



Source-related chemical and isotopic heterogeneities in granitoids

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A survey of a large number of post-orogenic plutons, shows that regional-scale, intraplutonic isotope heterogeneities (initial $^{87}\text{Sr}/^{86}\text{Sr}$ and/or ϵNd) are common in crustally derived granitic rocks. This is expected since the source materials, from which the granitic magmas were created by partial melting, are themselves heterogeneous, especially from metasedimentary sources. If we accept models of granite emplacement involving the rapid ascent of magma along dykes, there must be potential for the preservation of source-inherited chemical and isotopic heterogeneities. However, their preservation will depend on the extent of post-emplacement homogenisation processes, such as diffusion and convective mixing, in the magma chambers. Micro-sampling of feldspar crystals in granites has revealed complex internal Sr and Nd isotope variations thought to reveal subtle variations in the isotopic composition of the melt from which particular zones crystallised. We therefore have evidence of both macro-scale (regional) and micro-scale isotopic variation within granitic magmas. What is unknown is the extent of chemical and isotopic variation on the *meso-scale*.

We have obtained high-precision geochemical and isotopic (Sr, Nd, and O) analyses for spatially well constrained samples, from two granitic intrusions from the UK, to study the scales over which isotope heterogeneities are preserved, and the maximum volumes of magma over which isotope and elemental homogenisation may have been achieved. These data provide important constraints on the physical and chemical characteristics of processes that occur during magma genesis, ascent, and emplacement.

The Criffell pluton (SW Scotland) has previously been shown to be isotopically heterogeneous on the regional scale, with initial $^{87}\text{Sr}/^{86}\text{Sr}$ varying from 0.70521 to

0.70728, generally increasing inward, towards the centre of the pluton. This was interpreted as representing isotopic heterogeneity within the source region. Our study has revealed $^{87}\text{Sr}/^{86}\text{Sr}$ and ϵNd homogeneity on the 10 to 100 m scale. This scale therefore represents either the minimum scale over which homogenisation was achieved, or alternatively, the size of a single isotopically distinct batch of magma, within a pluton composed of many such batches.

In contrast, the Dartmoor granite (SW Britain) shows marked variations in geochemistry, mineralogy, and texture within samples collected from the same location. Modelling suggests that geochemical variations cannot be explained by fractional crystallisation alone, implying the presence of more than one magma. Initial $^{87}\text{Sr}/^{86}\text{Sr}$ ratios (0.70961 to 0.71291 ± 0.0003) and $\delta^{18}\text{O}$ values (10.01 to 10.98 ± 0.1) show that isotopic variation exists on scales at least as small as 0.5 m. The scale of isotopically distinct domains in the intrusion may represent the sizes of magma batches that were emplaced as successive magma pulses that coalesced to form the pluton. Alternatively these heterogeneities may represent volumes of magma that escaped homogenisation by mixing and diffusion. The physical causes of the preservation of such heterogeneities are under investigation. Chemically, it seems certain that diffusional equilibration (mixing) has been quite inefficient, at least in Dartmoor.