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Magmatic sulfur compounds and sulfur diffusion in albite melt at 1 GPa and 1300–1500 °C

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Abstract

The speciation and diffusion of sulfur in nominally dry albite melt at 1300–1500 °C has been investigated by analyzing glasses formed in piston-cylinder runs using electron microprobe, micro-Raman, infrared-, UV-, and visible-light-spectroscopy, and other techniques. The sulfate ion is very stable in the albite melt even at low f_{o_2} and is the dominant species in all glasses. In the presence of graphite the glass acquired a characteristic strong violet color, as a consequence of conversion of some of the sulfate to S_2^- and S_3^- radical anions. The equilibration between S_2^- and S_3^- was rapid and both radicals were found to be very stable at elevated temperatures. Both S_2^-, S_3^-, and sulfide diffuse faster then the sulfate anion, so these species will control the diffusion process when present. In violet-colored albite glass in which some of the sulfur is S_2^- and S_3^-, the diffusion coefficient for bulk sulfur diffusion was found to be:

$$D = 14.7 \exp\left(\frac{-458100\ \mathrm{J \cdot mol^{-1}}}{\mathrm{R}T}\right)\frac{\mathrm{m}^2}{\mathrm{s}}$$

where T is the temperature in K and R the gas constant. This relation defines D values significantly lower than those determined for sulfur in dry andesite, dacite, and rhyolite melt, in which the diffusion is controlled by sulfide. The reason for this difference is the higher degree of melt polymerization, the stabilization of sulfate over sulfide in the albite melt, and the slow diffusion of S_2^- and S_3^- radical anions compared to sulfide.