Elemental and multiple isotopic geochemistry of a spheroidal weathering profile on granodiorite in southeast China

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Continental weathering plays an important role in earth surface processes by linking Earth's spheres and producing material for cycling. This study presents elemental and Sr-Nd-U-Th-Pb-Hf isotopic geochemistry of a 1m-thick spheroidal weathering profile on granodiorite in a mountainous watershed of southeast China, and aims to investigate element mobility and isotopic fractionation during weathering. The element mobility is featured by substantial loss of SiO_2, MgO, CaO, Na_2O, K_2O, P_2O_5, Sr, Y and Ba, and moderate loss of Al_2O_3, $Fe_2O_{3(T)}$, MnO, V, Cr, Rb, Hf and Pb. Variables in the loss of rare earth elements (REE) show that light REE are less mobile than heavy REE. Ti, Zr, Nb, Ta, Th and U are immobile elements during weathering. Meanwhile, the ε_{Nd} overall decreases from -5.356 in bedrock to -5.506~-5.786 in soils, corresponding to the enhanced weathering. Similarly, various fractionation patterns of Sr-Pb-Hf isotopes are also recorded in this profile, which suggest the mineral fractionations during weathering/pedogenic processes as revealed by the XRD and SEM-EDX data.

While the chemical weathering rate of silicates potentially provides valuable constraints on the balance between surficial weathering and denudation through time, U-series isotope ratios of $^{234}U/^{238}U$, $^{230}Th/^{234}U$ and $^{230}Th/^{232}Th$ will be applied to determine the evolution of weathering. Bulk soils have $^{234}U/^{238}U$ ratios above the equilibrium (soils: 1.022~1.186; bedrock: 0.951), increasing gradually with weathering degree in the soil profile. This suggests a congruent leaching of U and Th isotopes, which is a prerequisite for a widely-used closed-system leaching model. The weathering rates deduced from our data using U-series isotopes could be a valuable study for further comparing weathering processes between mountainous and large river basins in East Asia continental margins.

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