

Quantifying the weathering fluxes of Mg from its isotopes in the Critical Zone at Sierra Nevada, California

DAVID UHLIG^{1*}, JAN A. SCHUESSLER¹,
JULIEN BOUCHEZ^{1,2}, FRIEDHELM VON BLANCKENBURG¹
AND JEAN L. DIXON^{1,3}

¹GFZ German Research Center for Geosciences, Potsdam, Germany, Earth Surface Geochemistry, (*correspondence: david.uhlig@gfz-potsdam.de)

²IPG Paris, CNRS, France

³Department of Earth Sciences, Montana State University

Rock weathering releases elements to the multiple compartments of the Critical Zone. These weathering processes and fluxes can be inferred using stable metal isotopes. We apply Mg isotopes in a small forested watershed on granodiorite bedrock in the southern Sierra Nevada, California (Southern Sierra Critical Zone Observatory), to identify the pathways of Mg and to quantitatively assess the relative contributions of physical erosion and chemical weathering directly from Mg isotope data.

Dissolved Mg in soil water, stream water and the exchangeable fraction from soil and saprolite is isotopically lighter than the source rock, showing a dominant control by uptake of heavy Mg into plants. Time series of stream water samples indicate a seasonal control on dissolved stream water Mg isotope compositions. Solid weathering products (soil, saprolite, bedload and suspended load) are isotopically identical to bedrock, suggesting that isotope fractionation during chemical weathering of bedrock and formation of clay minerals do not dominate the isotopic mass balance.

Using an isotope mass balance model [1], we estimate the ratio of Mg physical erosion to Mg dissolved export at this field site solely from Mg isotope ratios of stream water and bedload. Particulate export from the weathering zone accounts for up to 95% of Mg loss from regolith. These isotopically derived estimates are consistent with weathering fluxes derived from measurements of stream water Mg concentrations and discharge and also from ¹⁰Be-derived chemical weathering rates [2]. Our findings indicate a kinetically-limited weathering regime operating at steady state.

[1] Bouchez, J., von Blanckenburg, F., Schuessler, J.A. (2013) Modeling novel stable isotope ratios in the weathering zone, *American Journal of Science*, **313**, 267-308 [2] Dixon, J. L., Heimsath, A. M., Amundson, R. (2009) The critical role of climate and saprolite weathering in landscape evolution, *E.S.P.L.*, **34**, 1507-1521