

Determining the activity of H₂O in silicate melts at H₂O- undersaturated conditions

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It is well known that H₂O plays a significant role in determining the chemical and physical properties of silicate melts. It is also observed that H₂O-rich fluids in equilibrium with magmas are not pure (e.g. CO₂, S, Cl, F, Si, are common fluid solutes), and that fluid-undersaturated magmatic conditions are common in the Earth. Taken together, these facts highlight how the variation of the chemical activity of H₂O in silicate melt at concentrations below its pure solubility limit represents an important characteristic of magmatic systems. Despite this importance, there are few studies that attempt to quantify H₂O activity. Those that do rely heavily on assumed H₂O-melt solution models for which there are no experimental measurements at H₂O-undersaturated conditions to assess their validity. We present here new experimental determinations of the activity of H₂O obtained for both andesite and basaltic melts at superliquidus temperatures and 500 MPa.

Using a modified double capsule method, Matjuschkin *et al.* [1] showed that the oxygen fugacity of a piston cylinder experiment can be successfully controlled using solid state oxygen buffers (e.g. Ni-NiO). For H₂O saturated conditions, the oxygen fugacity of an inner melt capsule will equal that of the oxygen buffer. We have used this technique for H₂O-undersaturated conditions however, (i.e. an activity of H₂O less than 1), where the oxygen fugacity inside the melt capsule will necessarily be lower than that of the solid oxygen buffer. Measuring the melt ferric-ferrous ratio allows us to calculate the oxygen fugacity, and thereby constrain the melt H₂O fugacity. The melt ferric/ferrous ratio in our runs are measured using several techniques, and constrain the melt H₂O activity in both an andesite and a basalt as a function of H₂O concentration at undersaturated conditions.

[1] Matjuschkin *et al.* (2015) *Contrib Mineral Petrol.* **169**:9