Amphibole barometry in rhyolitic systems: an experimental recalibration and application to the Cappadocian ignimbrites (Turkey).

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Classical Al-in hornblende barometry relies on the hypothesis that the Al content in amphibole only depends on pressure, through the Tschermack substitution MgSi=^{VI}Al^{IV}Al. When temperature variations are taken into account, however, Al content in amphibole also varies through the edenite substitution _Si=Na^{IV}Al. Accurate Al-in hornblende barometers thus needs either to take into account the effect of temperature, or exclude the edenite substitution. We have performed a detailed experimental study of amphibole compositions as a function of pressure and temperature in a rhyolitic pumice from the Kizilkaya ignimbrite (Central Turkey). Samples were analyzed using optimized microprobe conditions in order to reduce uncertainties on Al content. Our data, combined with existing litterature data, show a very good pressure-dependence of the Tschermack substitution (correlation coefficient of 0.95) for amphiboles in equilibrium with biotite, plagioclase and quartz, reproducing experimental pressures with an average error of 36 MPa in the 100-400 MPa range. More experiments are underway to improve the accuracy of the barometer.

The Cappadocia area of Central Turkey superbly exposes a succession of Neogene dacitic to rhyolitic ignimbrites and fallout deposits, recording 10 Ma of magmatic activity. This provides an excellent example of long-lived, low frequency magmatic system, with a low average magma production rate (about 0.001 km3/a), but short-lived large eruptions (up to 300 km3 for the Cemilkoy ignimbrite). Extensive fieldwork campaigns, followed by AMS measurements, geochronology and geochemistry allow us to refine the characterization of the various units and provide a framework for petrological studies. Most of the ignimbritic and fallout units share a very similar phenocryst mineralogy (plagioclase + biotite + amphibole + magnetite + quartz). The low-variance phenocryst assemblage of those units makes them perfect target for our new Al-in amphibole barometer.

Amphibole-plagioclase thermometry of the six ignimbrite units and one plinian fallout unit investigated so far indicate relatively stable pre-eruptive temperatures between 700 and 760 °C for most units. Pressure estimates indicate that amphiboles crystallized in the upper crust, between 9 and 14 km depth, hinting at a constant depth of magma storage beneath the Cappadocian ignimbrite field over the last 10 Ma. Detailed investigation of various samples of one of the more recent unit, the Kizilkaya ignimbrite, produces a tight unimodal pressure distribution at 260 MPa (9.8 km), with a maximum data dispersion of 20 MPa (0.8 km), lower than the 2 sigma uncertainty of the barometer. If the erupted reservoir was homogeneous, as suggested by the absence of magma mixing, and amphibole was present in the entire reservoir, the aspect ratio of the erupted volume would be relatively low, with a minimum diameter of 7.5 km for a 1.5 km maximum height.