

The partitioning of oxidized sulfur between silicate melts and magmatic volatiles

ZOLTAN ZAJACZ¹

¹University of Toronto, Department of Earth Sciences, 22
Russell St., Toronto, ON, M5S 3B1, Canada,
zajacz@es.utoronto.ca

Sulfur plays an essential role during the formation of magmatic-hydrothermal ore deposits and it is one of the major constituents in volcanic gases. Therefore, quantitative understanding of the effect of silicate melt composition, pressure and temperature on the volatile/melt partition coefficients of sulfur ($D_S^{\text{volatile/melt}}$) is a prerequisite for effective modeling of the above processes.

Systematic experiments were conducted to assess the effect of silicate melt composition and pressure on the volatile/melt partition coefficients of sulfur in piston cylinder and rapid-quench Molybdenum-Hafnium Carbide pressure vessel apparatus at $T=1100-1240$ °C and $P=30-500$ MPa. For the compositional series, Fe-free, synthetic ternary and quaternary aluminosilicate melt compositions were used and the compositional variables, such as the nominal ratio of non-bridging oxygen over tetrahedral cations (NBO/T) or the identity of the network modifier cations were varied independently, only one at the time. All these experiments were conducted at 1240 °C and 500 MPa. The results show that silicate melt composition has a very significant impact on $D_S^{\text{volatile/melt}}$, the values of which varied from 0.30 ± 0.04 (1σ) to 186 ± 98 (1σ). There is a pronounced increase in the $D_S^{\text{volatile/melt}}$ with increasing degree of melt polymerization (i.e. decreasing NBO/T) observed both in calcium- and sodium aluminosilicate glasses. In addition, the identity of network modifier cations available for sulfate complexation also greatly impacts $D_S^{\text{volatile/melt}}$. The network modifier cations associate with sulfate groups in the following order of preference: $\text{Na}\sim\text{K}>\text{Ca}>\text{Mg}\sim\text{Fe(II)}$. For example, sodium aluminosilicate melts show more than an order of magnitude lower $D_S^{\text{volatile/melt}}$ than calcium aluminosilicate melts with identical NBO/T. Apparent equilibrium constants derived from the above experiments allowed successful prediction of $D_S^{\text{volatile/melt}}$ for natural basaltic andesite and phonolite glasses used for the pressure series experiments. These latter experiments showed that $D_S^{\text{volatile/melt}}$ decreases significantly with increasing pressure, independent of melt composition.