Controls on the Ca-Sr-Ba stable isotope composition of the exchange pool along a soil climosequence

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Among the isotopic tools available for study of Earth's "Critical Zone", metal stable isotopes are increasingly being used in diverse avenues of research and are finally coming of age. Now that substantial exploratory discovery and "calibration" have been accomplished for several potentially diagnostic metal stable isotope systems, the time seems ripe to focus attention on using the isotopes for hypothesis-driven studies that address outstanding questions related to Critical Zone behaviour and function. Toward this goal, we are using stable isotopes of the geochemically-related alkaline earth elements Ca, Sr and Ba to further understand pedogenesis and rock weathering mechanisms along a previously well-characterized soil climosequence on the leeward flank of Kohala Mountain, Hawaii. Based on observed correlations of mass loss for Ca and Ba with that for the macro-nutrient P in these soils, our working hypothesis is that the chemistry of the soil cation exchange pool, which we view as an integrated record of rock weathering and hydrologic transport processes, reflects a significant component from nutrient (+proxy) "biolifting" from depth in addition to contributions from abiotic rock weathering, variable leaching of mobile elements and input from atmospheric sources as revealed by the Ca, Sr and Ba isotopes. The interpretation of an important role for biolifting is aided by the recognition of significant variability in the isotope composition of Ca, Sr and Ba in the igneous parent materials of these soils allowing us to establish realistic initial conditions to gauge losses to biolifting and weathering. Barium is more strongly retained than Ca and Sr in both natural and disturbed surface soils and shows the strongest correlation of mass loss with P in soils having the best evidence for nutrient biolifting, suggesting that Ba isotopes may provide a useful proxy for P dynamics in soils.