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Keeping up with Kīlauea: Interdisciplinary insights from monitoring and research on 2020-2025 eruptions

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Kīlauea has had eight eruptions from December 2020 to February 2025 since the 2018 lower East Rift Zone eruption and caldera collapse. Six of these have been intra-caldera Halemaʻumaʻu eruptions lasting from several days to over a year. Here we focus on the chemistry and petrology of those eruptions (2020–2021, 2021–2022, January–March 2023, June 2023, September 2023, and 2024–2025) to assess changes to Kīlauea's plumbing system in the post-2018 period. Each eruption produced an initial tephra deposit from vigorous fountaining at eruption onset; these initial deposits were sampled for each eruption, with additional sample collection throughout each event when conditions permitted. Samples were analyzed in near-real-time, often on the same day as sample collection, and resulting data provide information on magma characteristics used to refine eruptive hazard information. Further work on glass and mineral compositions and textures has aided in understanding changes within individual eruptions and between events.

The bulk composition of Kīlauea's shallow magma reservoir has become slightly more primitive in recent years, with whole-rock MgO higher in 2020 (7.4 wt. %) compared to the 2018 compositions (6.9 wt. %) and increasing almost 1 wt. % from 2020–2025 with no appreciable change in olivine volume percent. Olivine macrocrysts 0.5–2 mm in size include three dominant populations that are distinguishable by their compositions (cores of Fo_{88}, Fo_{82}, and $Fo_{75–80}$), zoning patterns (dominantly normally zoned or non-zoned), and textures (euhedral vs. skeletal overgrowth rims). Combined with fluid inclusion barometry, these data indicate storage of $Fo_{82–89}$ crystals at 1–2 km depth (Halemaʻumaʻu reservoir) and recycled from within the post-2018 lava lake. Re-erupted lake-derived olivine crystals record cooling and fractionation of the lake from 2021–2025 (olivine rims decrease from Fo_{80} to Fo_{75}) with olivine and clinopyroxene+plagioclase clusters in the recycled material. Modeling the diffusive re-equilibration of Fe-Mg in the olivine derived from the Halemaʻumaʻu reservoir yields timescales of storage and transport that align with seismic and geodetic signals of unrest. Many olivine crystals from later eruptions record diffusion timescales related to the precursor signals of earlier eruptions.