The individuality of melting regimes in small basaltic systems: Variations in space and time

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Understanding how magmas evolve in space and time in all tectonic environments is of importance for our knowledge of magma generation and ultimately, volcanic risk. Recent work by numerous groups has highlighted that the detailed analysis of mafic small eruptive centres (SECs) often captures extraordinary geochemical variation which is masked in larger volume events. Such studies are powerful means of investigating the evolution from mantle source dynamics, through magma ascent and transient storage to subtle triggering mechanisms. Examining deposits in stratigraphic order and with a range of geochemical tools reveals temporal features, sometimes in exceptional detail, allowing the geochemical and volcanological evolution over time to be studied.

Intraplate SECs are an excellent place to start unravelling where geochemical heterogeneity begins, due to the generally smaller amounts of crustal interaction involved. Meanwhile, SECs in subduction environments provide an opportunity to test ideas of melt generation and evolution from intraplate scenarios, with the additional spatial aspect of this tectonic environment. We compare melting regimes from the truly intraplate, non-plume related Auckland Volcanic Field (New Zealand) and several fields of SECs in the Southern Andean Volcanic Zone of Chile. In both scenarios, spatially highly variable rock compositions suggest that magmas are generated from individual melting events with no within-field or across-arc (respectively) mixing.

This and other studies have identified great geochemical variation related to mantle source contributions, depths of melting and many other parameters both on the scale of a volcanic field and within single SEC eruptions. An important question is: what is the ‘complexity threshold’ above which these subtle geochemical signals are overwhelmed? How does this relate to the timescale of magma evolution? Here we use examples from our current research and the recent literature to discuss what this threshold might be and how such concepts may be taken further to explore magmatic evolution.