Cotectic compositions: A new geobarometer for dry rhyolites

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Despite recent progress in geobarometry for magmatic systems, the storage depth of rhyolitic magmas is still difficult to constrain from established mineral-mineral or mineral-melt equilibria thermobarometers. In this study we present a new geobarometer relevant to water-poor rhyolitic systems, and demonstrate its potential in application to rhyolites from Snake River Plain, Yellowstone volcanic province. Our new data demonstrate the change of magma storage depths of rhyolitic magmas in space and time.

The geobarometer calibrated in this study is based on the SiO_2 content of a rhyolitic melt saturated with respect to quartz (Qtz) and feldspar(s) (Fsp). In the system Qtz-Ab-Or, the melts normative Qtz content (Qtz^L) increases with decreasing pressure but this effect is obscured by the presence of CaO in the melt (e.g. expressed as normative anorthite (An^L)) [1] [2]. We performed a series of near-liquidus crystallization experiments (870 to 1050°C) in IHPVs to calibrate the position of the cotectic curve separating the Qtz and Fsp primary fields at 200 and 500 MPa for two melt water contents (H_2O_{melt} of 1.3 and 3 wt% H_2O) and 3.5 and 7 wt% An^L. The Qtz^L content of cotectic compositions was estimated as a function of pressure, H_2O_{melt} and An^L. Preliminary results indicate that at identical H_2O and An^L the Qtz^L decreases by ~5.3 wt% with increasing P from 200 to 500 MPa. When compared to a Ca-free system, the effect of 7 wt% An^L results in an increase of the Qtz^L of up to ~9.2 wt%.

We applied our new geobarometer on samples collected from the Twin Falls eruptive center (Kimberly ICDP drill core) [3]. Preliminary results demonstrate different pressures for three erupted rhyolite units previously distinguished in the drillcore: ~425 MPa for the uppermost and therefore youngest unit, ~280 MPa for the intermediate unit and less than ~130 MPa for the oldest, lowermost unit. These results clearly illustrate the descend of rhyolitic magma chambers with time.

[1] Gualda & Ghiorso (2013) *Journ. Geol.* **121**, 537-545. [2] Blundy & Cashman (2001) *Contrib. Mineral. Petrol.* **140**, 631-650. [3] Shervais et al (2013) *Scientific drilling* **15**, 36-45.