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Sources and fates of magmatic sulfur in the Troodos Ophiolite

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Sulfur cycling in the lithosphere is controlled by volatile behavior, changes in redox state, and liquid immiscibility, which in turn drives the mobility of chalcophile elements. In subduction-influenced melting environments, sources of S include the mantle, fluids evolved from the subducting slab, and pre-existing crust. At various stages, magmatic S can be redistributed due to saturation with a separate sulfide or sulfate phase, magmatic degassing, and/or by hydrothermal interactions such as those that produce ore deposits. Each of these processes fractionate S isotopes, which can be used to evaluate the fate and distribution of S in the vicinity of subduction zones.

Here, we focus on the Troodos Ophiolite as a model for supra-subduction zone extensional melting environments that produce massive sulfide ore deposits. We present in-situ S isotope measurements of quenched volcanic glasses from the ophiolite and compare them to previous S isotope data of pyrite-associated S in altered rocks and massive sulfides that interacted with Cretaceous seawater. The glass data confirm that magmatic S in the ophiolite is mostly derived from depleted and heterogeneous mantle that is residual to a previous episode of melting. Despite isotopic, volatile, and trace element evidence for subduction influence in the generation of Troodos lavas, the flux of S from the subducting slab was minor, as was the influence of subduction on the prevailing redox state in the lithospheric mantle.

Accordingly, petrographic observations of picritic pillow lavas demonstrate that some primitive Troodos melts were initially sulfide-saturated and evolved to become sulfide-undersaturated upon eruption. We synthesize volatile, geochemical, and isotopic measurements of the same glasses to trace how the sulfide saturation state evolved during differentiation of the ophiolite, finding evidence for both early and late sulfide saturation.