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Southwest Rift Zone eruptions of Mauna Loa, Island of Hawai‘i: lessons from the crystal cargo

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Mauna Loa has erupted 34 times since 1843, posing significant hazards to Island of Hawai‘i communities on its slopes [1]. Eruptive activity occurs either in the Moku‘āweoweo summit caldera or along the Northeast or Southwest Rift Zones. Southwest Rift Zone eruptions (e.g., 1868, 1887, 1907) pose a significant hazard due to their proximity to residential communities, as seen in the 1868 eruption, one of the most destructive natural disasters in Hawaiian history. Rift eruptions are typically associated with a sequence of events that is observed in many Kīlauea and Mauna Loa eruptions, where effusion begins at the summit and moves downrift following a large earthquake [2]. Understanding this sequence is critical for hazard assessment. The crystal cargo contains an archive of information (pressure, temperature, magma transport timescales, melt composition) that may shed light on mechanisms of magma storage and flow beneath the summit and the Southwest Rift Zone.

The crystal cargo of magmas erupted from Mauna Loa's lower Southwest Rift Zone shows systematic differences from summit eruptions, as well as variability among Southwest Rift Zone eruptions themselves. Lower Southwest Rift Zone lavas can host abundant olivine, orthopyroxene, plagioclase phenocrysts and oxides, with minor clinopyroxenes, exhibiting a range of compositions and zoning patterns. The 1868 olivine-rich lavas contain 15-25 vol% of large (up to 10 mm) primitive (87-89 mol% Fo) olivines, with a diversity of textures. The olivine zoning patterns reflect the existence of at least two magmatic environments [3]: a hotter environment with picrites, and a more fractionated tholeiitic reservoir (82-85 mol% Fo, complex zoning pattern). However, the 1887 and 1907 lavas are olivine-poor (< 5 vol% olivines), with normal zoning patterns, and have a greater proportion of plagioclase and pyroxenes, which indicates a distinct magma storage system. Here we use textural and compositional features of the crystal cargo to construct a framework of understanding the structure and dynamics of magma storage regions beneath the summit and Southwest Rift Zone of Mauna Loa.

References:

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