A thermodynamic model for sulfur content at sulfide saturation (SCSS) in hydrous silicate melts: with implications for arc magma genesis and S recycling

HUIJUAN LI AND LIFEI ZHANG
Peking University
Presenting Author: huijuan.li@pku.edu.cn

Modeling the effect of H$_2$O on the “sulfur content at sulfide saturation” (SCSS) in silicate melt is essential for the estimation of SCSS in both arc magmas and slab melts. Here we present a SCSS model for hydrous silicate melt, in which SCSS has been modeled as a combination of S dissolving as S$^{2-}$ and HS\text{/}H$_2$S, based on the sulfide capacity ($C_{S^{2-}}$) and the hydro-sulfide capacity ($C_{HS}$), respectively. By adopting the thermodynamic framework of O’Neill and Mavrogenes [1], S dissolution as HS\text{/}H$_2$S can be modeled in an analogous fashion to that for modeling S$^{2-}$ in anhydrous melt. With the contribution of S dissolving as S$^{2-}$ in basaltic and andesitic melts calculated based on the updated SCSS model for anhydrous basic melt from O’Neill [2], and S$^{2-}$ considered negligible in rhyolitic and dacitic melts, we obtain an expression for $C_{HS}$ based on a compilation of published experimental data on SCSS in hydrous silicate melts covering a PT range of 0.15-3 GPa and 785-1600°C, and melt H$_2$O contents of ~1-13 wt%.

Our model produces SCSS values for the primitive arc magmas compiled by Ruscitto et al. [3], that are in most cases higher than the measured S contents, implying sulfide undersaturated conditions during mantle wedge melting. The contribution of H$_2$S dissolution to the calculated SCSS values varies in a range of 82-1410 ppm, which increases with the increase of H$_2$O content (0.3-6.2 wt%). H$_2$S dissolution therefore contributes to the higher S content in arc basalt compared to MORB. Applying our current model to experimentally produced sediment melts spanning a PT range of 690-1050°C and 2.5-4.5 GPa, demonstrates that sediment melts, especially those of intermediate supercritical character with >25 wt% H$_2$O and peralkaline in composition, can have high SCSS values as a result of H$_2$S dissolution, and act as the transfer medium for S recycling between the slab and mantle wedge under reduced conditions.