Geophysical Research Abstracts
Vol. 16, EGU2014-6615, 2014
EGU General Assembly 2014

Conversion of bedrock to soil and feedback processes between the surface and the weathering front in a deeply weathered regolith, Central Sri Lankan Highlands

Ricarda Behrens (1,2), Julien Bouchez (1,3), Jan A. Schuessler (1), Stefan Dultz (4), Tilak Hewawasam (5), and Friedhelm von Blanckenburg (1)

(1) GFZ German Research Centre for Geosciences, Section 3.4 Earth Surface Geochemistry, Potsdam, Germany, (2) Deutsche Forschungsgemeinschaft (DFG) Graduate School 1364, Institute of Geosciences, University of Potsdam, Potsdam, Germany, (3) IPGP-Université Paris Diderot, Paris, France, (4) Institute of Soil Science, Leibniz University of Hannover, Hannover, Germany, (5) Department of Geography, University of Peradeniya, Peradeniya, Sri Lanka

In the Sri Lankan highlands denudation rates and chemical weathering rates represent the low-end-member in global weathering rates [1, 2]. Here we explore the causes for these low rates by a detailed soil-mineralogical study of a highly weathered deep saprolite profile developed from charnockite bedrock. Spheroidal weathering of the bedrock characterized the weathering front where rounded corestones are produced at the rock-saprolite interface. The first mineral attacked by weathering was found to be pyroxene but plagioclase is the first mineral depleted to near-completion at the corestone-saprolite-boundary. Weathering of pyroxene is initiated by in situ iron oxidation, leading to an increase of porosity due to micro-cracking [3]. The accrued micro cracks allow for fluid transport and the dissolution of biotite and plagioclase. The strong plagioclase weathering leads to formation of high secondary porosity over a small distance and the final disaggregation of bedrock to saprolite. Sequential extraction showed that the first secondary phases are amorphous oxides from which secondary minerals (gibbsite, kaolinite, goethite and minor amounts of smectites) precipitate. Modeling of the strain formation due to increasing volume during iron oxidation in pyroxene and biotite showed that spheroidal weathering can be explained with this process only if the formation of secondary porosity, due to a negative volume budget during primary mineral weathering to secondary phases, occurs. As oxidation is the first occurring reaction, O_2 is a rate limiting factor for chemical weathering in this setting. Hence the supply of oxygen and the consumption at depth connects processes at the weathering front with those at the surface as a feedback mechanism. Advective and diffusive transport modeling shows that the feedback will be much more pronounced with dominating diffusive transport. Due to the low porosity of the bedrock the O_2 transport in the pristine bedrock occurs via diffusion. The slow weathering rate is, beside tectonic quiescence, related to this feedback and to lithological factors such as low porosity and the amount of Fe-bearing primary minerals.

1. Hewawasam, T., et al., Slow advance of the weathering front during deep, supply-limited saprolite formation in the tropical Highlands of Sri Lanka. Geochimica et Cosmochimica Acta, 2013. 118: p. 202-230.
2. von Blanckenburg, F., T. Hewawasam, and P. Kubik, Cosmogenic nuclide evidence for low weathering and denudation in the wet tropical Highlands of Sri Lanka. J. Geoph. Res., 2004. 109: p. doi10.1029/2003JF000049.
3. Buss, H.L., et al., Weathering of the Rio Blanco quartz diorite, Luquillo Mountains, Puerto Rico: Coupling oxidation, dissolution, and fracturing. Geochimica et Cosmochimica Acta, 2008. 72(18): p. 4488-4507.