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Ultra-Mafic Cumulates from Kaupulehu, Hualālai Volcano, Hawai'i:Geochemical Resetting of Mantle-inherited Olivine

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We characterized the chemical composition and microstructure of six ultramafic cumulates from the Kaupulehu lava flow, Hualālai (Hawai'i Island), to decipher their origin. The samples are mostly wehrlites with a poikilitic textures. The chemical compositions obtained from electron probe microanalyses and laser ablation inductively coupled with plasma mass spectrometry confirm the magmatic origin of pyroxenes. Olivines display homogeneous compositions in major, minor and trace elements. Their Fo# (81-88) are typical of magmatic compositions, but first row transition elements concentrations are intermediate between mantle and magmatic olivine compositions. Rare Earth element (REE) patterns are similar to those of mantle olivine, but Kaupulehu olivines are more enriched in heavy REE than mantle specimens. Results from Fourier transform infrared spectroscopy showed that nominally anhydrous minerals are very poor in hydrogen: 1.3-2.2 ppm H_2O by weight in olivine, 6.4 in orthopyroxene, and 12.6-48.2 in clinopyroxene. Nevertheless, fluid inclusions and bubbles evidenced by scanning electron microscopy, demonstrate the presence of volatiles, which are expected to exsolve during degassing. Despite the undeniable magmatic imprint in these ultra-mafic cumulates, electron backscatter diffraction maps evidence subgrain boundaries in olivine, important internal misorientation (>10 °), and crystallographic preferred orientation (axial [010], orthorhombic and transitional toward axial-[001]), not associated with shape preferred orientation or euhedral olivine shape. All these features are evidence of high temperature dislocation creep within the asthenospheric mantle, prior to melt percolation and chemical resetting, well before their mobilization by the volcanic eruption. We conclude that olivines are mantle-inherited, while clinopyroxenes result from crystallization of percolating melt.