Depths of crystallization and magma storage beneath Kilauea and Mauna Loa based on CO_2 in melt inclusions

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Concentrations of H_2O and CO_2 in olivine-hosted melt inclusions (MI) can be used to estimate crystallization depths and thus provide information on magma storage. However, the original dissolved CO_2 concentration of MI at the time of trapping can be difficult to measure directly because in many cases substantial CO_2 is transferred to a bubble that forms post-entrapment [1]. Considerable progress has been made to correct for this effect using experimental rehomogenization [2,3,4], Raman analysis of CO_2 in bubbles [5,6], and computational models of bubble formation [2,7].

Application of these methods to Kilauea and Mauna Loa has revealed some interesting features. At Puu Wahi, a 910 yr B.P. line of scoria cones at ~3000 m elevation on the NE rift zone of Mauna Loa, pressures of MI entrapment range from 0.5-1.1 kb, indicating that Mg-rich olivine (Fo88.1±0.2) crystallized at very shallow depths [2]. Samples from the early phase of the 1859 Mauna Loa eruption have olivine compositions in three groups: Fo82-84, Fo86-87, Fo88-89 [7]. Restored CO_2 contents of MI yield trapping pressures of 0.5-2.0 kb [7]. Half of the MI have pressures that correspond to a narrow range of formation depths at or just above the inferred top of the summit reservoir.

MI from the early part of the 1959 Kīlauea Iki eruption were mostly trapped at 1-3 km depth [4]. These depths suggest that Kilauea Iki magma was supplied from Kilauea's summit magma reservoir. In contrast, olivine from the 1960 Kapoho eruption, which was the rift zone extension of the Kilauea Iki eruption, crystallized over a much wider range of depths (~1-16 km)[4], requiring magma transport from deep beneath the summit region and/or from deep beneath the east rift zone. The deeply derived olivine crystals and their host magma mixed with stored, more evolved magma in the rift zone, and the mixture was later erupted at Kapoho. MI in olivine (Fo82-90) from the Keanakakoi Ash Member (1500-1790 A.D.) were trapped at 0.1-2 kb. The Mauna Loa, Kilauea Iki and Keanakakoi data show that Mg-rich olivine can crystallize at shallow depths beneath Hawaiian volcanoes.

[1] Anderson & Brown (1993) Am. Min. [2] Wallace *et al*. (2015) Am. Min. [3] Mironov *et al*. (2015) EPSL. [4] Tuohy *et al*. (2016) J. Pet. [5] Esposito *et al*. (2011) J. Pet. [6] Moore *et al*. (2015) Am. Min. [7] Riker (2005) unpubl. M.S. thesis.