 and 99% of Re, and 45 to 95 % of OC_{petro}: confirmation of coupled Re and OC_{petro} oxidation. In un-weathered late Devonian aged samples, δ^{187}Re is similar to Miller et al. 2015 [4] with values from -0.2 to -0.3 ‰. Miocene and Eocene aged black shales range from -0.08 to +0.03 ‰. Weathered samples display either heavier or lighter δ^{187}Re values compared to unweathered bedrock, depending on the soil profile. We discuss the mechanisms behind the observed Re isotope fractionation and examine the implications for using Re isotopes to trace OC_{petro}oxidation.

[1] Petsch (2014) Weathering of Organic Carbon.[2] Copard, Amiotte-Suchet & Di-Giovanni (2007), *EPSL* 258, 345-357. [3] Hemingway *et al*. (2018), *Science* 360, 209-212.[4] Miller et al. (2015), *EPSL* 430**,** 339-348.