On Mike Garcia's Contributions to the Understanding of Ocean-Island Volcanism

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Two aspects of Mike Garcia's collected works on ocean island volcanism stand out. First is the level of collaboration: he is one of the world's most-cited scientists on ocean-island volcanism, and the vast majority of his works are multi-authored. Second, Mike made the most of his location, and he has also been a catalyst for innovation in the study of ocean-island volcnanism. One of the most influential aspects of his insight was the realization that the submarine sectors of volcanoes possess information that is not attainable from the subaerial parts. Another was the prescient idea to time-sample the Pu'u O'o eruption, when no one predicted the duration of the eruption and the remarkable geochemical variation of the eruptive products. The designs of these studies directly influenced my lifetime of work in the Galápagos Archipelago.

Submarine lavas have immense advantages: most are glassy, thus melt compositions can unequivocally be measured. Also, many are quenched at pressures greater than that of water saturation, thus preserving magmatic concentrations. Like Hawaii, the water concentrations in Galápagos submarine lavas (Peterson et al., 2017) strongly correlate with isotopic compositions, indicating that the mantle plume is rich in water. Water and carbon dioxide have strong effects on where an ascending plume melts and the compositions of those melts, both due to the chemical effects on the melting of peridotite and the influence on rheology. Many submarine lavas in both Hawaii and Galápagos are much richer in olivine than their subaerial counterparts. The compositions of the olivine and host glasses indicate that they are abundant because they scavenged olivine-rich mush from the middle crust. Moreover, both the mush and the erupted mixtures are density-stratified, and dense olivine-phyric lavas only erupt from the deeper sectors of the volcanoes.

Time-series monitoring of the early part of the Puu Oo eruption at Kilauea indicates that a dike intersected a batch of cool differentiated magma stored in the east rift. Olivine content then fluctuated with eruptive vigor. In a similar way, the 1998 eruption of Cerro Azul was driven by a dike that hit evolved magma, but then the flowing magma intersected mush, eroded it, and flushed it with time (Teasdale et al., 2005). The two most recent eruptions at Sierra Negra are poor in crystals and homogeneous, because they were driven by magma injecting into a melt-rich sill beneath the caldera.