A Review of Mantle Thermobarometry for Primitive Arc Magmas

CHRISTY B. TILL[1]

[1]School of Earth & Space Exploration, Arizona State University Tempe AZ USA christy.till@asu.edu

Erupted magmas remain the best tools we have to ascertain the mantle processes that give rise to the compositional diversity and spatial distribution of near-primary magmas at volcanic arcs. A compilation of the mantle pressure-temperature constraints from natural, primitive arc magmas published to date reveals estimates from ~1000-1600°C at ~6-50 kbars. In addition to the variability of mantle melting processes within and between different arcs, this range of conditions is the result of different methodology, such as how the magmas were corrected for fractional crystallization, the choice of thermobarometer, how magmatic H_2O was quantified and its calculated affect on pressure and temperature, and choices about mantle lithology and oxygen fugacity. Although most modern thermobarometers agree to within ~30°C, the cumulative effect of these different methods can produce variations in the pressure and temperature estimates for the same sample of up to 100-300°C and 6-20 kbars. An internally consistent set of calculations using modern approaches for a representative subset of the samples where sufficient petrographic, mineralogical and H_2O data are available suggests the range of mantle conditions recorded by primitive arc magmas is in fact much smaller than the range in the literature; instead it is likely limited to ~1075-1450°C at ~8-19 kbars. These results suggest primitive arc magmas record the conditions of the melt's re-equilibration with the mantle during ascent rather than the magma's point of origin, and reflect a last equilibration in the hot, shallow nose of the mantle wedge. The recalculated range agrees well with the overall range of temperatures predicted beneath arcs by geodynamic models, although it suggests some subduction zones may have slightly higher maximum temperatures at shallower depths in the wedge than originally predicted. Thus this dataset is useful for understanding melt migration and the temperature structure in the uppermost part of the mantle wedge below arcs, rather than conditions at the onset of melting