Element redistribution during weathering of volcanic rocks in sedentary landscapes

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Volcanic rocks of Plio-Pleistocene age from Hawai'i and Guatemala, in sedentary landscapes, have experienced spheroidal or corestone weathering in which corestones of minimally weathered rock are surrounded by concentric saprolitic shells and saprolite derived from the decomposition of the volcanic rock. These corestone–shell complexes are geochemical dynamic systems. Many major elements and some minor elements (REE) are depleted from the saprolitic portions of these regoliths. The major elements and some of the minor elements are progressively lost from the system as the degree of weathering increases, producing a systematic decrease in concentration from the least weathered part of the system to the most weathered. However, several of the minor elements (e.g. REE) are re-distributed within the regolith, displaying more complex patterns of abundance.

The REE are mobilized to incipiently weathered portions of the corestones, where they incorporated into secondary minerals, resulting in increased concentrations of these elements. The concentration pattern for the REE shows an initial increase during incipient weathering stages, and then a decrease as weathering progresses. As the weathering front moves inward in the corestone, these secondary minerals break down and the weathered rock has similar REE composition to the initial composition of the lava flow. The overall pattern of REE distribution in sedentary regoliths suggests that REE leached from saprolite are transferred within the regolith to secondary minerals formed during incipient weathering. It is not until the most advance stages of regolith formation that these elements are mobilized out of the weathering system.

Desert soils and global climate cycles: Vapor lock in the earth's weathering engine

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In most of earth's surficial environments, ecosystems and hydrology interact to fuel the weathering engine. Atmospheric deposition and by-products of biota combine to solubilize minerals, and circulating water carries away both the dissolved materials and the atmospheric deposition, leaving only the least soluble by-products behind. Recent research has emphasized that desert ecosystems operate in a fundamentally different fashion. The interaction of vegetation and hydrology produces upward hydraulic gradients through the vadose zone, isolating soils from groundwater and surface water systems. Soils become quantitative sinks for deposited and dissolved materials, instead of sources. Even nutrients such as nitrate are retained. Instead of promoting weathering, vegetation produces the "vapor lock" of upward hydraulic gradients and thus stalls the weathering engine. This stalled engine is periodically kick-started by global climate cycles. Increased precipitation (and possibly decreased temperature) effect changes in the ecosystem. These ecosystem shifts, in turn, begin to permit downward fluxes through the vadose zone. Solutes and nutrients that have been accumulating in the vadose zone for millennia are flushed into newly-invigorated groundwater and surface water flow systems and are exported. Arid regions do possess a chemical weathering cycle, but both the timescales and the products of the process are fundamentally different than under humid climates.