

## **Kinetics in the critical zone : insights from Mg & Sr isotopes in landslides**

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The critical zone is characterized by a wide range of characteristic time, from s to Myr. When the water/rock interaction is considered, the kinetic of the chemical reaction can be slow enough to become the driver of the geochemical imprint of the water (rather than the hydrological residence time). This led the idea that the changes in isotopic ratios in terrestrial surface waters should correspond to changes in the overall dissolution. When chemical elements or isotopic signatures are characteristic to one lithology, namely silicate, this implies that the silicate mineral phases that act as sources of a given isotope dissolve at a rate that is proportional to the overall silicate weathering. However, bedrock landsliding exhumes large quantities of fresh rock that get weathered in transient storage (the bottom of the landslide's scar), and rapid weathering in these deposits is controlled primarily by dissolution of the most reactive phases. In this study, we test the hypothesis that preferential weathering of labile minerals can decouple the dissolution of strontium and magnesium sources from the actual silicate weathering rates in the rapidly eroding Western Southern Alps (WSA) of New Zealand. We find that rapid dissolution of calcite enriched in radiogenic strontium during regional metamorphism and biotite (minerals always characterised by elevated  $^{87}\text{Sr}/^{86}\text{Sr}$ ) in landslides leads to high local fluxes in strontium with isotopic ratios that offer no clear discrimination between sources. These higher fluxes of radiogenic strontium are in contrast to silicate weathering rates in landslides that are not systematically elevated. On the contrary, the magnesium isotopes are barely affected by the preferential weathering of these 2 labile minerals. This could be related that biotite hosts the majority of the magnesium in the Alpine Schist and its dissolution buffer the isotopic signature. However the values are different from the signature of pure biotite. Magnesium isotopic variation is generally characteristic of the isotopic fractionation associated to the precipitation of secondary minerals (clays and/or oxides) rather than to the dissolution of primary minerals. And in that case, the residence time of the water is long enough to be affected by secondary mineral precipitation, including in landslides deposits that are few years old, suggesting that clay formation can start within months rather than years. Therefore, in settings where bedrock landsliding is a dominant erosive process (i.e. active mountain belts) there is potential for both random and systematic bias in isotope proxies since the most reactive phases exposed for dissolution by landslides disproportionately contribute to the proxy of choice. This could lead to errors in linking periods of rapid mountain uplift and erosion to any resultant silicate weathering in the Cenozoic using isotopic proxies.