Open-system processes revealed by melt trace element inversion from calcic amphiboles

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Open magmatic processes, including magma mingling, fractionation or assimilation, are commonly responsible for much of the diversity of magma and crystal compositions commonly seen at subduction zones. There is increasing evidence that mid- to deep-crustal fractionation of hydrous mafic magmas is an important factor in generating the intermediate to silicic rocks that are typically erupted at the surface. This process may involve crystallisation of pyroxene and/or amphibole and generation of abundant mafic cumulates.

Amphibole is a common mineral phase in water-bearing arc magmas. Its stability is a complex function of temperature, pressure, oxygen fugacity ($f\mathrm{O_2}$), and melt and volatile compositions. Even where amphibole is not observed in the erupted magmas, it is commonly implicated in earlier periods of fractionation [1]. We have therefore developed a new multiple regression analysis of published trace element partitioning data between calcic amphibole and melt. We are able to retrieve statistically significant relationships for REE, Y, Sr, Pb, Ti, Zr and Nb. We also present new pressure-independent and temperature-independent empirical chemometric equations to predict melt major element chemistry from amphibole crystal compositions.

This enables us to reconstruct melt chemistry in detail from *in situ* analyses of amphibole in magmas and plutonic xenoliths. Linking these inverted melt compositions to the observed crystal textures allows us to make robust interpretations of magmatic processes throughout the volcanic system. We demonstrate the potential of this approach using examples from Mangakino volcano, Taupo Volcanic Zone; Mt Lamington, Papua New Guinea; and Grenada, Lesser Antilles.

[1] Davidson et al. (2007) Geology, 35, 787-790