# Redox History of the 1959 Kilauea Eruption Determined by XANES Analysis of Glassy Scoria

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The 1959 Kilauea summit eruption was dominated by high lava fountains of gas-rich, primitive magma, erupted in 17 phases over 36 days. Euhedral rims on olivine, in direct contact with glass, vary significantly in forsterite content, at constant melt composition, in all samples but those erupted in phases 10-17. Ferric/total iron of glass in seven 1959 scoria samples was analyzed using XANES to test the hypothesis that the variable Fo content reflects variation in oxidation state of iron in the coesixting melt.

XANES analyses for 7-14 points on glass in each sample show significant variations in ferric/total iron, which explain much of the variation in Fo. Two processes are involved: first, ferric/total iron variation in early-erupted samples is positively correlated with sulfur content of the glass (a proxy for extent of degassing). Melt inclusions in phase 1 olivines are high in sulfur (1240-1500 ppm S), with 18.0-18.5% of the iron present being ferric. Matrix glasses are degassed (S<267 ppm) with lower fractions of ferric iron (mostly 12.6-14.5%), though one outlier point has 11.5% ferric iron. Interstitial glasses within clumps of olivine crystals locally show intermediate levels of sulfur and ferric iron. The pattern suggests that (1) the 1959 magma was significantly reduced by sulfur degassing during the eruption and (2) primitive Kilauea melts have ferric/total iron $\geq$ 18%.

The second process is progressive interaction between the melts and atmospheric oxygen, which result in higher ferric iron contents. Detailed XANES traverses show gradients in ferric iron content of 0.155 to 0.638 over distances of 100-150 micrometers in thin, visibly reddened matrix glass bordering the scoria. The matrix glasses in late-erupted samples are relatively oxidized, with most having 13.7-24.3% ferric/total iron [in spite of their being thoroughly degassed (S<134 ppm)], presumably because of exposure to air and re-cycling of oxidized scoria and lava from drainback. One final observation is that, of 60 XANES determinations made, none shows the 10% ferric/total iron that has traditionally been assumed to represent the oxidation state of fresh Kilauea magma.