AGU 100 FALL MEETING
Washington, D.C. | 10-14 Dec 2018

# H53H-1695: Weathering mass losses, plastic deformation and hydrologic evolution in a volcanic landscape. (Invited)

**Friday, 14 December 2018**
**13:40 - 18:00**
*Walter E Washington Convention Center - Hall A-C (Poster Hall)*

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- *Plain-Language Summary (Optional)*

With well constrained substrate compositions, ages and climate patterns Hawai'i is a useful natural laboratory for studying weathering processes in volcanic landscapes. Landscape level observations indicate that runoff ratios are essentially zero on the young active volcanic surfaces of Mauna Loa and Kilauea, and increase with age on Mauna Kea and Kohala surfaces. The transition from a landscape dominated by infiltration to one with stream dissection and runoff is a critical step in hydrologic and landscape development, and is correlated with the development of a weathered regolith. Chemical weathering mass losses become substantial when the long term soil water balance is positive, with large losses of base cations, Si, and partial losses of Al and Fe (Chadwick et al., 2003). Under these conditions the time scale for formation of a substantial weathered regolith is (*O*) 20 ka. Mass losses estimated from immobile element ratios and porosity increase to ca. 20 ka, after which porosity and $K_h$ began to decrease, while the rate of mass loss slows. Soil strain also becomes important on this time scale. These observations suggest that the development of a weathered carapace results in lateral flow to topographic lows and the inception of stream flow and incision. Once incision begins, streams capture increasing amounts of subsurface flow, increasing stream power and incision rate. Extensive mass losses from the basalts preclude a model in which secondary mineral formation alone reduces permeability. Strain collapse of the soils is necessary to reduce hydraulic conductivity. We adapt a porous-plastic model of deformation (Gurson, 1977) to model the change in in surface hydrologic properties. Increased porosity and decreased material strength of the remaining matrix result in the plastic limit of soil deformation to enter a regime accessible by wetting-drying and thermal stresses on the relevant time scale. The yield stress of the residual material depends on the loss of network-forming silica, and can be parameterized from Ge/Si and Si/Nb ratios. Coupled reactive transport and mechanical deformation appear capable of inducing a fundamental transformation in hydrologic and geomorphic processes in volcanic landscapes.

Chadwick et al. 2003 Chem Geol 202 195-203; Gurson 1977, Trans ASME 99 1-25.

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