Unique metal isotope signatures from lava-seawater interaction during the 2018 eruption of Kīlauea

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The 2018 eruption of Kīlauea was associated with massive input of molten lava into the coastal ocean, which altered seawater chemistry and increased phytoplankton production. In seawater plumes advected away from the site of lava entry, we observed elevated concentrations of over a dozen metals relative to background seawater and unique isotopic compositions of Fe, Cu, Ni, Cd and Zn. The δ56Fe of iron released from lava was lower than basaltic, riverine and coastal iron from Hawai'i, but similar to observations of other high-temperature hydrothermal vent fluids. However, rapid precipitation led to only modest enrichments in dissolved iron (<10 nM), with dissolved δ56Fe appearing to increase as a result of fractionation associated with ligand-mediated dissolution of particulate Fe. The isotopic composition of copper and nickel show evidence for two-endmember mixing between background seawater and a lava source. While the Ni isotopic endmember reflected basaltic δ60Ni, endmember δ65Cu, δ66Zn, and δ114Cd were isotopically lighter than basalt. We hypothesize that high diffusivity and volatility of chalcophile elements leads to strong kinetic fractionation in rapidly cooling lavas, similar to Cu, Zn and Cd isotopic patterns observed in tektites. The isotopic signatures of Cu and Ni observed during the 2018 eruption of Kīlauea far exceed their normal seawater range and may be useful for identifying large-scale lava input into ocean waters during the formation of large igneous provinces and other episodes of volcanism.