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## Tracking sulfur and its chalcophile allies at Kīlauea Volcano, Hawaii: A story of sulfide saturation, sulfide resorption and magmatic degassing

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Kīlauea Volcano emits large quantities of sulfur and other chalcophile elements into the troposphere as gas and aerosol particles, with widespread implications for regional air quality. The concentration of these elements in erupting melts is controlled by sulfide saturation, as well as the interplay between the exsolved volatile phase, silicate and sulfide liquids on eruption. Analysis of sulfur and other chalcophile elements (e.g. Ni, Cu, Se, As, Bi, Cd) in melt inclusions and matrix glasses allow deconvolution of these various processes. Olivine-hosted melt inclusions have significantly lower Ni and Cu concentrations than matrix glasses, defining trajectories consistent with sulfide saturation. These observations, when interpreted with the latest generation of sulfide saturation models, demonstrate that sulfides saturate at high MgO contents (10-14 wt%), in contrast to the traditional interpretation that sulfide saturation occurs relatively late at Kīlauea (~ 2 wt% MgO). This apparent discrepancy may be reconciled by considering the behaviour of sulfides during syn-eruptive degassing. The release of ~90% of dissolved sulfur into the vapour phase at low pressures leads to previously sulfide-saturated magmas becoming sulfide-undersaturated, driving the resorption of sulfides in contact with the degassing silicate melt. Sulfide resorption releases Cu, Ni, S and other chalcophile elements into the vapour-melt-(sulfide) system. Comparisons of melt inclusion and matrix glasses reveals that significant quantities of S, Se, Bi and As partition into the exsolved volatile phase. Other elements, such as Ni and Cu, remain largely in the melt. The contrasting behaviour of Se and Cu demonstrates that chalcophile element degassing is largely controlled by fluid-melt, rather than sulfide-melt partitioning. Crucially, sulfide resorption obscures the textural and chemical record of sulfide saturation in matrix glass and whole-rocks, but not in melt inclusions, which are isolated from the late-stage release of chalcophile elements from sulfide breakdown. Sulfide resorption during degassing and eruption provides a significant, but previously unquantified flux of sulfur to the atmosphere (as SO<sub>2</sub>) at Kīlauea. Careful evaluation of melt inclusion Cu-Ni-S systematics reveals that the total S release during eruptions is ~1450 ppm (1.8 x previous estimates).