Volcanic vs Plutonic Hornblende: Tools for Discerning Crystal Accumulation and Melt Loss

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Bulk-rock compositions of plutonic rocks are commonly used as proxies for melts to evaluate magmatic processes or as input in modeling. However, crystal accumulation and melt loss may be difficult to assess in evolved magmatic systems, because crystal accumulation trends may follow a similar but opposite trajectory as crystal fractionation trends [1]. Recent studies suggest that melt composition and temperature are primary controls on amphibole compositions [2,3,4]. Thus, calcic amphibole may be a powerful tool for recognizing crystal accumulation, assessing equilibrium, and establishing potential equilibrium melt compositions.

This study compares amphibole compositions from volcanic and plutonic systems (ranging from basalt to rhyolite) and evaluates whether bulk-rock and glass compositions are reflective of the melts from which their amphiboles crystallized by employing amphibole-melt $^{Fe/Mg}Kd$ tests [3] and amphibole chemometry [2,3,4]. Our findings suggest that many plutonic rocks are too primitive to be in equilibrium with their constituent amphiboles and are instead partial cumulates, having lost evolved melts. Glass compositions of silicic volcanics are instead typically too evolved to be in equilibrium with their amphiboles. Comparisons between some plutonic and volcanic amphiboles (e.g. Tuolumne Intrusive Complex vs Fish Canyon Tuff) demonstrate that their initial melt compositions were quite similar but that the compositional range of amphibole in plutonic systems extends to values not observed in volcanics, indicating crystallization from lower temperature interstitial melts.

[1] Deering and Bachman (2010) *EPSL* **297**, 324-331 [2] Zhang et al., (2017) *Am. Min.* **102**, 1353-1367. [3] Putirka (2016) *Am. Min.* **101**, 841-858. [4] Ridolfi & Renzulli (2012) *Contrib Min. Petrol.* **163**, 877-895