Geophysical Research Abstracts
Vol. 16, EGU2014-1249, 2014
EGU General Assembly 2014

Enclaves in Granitic Magmas: Keys to the Petrogenetic Puzzle?

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We have accumulated a large database of the geochemistry and isotope chemistry of igneous, quench-textured, microgranular enclaves (ME) from both I- and S-type felsic volcanic and plutonic complexes in Central Victoria, Australia. The post-orogenic, granitic, host magmas here were emplaced mainly in the Late Devonian, with most occurrences dated close to 370 Ma. The main purposes in accumulating these data were to discover whether there are commonalities in ME chemistry across the region (i.e. whether they had a common parent magma), and whether the ME from each individual granitic or felsic volcanic host can be related to each other by some simple petrogenetic process (e.g. magma mixing or crystal fractionation). Combining this information with field and petrographic observations, we propose a common mechanism by which most of the ME probably formed.

Major findings are that:
• ME vary widely in their chemistry and mineralogy, with dominant granodioritic to tonalitic compositions.
• Within a given host magma or igneous complex, the major-element, trace-element and isotopic variations among the ME do not seem to form mixing trends, either with each other or with their host magmas, despite petrographic evidence for the incorporation of host-derived crystals in many ME.
• The variations within individual ME suites do not extrapolate back to any reasonable mafic to intermediate parent composition and the ME from different host rocks (even those spatially and temporally associated with each other) are commonly quite different in their characteristics. Such variations could be described as chaotic.
• Broad mineralogical and geochemical kinships do exist between ME and their host rocks, but there are also some major contrasts.
• I-type ME are certainly less aluminous than those found in S-type hosts but the S-type ME in some complexes are considerably more peraluminous than their host rocks and the ME in I-type hosts are not significantly less evolved in their Sr isotope characteristics than the ME in S-type hosts.

These features mean that studies of ME are, in general, unlikely to result in much useful information on the genesis and evolution of their host magmas. For the ME magmas themselves, it seems likely that their compositions represent combinations of deep-level hybridisation between mantle-derived mafic to intermediate magmas and a wide variety of crustally derived partial melts. Their compositions are further modified through high-level cumulate-like processes as well as further, minor hybridisation with their host magmas at emplacement levels. All these processes seem to have operated on short length scales, at different levels in the crust, resulting in the apparently chaotic variations among ME magmas.