Exploring seasonal and lithological controls on lithium isotopes during weathering

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Chemical weathering is a key process that controls Earth's geochemical cycles and global climate, yet at present the climate-weathering feedback is poorly understood. Since lithium (Li) isotopes are sensitive to silicate weathering processes [1], records of past seawater compositions contain valuable evidence on past weathering regimes [2]. However, the interpretation of such records is hindered by uncertainty in the influence of lithology on Li isotopes during fluid-rock interaction. In addition, the potential for seasonal variability in natural systems [3] needs to be considered, and may provide new insight into weathering processes and timescales.

To address the effect of lithology, batch reactor experiments were conducted to replicate natural weathering of shale and granite rocks. In both cases, at timescales of hours to weeks, Li isotopes and concentrations of the weathering fluids indicate that Li release from primary mineral dissolution dominates over removal by secondary mineral formation. Interestingly, these results contrast with previous low-temperature experiments on basaltic river sands, in which net removal and fractionation of Li was attributed to secondary clay formation. The new results indicate that Li isotope behaviour is sensitive to the lithology and/or prior weathering of a sample, which will be further explored with data on the release and removal of other major/trace elements.

For natural systems, cave drip-waters provide an ideal opportunity for time series monitoring of Li isotopes in soil porewaters (i.e. weathering fluids) over short timescales. To this end, Li isotopes were analysed on a series of drip-waters collected in Ease Gill and White Scar caves, Yorkshire Dales, U.K. Those data reveal temporal variations in δ^7Li of 4 to 8 permil, hinting at rapid changes in weathering processes on monthly to seasonal timescales. Comparison to records of temperature and precipitation, drip-water chemistry, and cave monitoring results will enable the local controls on weathering to be explored and will provide key ground-truthing for interpreting records of past changes.

[1] Pogge von Strandmann *et al.* (2017) *GCA* **198**, 17-31. [2] Misra & Froelich (2012) *Science* **335**, 818-823. [3] Liu *et al.* (2015) *EPSL* **409**, 212–224.