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# Helium isotopes constrain magma sources and emplacement beneath Kīlauea caldera during the 2018 and 2020 eruptions

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Kīlauea volcano erupted in May 2018 with extensive lava flows covering much of the lower East Rift Zone and a concomitant collapse of the summit caldera focused on Halema'uma'u crater, the site of a former and presently active lava lake. $^3He/^4He$ ratios, expressed as the air-corrected ratios $R_c/R_a$, in collected summit fumarole gases from two separate wells at Sulfur Bank solfatara were initially 13.5 ± 0.2 $R_a$ before the eruption, and rose to 15.5 ± 0.1 $R_a$ nearly 12 months later. Assuming an average Loihi (Hawaiian mantle plume) injected magma composition of 25 $R_a$ and simple mixing, we calculate about 17% of the magma volume in the summit reservoir was added over the course of the year, in agreement with geophysical estimates of between 11 and 33% of the magma reservoir that was lost in the summit eruption. These magma injection percentages are maximum values because uniform mixing within the shallow magma chamber zone is unlikely, especially on short time scales. For the 2018 eruption, the long sampling interval suggests nine months as a maximum period for addition of new magma and subsequent mixing, but mixing durations were likely significantly shorter. A test deployment of the new Helium Isotope Monitor (HIM) at Sulfur Bank detected a rise in He isotopes from 14.7 ± 0.11 $R_a$ to 16.0 ± 0.67 $R_a$ on the days prior to the eruption. The rise in He isotopes prior to the 2020 summit eruption suggests very rapid mixing, unless the process was ongoing in a restricted zone (a dike?) that was not tapped by the Sulfur Bank system prior to magma outbreak at the surface in nearby Halema'uma'u Crater.