THE CHEMISTRY OF LAVA-SEAWATER INTERACTIONS
AT THE
SHORELINE OF KILAUEA VOLCANO, HAWAII

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ABSTRACT

The flow of lava into the ocean at the shoreline of Kilauea Volcano during the Puu Oo eruption allowed for a detailed study on the geochemical interaction between lava and seawater.

The chemical signature of lava-seawater interactions is dominated by two sets of processes, one that generates acidity and one that produces elemental enrichments. The acidity has two sources: the magmatic volatiles SO₂, H₂S, S₂, and HF and water-rock reactions, which create acid by sequestering Na⁺ and Mg²⁺ from seawater into a silicate solid phase while releasing H⁺. On average 4 ± 1.5 meq of acid are generated per kg lava entering the ocean and of this, 1.0 ± 0.5 meq comes from acidic volatiles, and the remainder from water-rock reactions.

The elemental enrichments are dominated by four processes. The first is evaporation of water from seawater which creates solutions enriched in the major elements found in seawater. The second is congruent dissolution of the basalt glass matrix, which is limited by the solubility of some of the elements in seawater. The third process is exhalation of volatile phases from the lava upon contact with seawater. Finally, the fourth is the reaction between water and reduced Fe to form H₂.

Heat inputs from Kilauea to the ocean (1.5-7 GW) are comparable to those from ridge crest hydrothermal vent fields. Approximately 80% of this heat warms nearshore water while ~20% creates steam plumes. Heat from lava flowing into the ocean results in distinctive hydrography in the nearshore region including areas of upwelling water, termed
roils, and jets of steaming water extending away from the lava entries. The residence time of the water proximal to the lava entries is ~1 hour, while the residence time for particles < 50 μm is ~2 hours and for particles < 15 μm, 6-30 hours. These plumes therefore are visually traceable for almost a full day after their creation.

Submarine volcanism at mid-ocean ridges is the dominant form of volcanism on the earth. Understanding the geochemical interaction between lava and seawater is an important tool to predict the flux of elements from mid-ocean ridges through volcanism and to use chemical tracers to identify ongoing submarine eruptions.