Potassium Isotope Fractionation During Chemical Weathering of Granite

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Continental weathering links the outer parts of the Earth i.e., atmosphere, hydrosphere, biosphere and continents. It plays a significant role in the evolution of the atmosphere, compositional change of the continents and chemical variation of the oceans over the geological time. For example, chemical weathering has been considered as one of the main processes that shift the composition of the continental crust from mafic to intermediate.

Here we investigate the behaviors of K isotopes during continental weathering by analyzing a well-characterized weathering profile developed in granite in tropical environment in South China, in order to understand the role of continental weathering on controlling the global K budget. The samples are from a 40 m long drill core through the entire weathering profile, encompassing near-surface laterite to unaltered granite at depth. The samples were dissolved in a mixture of concentrated HF-HNO_3-HCl acids. Potassium is completely separated from matrix elements through cation exchange chromotagraphy with Bio-Rad AG 50W-X8 cation exchange resin in 0.5 N HNO_3 media. The purified sample K was intro into the "cold plasma" via a DSN-100 desolvation system. The K isotopes were measured using pseudo high-resolution mode, at the interference-free shoulders of ^{39}K and ^{41}K by using Nu Plasma II MC-ICPMS at the University of Washington, Seattle.

Our data show that K isotopes are gradually shifted to lighter values with increasing degree of weathering of the granitetowards the surface, which can be modelled by a Rayleigh distillation process. These observations are consistent with the release of heavy K to the hydrosphere and the retention of isotopically light K in the weathered products. Our results suggest that continental weathering can signifcantly fractionate K isotopes and it plays a major control in the global K isotopic budget. Weathering shifts the K isotopic composition of the continental crust to values lower than the mantle and thus the hydrosphere has a complementary higher $\delta^{41}K$ value.