The origins of geochemical trends in felsic igneous rocks: Insight into processes in the source.

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Earth has had a granitic (sensu lato) continental crust since at least Archean times and both crustal composition and structure are consequences of the partial melting of pre-existing deep crust and the ascent of incompatible-element enriched granitic magmas into the upper crust. This is fundamental to the stability and longevity of the continents. Despite advances in understanding the generation of the continental crust, and patterns of crustal growth with time, the processes that produce systematic chemical variations within the granitic magmas that achieve crustal differentiation remain poorly constrained. The primary uncertainties concern the relative contributions to granitic magmas through the entrainment of the solid fraction of the source, e.g.[1], mixing with the mantle-derived basaltic magmas, e.g.[2] that provide the heat for large-scale partial melting of the crust, and fractionation processes within the magma systems, e.g.[3]. This study has used a new phase-equilibrium modelling approach to demonstrate that the main controls on granite chemistry are, in order of significance: 1. Selective entrainment of components of the source into the magmas, i.e. the peritectic assemblages produced by the incongruent melting reactions and the accessory minerals liberated during mica and/or amphibole breakdown. Restricted equilibration volumes during anatexis are important in controlling the stoichiometry of the reactions; 2. Mingling between granitic magmas from different sources that melted concurrently; and 3. Fractionation of melt from crystals, typically through the separation of a subordinate melt fraction (< 40%) from a crystal mush. Thus, the chemistry of granitic magmas is fundamentally controlled by the stoichiometries of the incongruent melting reactions by which they were produced. As the entrained component adds compatible elements to the magma in proportions that mirror the stoichiometries of the most thermally stable reactant hydrous minerals, this process endows the continental crust with the chemical characteristics that ensure maximum thermal and rheological stability during the challenges posed by subsequent heating events.

[1] Chappell et al. (1987) *J. Petrol.* **28**, 1111-1138. [2] Gray & Kemp (2009) *Lithos*. **111**, 113–124. [3] Dahlquist *et al*. (2007) *Lithos*. **95**, 177–207.