O_2 driven weathering feedback controls low saprolite production rates in Sri Lankan Highlands

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Feedbacks between the deep weathering zone and the Earth's surface are most effective in weathering profiles where the supply of O_2 to the reaction front is diffusion-dominated. We test this hypothesis on a thick saprolite profile on charnockite bedrock in the Sri Lankan Highlands, where despite the tropical climate, the denudation and chemical weathering rates represent the low end-member of global rates [1, 2]. The first mineral attacked by weathering is Fe(II)-rich pyroxene, showing *in situ* Fe(II) oxidation. This oxidation leads to a porosity increase due to micro-cracking [3]. The accrued microcracks support aqueous fluid transport and favor the dissolution of biotite (also starting with *in situ* Fe(II) oxidation) and plagioclase. Extensive weathering of Na-rich plagioclase leads to further formation of secondary porosity. HR-TEM-analyses on primary and secondary minerals, and chemical sequential extractions showed that the first weathering products are non-crystalline and the precursors of secondary minerals (gibbsite, kaolinite, goethite, and smectite). The combination of strain build-up by oxidation of structural Fe(II) in pyroxene and biotite and the porosity formation by plagioclase dissolution leads to formation of spheroidally weathered corestones and their surrounding rindlets. Our evidence suggests that oxidation is the first occurring reaction, hence, O_2 supply is a rate-limiting factor for chemical weathering in this setting. Importantly, the supply of O_2 and its consumption at depth connects processes at the deep weathering zone with those at the surface in a feedback mechanism. Besides low erosion rate, the low weathering rate is the result of this feedback mechanism, promoted by low porosity bedrock, Fe(II) content in the bedrock and thick clay-rich saprolite.

[1] Hewawasam *et al* (2013) *Geochimica et Cosmochimica Acta* **118**, p. 202-230 [2] von Blanckenburg *et al* (2004) *J. of Geophys. Research* **109**, p. 1-22 [3] Fletcher *et al* (2006) *EPSL* **244**, p. 444-457