Kilauea's magma plumbing system

Michael P. Poland[1], Asta Miklius[1], Emily K. Montgomery-Brown[2]

[1]USGS - Hawaiian Volcano Observatory, USA, [2]University of Wisconsin, USA

E-mail: mpoland@usgs.gov

We propose a conceptual model of the magma plumbing system at Kilauea Volcano, Hawai'i, that we hope will provide an improved framework for studies of eruptive and intrusive activity at the volcano. The model is built upon a foundation defined by decades of previous work, with refinements based on geophysical, geochemical, and geologic data collected during recent eruptive activity. These datasets allow us to resolve two levels of magma storage and transport within Kilauea.

The deeper part of Kilauea's magma system is centered on the largest (about 10 km^3) magma reservoir, 3 km beneath the south caldera. This reservoir is connected to the volcano's rift zones, which radiate to the northeast and southwest and define the structural boundary between the volcano's stable north and unstable south flanks. Magma occasionally accumulates in those parts of the rift zones that are adjacent to the summit caldera, especially during periods when the main reservoir is highly pressurized. The more active east rift zone is continuously molten from the summit to at least its subaerial tip (about 60 km in length). Both rift zones contain small, isolated pods of magma that are relicts of past intrusions, can be highly differentiated, and are trapped in the crust above the continuous molten core (as indicated by deformation, seismicity, petrologic data, and geothermal drilling). The Koa'e fault zone, which structurally connects the east and southwest rift zones south of the summit caldera, occasionally can be intruded by magma and may connect the rift zones independent of the summit reservoir system.

The shallower magma system is rooted in a smaller (about 1 km^3) reservoir at 1 to 2 km beneath the east margin of Halema'uma'u Crater, near the center of the caldera. From this shallow reservoir, secondary magma pathways branch at 1 km depth or less, as indicated by historic eruptive fissures and fracture systems that extend to the east and west from Halema'uma'u Crater. These pathways may represent the former locations of the structural rift zones before they migrated to the south due to due to seaward motion of the Kilauea's south flank. Whether magma accumulates within the deep rift zones, below 3 km depth, is uncertain. Magma storage is suggested by a lack of earthquakes and by deformation that indicates rift opening, while gravity highs and fast seismic velocities argue for the presence of dense cumulates.