

The impact of weathering on $^{238}\text{U}/^{235}\text{U}$ systematics in the critical zone

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The weathering of continental rocks plays a vital role in providing riverine influxes of elements to the oceans and partially controls marine geochemical budgets. The dissolved riverine pool of a range of metal isotope systems (e.g. Mo, Ni, Cu) have shown a mean flux that is different from the isotope composition of the continental rocks [e.g. 1]. Understanding the physico-chemical processes leading to isotope fractionation during weathering and transport is therefore key for understanding and constraining the marine geochemical isotope cycling, both past and present. The $^{238}\text{U}/^{235}\text{U}$ ratio shows variable composition in the dissolved U of modern rivers, although a discharge-weighted mean U flux of these is close to the mean composition of the continental crust [2]. The $^{238}\text{U}/^{235}\text{U}$ variability in different rivers, however, warrants the need to understand the impact of physico-chemical processes in the critical zone.

Here, we have focussed on a Scottish soil chronosequence (Glen Feshie) formed during the last 13 ka from a granitoid substrate. Previous isotope work from this locality [1,3] includes U-series data which has constrained time-scales of weathering and the ability to differentiate competing processes of U leaching and adsorption in the soils [3]. Deeper B- and C-horizon soil samples, showing evidence of U loss from leaching in the U-series systematics, display no resolvable $^{238}\text{U}/^{235}\text{U}$ variation (within ± 0.05 permil) compared to the bedrock substrate (within ± 0.05 permil). Measured Glen Feshie water also shows a similar $^{238}\text{U}/^{235}\text{U}$ composition [2]. In contrast, organic-rich top H-horizon soil, showing evidence of U uptake from the U-series systematics, expresses $^{238}\text{U}/^{235}\text{U}$ that is fractionated towards lighter compositions (~ 0.2 permil), consistent with isotope fractionation during U^{6+} adsorption from percolating waters.

The Glen Feshie soil data provides first order constraints on limited $^{238}\text{U}/^{235}\text{U}$ fractionation during U release from weathering in modern well-oxygenated environments. However, significant $^{238}\text{U}/^{235}\text{U}$ variability from U adsorption processes and redox changes in the critical zone and during transport, may play an important role in the $^{238}\text{U}/^{235}\text{U}$ composition of river waters.

[1] Vance *et al.* (2016) *Chem. Geol.* 445, 36-53.

[2] Andersen *et al.* (2016) *Chem. Geol.* 420, 11-22.

[3] Andersen *et al.* (2013) *Chem. Geol.* 354, 22-32.