

Anhydrite solubility enhanced by CaO in silicate melt: Implications for sulfur dissolution mechanism and sulfur cycling in subduction zones

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The capacity of slab-derived melt in mobilizing sulfur from slab to the mantle wedge is important for understanding global S cycling in subduction zones of the present or ancient Earth. While the promotive role of melt CaO, provided chiefly by subducting sediments, in anhydrite dissolution in silicate melt has been noted before, the dependence of SCAS, sulfur concentration (in melt) at anhydrite saturation, on melt CaO content and the underlying dissolution mechanism have not been well constrained. Using a piston cylinder apparatus, we carried out five series of experiments of phase equilibrium between anhydrite and felsic melt to obtain constraints on the effect of melt CaO concentration, melt H₂O content, temperature (*T*) and Ca/(Ca+Mg) ratios on SCAS at 1–3 GPa and 1050–1350°C. Electron microprobe analyses of quenched products confirmed that the dissolved sulfur was predominantly as SO₄²⁻. The experimental results show that SCAS increased significantly with increasing melt CaO and with increasing Ca/(Ca+Mg) ratios at fixed silicate polymerisation ($n_{bo}/t = 0.43 \pm 0.01$). The SCAS also increased with increasing *T* and dissolved water content, and the effect of water may be non-linear. Previous SCAS models could not capture well enough our new experimental data, therefore a new SCAS parameterization was developed using previous and our new experimental data. With our new results and model, we find that slab melt with high CaO content could efficiently transport S from the slab to the mantle wedge in the Archean. In modern hot subduction zones, slab melt was also able to carry with more than 1800 ppm sulfur and elevate S concentration in the mantle wedge to the lower end of observed level by metasomatism. In modern intermediate subduction zones, however, slab melt is not an effective agent of sulfur transfer even at CaO content >10 wt%.