EARLY STAGES OF OLIVINE WEATHERING IN HAWAI'I. M. A. Velbel, Department of Geological Sciences, Michigan State University, East Lansing, MI 48824-1115 (velbel@msu.edu).

Introduction: Olivine weathers more rapidly than any other common orthosilicate [1] or other rock-forming silicate mineral, so olivine does not commonly survive to be part of the heavy-mineral fraction of most soils, sediments, or sedimentary rocks. Consequently, except for studies of alteration of olivine to iddingsite and/or other phyllosilicates products of weathering and other aqueous alteration, there are very few studies of olivine alteration textures in the literature on weathering or sedimentary petrology. Furthermore, much existing literature reporting olivine/phyllosilicate alteration textures emphasizes the distribution of the products but does not report etching or corrosion textures on the reactant olivine. This contribution describes olivine etching and corrosion textures formed at early stages of natural weathering, using optical and scanning electron microscopy.

Background: Samples from two localities were examine for this study. Spheroidally weathered vesicular subalkaline basalt was sampled near Schofield Barracks, Oahu (locality described by [2]). Olivine phenocrysts were examined from a slightly weathered corestone and its attached weathering rind. Both core and rind bulk samples (HS-1 & HS 2 of [2]) had enriched REE and a negative Ce anomaly, indicative of a slight to moderate degree of weathering [2]. An outcrop of minimally weathered basalt was sampled on the island of Hawai'i. A thin-section was cut perpendicular to the outcrop surface, and exposed a cross-section through both the outcrop surface and the outermost several centimeters of sample beneath the outcrop surface.

The outcrop sample represents the initial response of mineral and rock to weathering upon exposure of fresh rock directly at the land surface without development of any regolith. The Schofield Barracks suite emphasizes the least-weathered early stages of mineral and rock weathering in a regolith/outcrop setting that is extensively weathered overall. All samples were examined by optical petrography, secondary and back-scattered scanning electron microscopy (SSEM & BSEM, respectively) and energy-dispersive elemental analysis of polished thin-sections.

Results: The two sample suites share a number of olivine-corrosion textures despite substantial differences in eruption and weathering/exposure ages, and regolith history, at the two sites.

Oahu. Optical petrography of weathered vesicular basalt showed abundant olivine preserved with only slight staining of grain boundaries and trans-mineral fractures by ferruginous products. Numerous fine-scale parallel "beads-on-a-string" features occur in the immediate vicinity of trans-mineral fractures. SEM reconnaissance revealed individual funnel-shaped etch pits (each with a pointed end, that probably defines the dislocation around which the etch pit develops), and chains of funnel-shaped pits aligned and joined laterally along the shorter of the two geometric axes exposed by the intersection of the pits with the surface of the olivine (Fig. 2 in [3]). These etch pits range in size from less than 1 μm to 20 μm across. At high magnifications in the petrographic microscope, the "beads on an string" can be seen to be *en echelon* arrays of diamond-shaped etch pits, aligned and joined along the shorter of the two geometric axes visible in the cross-section view of the thin-section. SSEM & BSEM of polished thin-sections reveal more detail, including widespread occurrence of arrays of micron- to submicron-scale etch pits that appear to be smaller-scale and more widespread near fractures than the larger occurrences visible by optical petrography. At more advanced stages of weathering, larger pits that penetrate the entire thickness of a thin-section are up to 80 μm in their longest dimension. Etch pits are devoid of weathering products, even though the etch pit arrays are within tens of microns of product-filled fractures.

Hawai'i. Olivine exposed at the outcrop surface is penetrated to depths of up to 50 μm by individual or coalesced pairs of diamond-shaped etch pits. Interiors of the same olivine, and olivines in the interior of the sample, are unetched. Except for micron-scale comminution debris, etch pits are empty.

Conclusions: Olivine phenocrysts in Hawai'ian volcanic rocks from several volcanic centers and regolith/outcrop settings are similarly corroded by funnel-shaped etch pits occurring as individual pits or *en echelon* arrays. All are associated with, or proximal or directly connected to, fractures or exposed outcrop surface. All etch pits are devoid of weathering products, implying that olivine weathering can take place by a dissolution-reprecipitation mechanism as well as by long-understood replacement mechanisms.

References: [1] Velbel M. A. (1999) *Amer. J. Sci., 299,* 679-696. [2] Patino L. C. et al. (2003) *Chem. Geol. 202,* 343-364. [3] Velbel M. A. (1993) *Amer. Mineral., 78,* 408-417.