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Using radiogenic and stable Ca isotopes to trace granite weathering

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Calcium (Ca) is a highly soluble and mobile element during silicate weathering, and its isotopes could be a promising tracer for continental weathering processes. Granitoids are the main component of the upper continental crust. However, it is currently unclear if Ca isotopes fractionate during granite weathering, limiting our understanding of global Ca cycling. Here we analysed Ca concentrations, radiogenic ($\varepsilon^{40/44}$Ca) and stable Ca ($\delta^{44/42}$Ca) isotopes on the weathering profile of the Fogang granite (165 ± 2Ma) in a tropical climate in south China by thermal ionization mass spectrometry using a double spike method (DS-TIMS). We explored the fractionation behaviour of Ca isotopes during the intense granite weathering and evaluated the potential of Ca isotopes to trace the continental weathering. The results show extreme radiogenic and stable Ca isotopic variations among the saprolites. The variation of $\varepsilon^{40/44}$Ca in the saprolites can be attributed to the differential dissolution of rock-forming minerals and the variation of K/Ca molar ratios in K-feldspar. Moreover, the $\delta^{44/42}$Ca values of the saprolites are generally lower than those of unweathered bedrock, indicating that newly formed clay minerals preferentially uptake lighter Ca isotopes (e.g., ^{40}Ca), driving residual solutions to higher $\delta^{44/42}$Ca values. However, the stream waters near the weathering profile exhibit similar $\delta^{44/42}$Ca values to the unweathered bedrock. One possible reason is that too little Ca was adsorbed by new-formed clay minerals in the saprolite to shift the Ca isotope composition of dissolved Ca from the bedrock. Overall, our study highlights the potential of combining radiogenic with stable Ca isotopes to trace the source, migration, and transformation of Ca during continental weathering.