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Accumulated Pu‘u ‘Ō‘ō magma fed the voluminous 2018 rift eruption of Kīlauea Volcano: Evidence from lava chemistry

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The 2018 rift eruption of Kīlauea Volcano presents a superb opportunity to decipher the underlying role of magmatic processes on the behavior and hazards of basaltic volcanoes. Here, we examine the petrogenetic history of the most MgO-rich lavas (~7.7-8.7 wt.%) from the voluminous (>0.8 km^3) main phase of this eruption on the volcano's lower East Rift Zone (LERZ). Our results show that these lavas are compositionally homogeneous, but distinct from recent samples of the Pu‘u ‘Ō‘ō eruption on the middle ERZ (MERZ) and the summit lava lake within Halema‘uma‘u pit crater. The MgO-rich 2018 LERZ lavas have relatively high K_2O and TiO_2 abundances at a given MgO value, high Nb/Y ratios, and low CaO/TiO_2 and Sr/Zr ratios. These observations preclude a simple hypothesis that the collapse of the caldera in 2018 forced magma from the summit reservoir to erupt directly on the LERZ. Instead, the distinctive chemistry of the MgO-rich 2018 LERZ lavas supports a new model of mixing between three components: (1) olivine-controlled magma, derived from the summit reservoir via Pu‘u ‘Ō‘ō, (2) differentiated magma similar to the earliest lavas from the 2018 rift eruption, and (3) olivine. The differentiated magma was stored within the ERZ since the 1960s. The summit-derived magma (~91-95%) accumulated downrift of Pu‘u ‘Ō‘ō and mixed with the differentiated magma (~5-9%) over ~10 years prior to 2018. This process created a large (>0.8 km^3) magma body within the MERZ that was the direct source of the MgO-rich 2018 LERZ lavas. The magma that was removed from the summit reservoir during the 2018 caldera collapse (up to ~0.8 km^3) remains within the ERZ, along with any leftover magma from the Pu‘u ‘Ō‘ō and 2018 rift eruptions. The summit reservoir has likely been replenished with magma based on recent lava lake activity within Halema‘uma‘u. Thus, Kīlauea's plumbing system from the summit to the LERZ may now be flush with magma and primed for a new era of frequent and/or large eruptions.