5.4.57

Crystal inheritance and mixing in products of the Campi Flegrei caldera, Italy

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Phenocrysts of feldspar, biotite and clinopyroxene taken from the products of the Campi Flegrei caldera show wide variations in their $^{87}Sr/^{86}Sr_i$ isotope ratios due to mixing of different magmatic endmembers [1,2]. Single-grain isotopic analyses reveal that phenocrysts typically have $^{87}Sr/^{86}Sr_i$ ratios that lie between that of an isotopically distinct magmatic endmember and the groundmass glass. The analysed populations of crystals have $^{87}Sr/^{86}Sr_i$ ratios that scatter between that of the groundmass glass towards one of the magmatic endmembers. This implies that phenocrysts have cores inherited from single, distinct endmember magmas and rims grown from magmas comprised of a mix of endmember components.

For example, phenocrysts of the Minopoli 2 eruption of the caldera (9500 years B.P.) lie on mixing lines between the groundmass glass at $^{87}Sr/^{86}Sr_i$ of 0.70820 and both the "Minopoli" component at 0.70860 and a "Campanian Ignimbrite" component at 0.7072-0.7074. In addition there are some feldspar phenocrysts with distinct $^{87}Sr/^{86}Sr_i$ isotopic compositions of ~0.70670, a signal tentatively attributed to tephritic materials of this isotopic composition but whose eruptive record wholly pre-dates the Campanian Ignimbrite of 37,000 years B.P.

Further work integrating the existing whole-grain isotope work with microsampling isotope studies and crystal overgrowth textures should shed some light on the dynamics of crystallisation and magma mixing in the Campi Flegrei plumbing system over the past 37,000 years.

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References

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5.4.61

Sr and Nd evidence for successive contamination of the Slieve Gullion ring dyke magmas, Co. Armagh, Ireland

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Ring-dykes are roughly circular sheet intrusions that form when magma rises along a ring fracture. These features commonly encompass central collapsed blocks and many documented ring dykes also display compositional zoning. The Palaeogene Slieve Gullion Igneous Centre in southern Armagh consists of a layered central intrusive complex surrounded by a prominent slightly older ring dyke that intrudes both Lower Palaeozoic meta-sediments and the Caledonian Newry granodiorite pluton. The ring-dyke comprises two major rock types, porphyritic felsite and porphyritic granophyre. We analysed both rock types, both types of country rock, and local Palaeogene basalt for major elements, trace elements, and Sr and Nd isotopes.

The data suggest that there are two distinct groups of both felsite and granophyre: a Si-rich group and a Si-poor group, probably representing two main magmas from a zoned magma chamber and their mushy chamber wall equivalents. Sr and Nd isotope data show the low Si rocks to be higher in radiogenic Sr than the high Si rocks, which is inconsistent with a simple AFC scenario of increasing sediment assimilation with higher degree of differentiation. However, using a MORB type basalt as a starting composition, the low Si dyke rocks can be modeled through AFC with Lower Palaeozoic meta-ediment as assimilant (60-70% solidification). The decreasing 87/86Sr trend from low Si to high Si dyke rocks, in turn, may be explained by selective assimilation of the most fusible portions of Newry Granodiorite, which is lower in radiogenic Sr than the local meta-sediments.

The Sr and Nd data are consistent with a.) at least a two stage contamination history during upper crustal residence and storage, whereby fractionating magmas of basaltic and intermediate composition are contaminated by local meta-sediment, giving rise to rhyolite magmas that experience additional shallow contamination by Newry Granodiorite, and b.) a zoned rhyolite magma chamber where high Si magma is stored in the upper part of the chamber where crystallisation and crustal contamination is most extensive.