Integration of the intrusive and extrusive cycles of Palaeogene igneous activity in N.E. Ireland

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We compare trace element and isotopic (Sr, Nd, and Pb) geochemical data from the mafic intrusive complex of Slieve Gullion with new data from the thick sills (up to 100 m) at Portrush, Carrickarede and Fair Head in N Antrim and make comparisons to the Antrim Lava Group (ALG) flood basalts.

Slieve Gullion rocks (56.5±1.3 Ma) are characterised by flat ~10x chondritic HREE with slight +ve Eu-anomalies and LREE enrichment ($(La/Pr)_{CN}$ = ~2.5). Portrush sill rocks (54.9±0.6 Ma) show similar flat HREE patterns, +ve Eu anomalies and faint LREE enrichment ($(La/Pr)_{CN}$ >1). By way of contrast Carrickarede and Fair Head (60.2±0.3 Ma) rocks show convex upward REE patterns, with maximum REE enrichment at Nd ($(La/Pr)_{CN}$ < 1, $(Nd/Lu)_{CN}$ ~ 4). Multielement plots of incompatible elements for Slieve Gullion and Portrush rocks display similar flat patterns for HREE and HFSE, with distinctive +ve spikes at Pb, Sr and Rb and –ve Nb anomalies, that strongly resemble subduction modified melts or continental crust. The Fair Head rocks show distinctive, smooth upwardly convex patterns.

The Lower Basalts (~60-62 Ma) of the ALG show similar convex upwards REE patterns as the Fair Head and Carrickarede rocks, whereas many of the younger Upper Basalts (~59-57 Ma) resemble the younger intrusions at Portrush and Slieve Gullion, but with flat or LREE depleted REE patterns.

A key to understanding the evolution of the N.E. Irish sector of the North Atlantic Igneous Province is explaining such differences in temporally related rocks, which cannot be rationalised solely by partial melting of a similar source. We suggest that the LREE enrichment and Pb, Sr, Rb spikes so distinctive of the Slieve Gullion magmas, and also hinted at in Portrush, might derive from a lithospheric mantle component, as the melting regime penetrates into lithospheric mantle as extension developed across the Province.

Complex Al and P zoning in pallasite olivine: Constraints on high-T history

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Pallasites are mixtures of olivine and Fe-Ni metal, possibly formed near the core-mantle boundary of a differentiated asteroid [1]. The distribution of trace elements in pallasite olivine appears to reflect diffusion profiles [2] although complex structure has also been reported [3]. It has recently been shown experimentally [4] and in various natural samples [5] that Al and P diffuse very slowly in olivine and these elements can preserve early distributions which are resistant to later thermal modification.

To search for evidence of the early history of pallasite olivine, we have used Laser-Ablation Inductively-Coupled-Plasma Mass-Spectrometry (LA-ICP-MS) to produce trace-element maps of olivine from two pallasites: Brahin (with fragmental olivine) and Brenham (rounded olivine). Heterogeneous distributions are found over scales of ~100 microns for Al and elements likely to associate with it in coupled substitutions. P is also heterogeneously distributed but is negatively correlated with or unrelated to Al. In Brahin, these distributions bear no relationship to the olivine morphology; for Brenham, Al concentrations decrease at grain margins but the interiors have complex distributions.

Heterogeneous distributions of Al and P in pallasite olivine provides some constraints on its residence time in a high-T environment. Taking the diffusion parameters for Si [6] as a proxy for the diffusion behaviour of these elements (since they reside in the same crystallographic site), at 1650 K (~OPX out for a fertile peridotite composition; [7]) the characteristic timescale for diffusion over 100 microns is ~1 Ma. This represents an upper limit on the time between the establishment of trace element systematics in olivine and formation of pallasites by mixing with metal.

[1] Scott, E.R.D. (1977) *GCA* **41**, 693. [2] Miyamoto, M. (1997) *JGR* **102**, 21613. [3] Tomiyama T. & Huss G.R. (2006) *LPSC* **37**, 2132. [4] Spandler C. & O'Neill H.St.C. (2010) *CM&P* **159**, 791. [5] Milman-Barris M. *et al*. (2008) *CM&P* **155**, 739. [6] Dohmen R. *et al*. (2002) *GRL* **29**, 2030. [7] Walter M. J. (2003) in *Treatise on Geochemistry* 2.08, 363–394.