Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.18508

Dissolution features of naturally weathered olivine and implications for Coastal Enhanced Weathering projects

NAMY BARNETT AND KIRSTEN NICOLAYSEN

Whitman College

Presenting Author: barnetj2@whitman.edu

Coastal Enhanced Weathering is a Carbon Dioxide Removal (CDR) technology that proposes to accelerate the dissolution of olivine in seawater. The surface area of olivine available for the dissolution reactions is a rate-limiting factor, thus characterizing growth defects, internal cracks, and external features from dissolution prior to beach engineering provides important context for modeling and designing such projects.

Pu'u Mahana (HI) is a volcanic tuff cone that deposits olivine onto a beach at its base. Using a Scanning Electron Microscope (SEM) and Single Crystal X-Ray Diffraction (XRD), this study characterizes nondestructively the composition and morphology of olivine grains (n= 45) collected along a vertical transect of 4 locations on the cliff of the tuff cone. XRD results indicate that the composition of the (n=7) grains is forsterite80-90.

Backscattered electron images show dissolution features, such as diamond-shaped etch pits, in the surfaces of olivine (Ol) collected at all four sample locations. The olivine collected from the top of the tuff cone (t2-5), where a soil was beginning to form, shows numerous chains of etch pits that form a sponge-like texture on some grains. Some grains have euhedral or rounded chromite inclusions intersecting their surfaces. Around chromite inclusions, depressions and etch pits in the Ol grain surface indicate focused dissolution at the host-inclusion boundary. Occasionally, secondary metallic oxides fill etch pit chains. Olivine grains collected at two other locations, (t2-2, t2-4) show fewer etch pits compared to the olivine collected at t2-γ and t2-5.

The presence of etch pits, chains, and spongy textures suggests that olivine weathers subaerially prior to its interaction with seawater in the swash zone. Grains collected at the top of the cliff may have experienced a higher rate of weathering due to its extended exposure to the surface conditions. The implication of the olivine being weathered prior to deposition is that the pre-existing dissolution increases reactive surface area and provides dissolution pathways for carbonic acid when the grains come into contact with seawater.