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Lithium isotope response to plant-mediated weathering: evidence from Icelandic soil chronosequences and implications for paleo-records

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Vascular plants are expected to significantly influence chemical weathering and soil formation processes, but how exactly plants and their ecosystems have affected silicate weathering in soils over geological history is poorly constrained. Lithium (Li) isotopes are increasingly being used to quantify both modern and past silicate weathering processes, thereby providing valuable constraints on the operation of Earth's carbon cycle, and potentially insights into the role played by plants.

Here, we measured sequentially-leached fractions from soil chronosequences in Iceland spanning 25–63 years following afforestation. The Li isotope compositions in the exchangeable, carbonate, oxide, and clay fractions of the afforested soils were ~10‰ higher than in those of the heathland soils, and such differences can be attributed to both the input of heavy Li isotopes from litterfall decomposition and the effect of afforestation-mediated secondary mineral formation. The former mechanism is supported by our measurements of intra-plant variability in Li isotopes, but the latter mechanism is likely to be most important when considering mass balance constraints.

Overall, we find that silicate weathering processes traced by Li isotopes can respond significantly and rapidly to forest establishment, with the main response occurring within less than 25 years. These findings have implications for both paleoenvironmental reconstructions and the evolution of the critical zone, and I will explore examples of their application to palaeo-records we have generated from intervals of Earth's Phanerozoic history, including the Pleistocene and the Devonian periods.