

2020–21 eruptions of Kīlauea reveal steady recovery and mixing in the shallow summit magma chamber

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The 2018 lower East Rift Zone (LERZ) eruption and contemporaneous summit collapse of Kīlauea raised fundamental questions about how the volcano would respond following such a major disruption to its magmatic plumbing system. Kīlauea's summit erupted on December 20, 2020, after only two years of quiescence, and poured around 40 million m³ of lava into the new crater until mid-May 2021. A second eruption began on September 29, 2021, and added another 45 million m³ of lava by the end of January 2022. Both eruptions were initially highly energetic, ejecting tephra high enough to accumulate on the crater rim for collection. Preliminary whole-rock, glass, and mineral chemistry revealed similarities between 2020–21 lava and late 2018 LERZ phase 3 (LERZ-3) lavas.

The 2020–21 whole-rock samples are significantly different in incompatible elements and fractionation-resistant ratios (e.g., TiO₂, K₂O, Zr, CaO/TiO₂, Nb/Y) compared to 2008–18 Halema'uma'u summit (HMM) and Pu'u'ō'ō eruptions, but correspond well with LERZ-3. Previous work demonstrated that magma supplying Kīlauea eruptions has been shifting to higher TiO₂ and K₂O (relative to fixed MgO) since around 2011. The 2020–21 eruptions have similar TiO₂ and K₂O concentrations to the LERZ-3 values, implying this magma is from the same source. Olivine phenocrysts with high-Fo cores, common in LERZ-3 lava, are also found in the 2020–21 samples.

MgO-glass temperatures of 1150–1160°C and dominantly Fo_{81–83} olivine, however, indicate that the 2020–21 lava was stored prior to eruption in a shallow magma chamber similar to that which fed the HMM eruption. Glass trace-element compositions from the initial phase of the December 2020 eruption also reveal some overlap with HMM compositions that is not seen in September 2021 samples. This implies that the deeper magma that fed the LERZ-3 lava moved into, mixed with, and flushed out shallow, residual HMM magma. Geophysical data through 2021 also showed magma gradually reoccupying the shallow Halema'uma'u reservoir that existed prior to the 2018 collapse.