Modelling fractional crystallisation in Lachlan Fold Belt granites using the Magma Chamber Simulator

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Models for granite petrogenesis invariably attempt to explain in terms of sources and magmatic processes the cause of major and trace element variations and the origin of the isotopic character of the samples. For the granites of the Lachlan Fold Belt (LFB), Australia, there has been great debate between, on one hand, models positing that the isotopic variability and within-suite compositional trends can be accounted for by magma mixing and fractional crystallisation, and, on the other, the restite unmixing model that views the isotope compositions of diverse granites as a feature inherited from individual protoliths that underwent partial melting to produce magmas entraining varying proportions of residual material in a felsic melt. Reconciling all aspects of the geochemical data in a mixing model is contingent on a plausible fractionation regime to produce the observed consistently linear (or near-linear) trends on Harker diagrams; however, published fractional crystallisation models lack phase equilibria constraints on the liquidus assemblage and do not account for the likely changes in trace element partitioning across the compositional range modelled.

The Magma Chamber Simulator (MCS) [1] models fractional crystallisation alone or with assimilation (AFC), constraining phase equilibria using MELTS and accounting for the thermal budget. MCS models show that, although thermodynamically feasible major element trends may be sensibly linear over limited compositional ranges, and the involvement of assimilation extends the range in which trends are relatively simple and near-linear, neither fractional crystallisation nor AFC are able to correctly reproduce the geochemical evolution of the I-type Jindabyne Suite granitoids as a liquid line of descent. The results suggest that, contrary to previous studies that modelled these granitoids as evolving liquids, fractional crystallisation either was not involved in the differentiation of many of the LFB granites or involved incomplete separation of residual liquids from cumulates. Investigating the latter through MCS modelling is the next step towards an improved understanding of the formation of these rocks.

[1] Bohrson *et al.* (2014) *J. Pet.* 55, 1685-1717.