

## The fate of sulfur during mantle melting – Implications for the mantle sulfur budget and the mode of deep carbon storage

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Sulfur is one of the key volatile elements, whose distribution between exogenic and endogenic reservoirs are critical for evolution of biosphere, long-term climate and its fluctuations, concentration and mobility of ore forming metals, and for the deep storage of other key volatile elements such as carbon. Yet, systematic studies on deep sulfur cycle, i.e., the abundance in deep reservoirs, its fluxes from the interior to the surface and back are still limited.

In order to constrain the outflux of sulfur from the mantle by volcanism and constrain the budget of sulfur in the mantle, here we combine thermodynamic model and experimental constraints on melting in the Earth's upper mantle and models and experiments for sulfur solubility in silicate melts to explain the sulfur budget of primitive MORBs and OIBs. MORB and OIB (e.g., Loihi, Samoa, Iceland and Galapagos) major element, chalcophile element, and sulfur content were compiled from literature, which show that although differentiated basalts may be sulfide saturated, basalts with  $MgO > 8$  wt.% fall in the range of 800-1200 ppm, and do not show any systematic trends with major element compositions. Sulfur concentrations of partial melts for variable mantle potential temperatures,  $T_p$  were calculated for a given mantle source (initial bulk S content and the lithology of interest, i.e., peridotite or eclogite) by coupling the available SCSS (sulfur content at sulfide saturation) models, which vary as a function of  $P$ ,  $T$ , and melt composition, and also taking into account that the sulfide melt composition may have non-negligible Ni and Cu contents. Our modeling suggests that the S and Cu budgets of primitive ocean floor basalts are best explained by exhaustion of sulfide from the residue after 10-20% melting. This analysis also brackets the sulfur content of the MORB source at 100-200 ppm for  $T_p$  of 1350 °C, of high  $F$  (>5%) OIB peridotite source (Galapagos and Iceland) at 50-200 ppm for  $T_p$  of 1450-1550 °C. The presence of eclogite is critical to reconcile the measured S contents in low  $F$  (<5%) OIBs (Samoa and Loihi) for  $T_p$  of 1550-1600 °C.

Finally, we will show that for our bracketed range of sulfur in the peridotitic mantle, sulfide-carbon±alloy interactions in the deep upper mantle lead to stabilization of diamond along with some carbon being stored in the sulfide-rich melt.