Geophysical Research Abstracts, Vol. 9, 03904, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-03904

Magma ascent at a major terrane boundary: crustal contamination at the Drumadoon Intrusive Complex, Isle of Arran, Scotland

F.C. Meade, D.M. Chew and V.R.Troll

Department of Geology, Trinity College Dublin, Dublin 2, Ireland. (meadef@tcd.ie)

Magma is one of the most important probes into the Earth's interior, preserving isotopic information on both its source and the crust through which it has passed. In old and lithologically variable crustal terranes, the boundaries between crustal blocks are often marked by extremely diverse lithologies of different ages. These compositional variations are frequently reflected in the radiogenic isotope signature of the rocks. Such boundaries may in turn act as preferential pathways for subsequent ascending magmas. Therefore, due to the juxtaposition of discrete isotopic end-members, a magma's course may be traced isotopically, elucidating not only from which crustal domain the magmas have originated, but also at what point a boundary may have been crossed; providing a picture of magma ascent and storage along major crustal discontinuities. The Isle of Arran, a site of intense igneous activity during the Palaeogene, is bisected by the Highland Boundary Fault, and affords the opportunity to investigate magmatism at a crustal-scale terrane boundary. The Highland Boundary Fault forms the border between the Neoproterozoic - Lower Palaeozoic Grampian Highlands to the north, and the Palaeozoic and Mesozoic Midland Valley to the south. The Drumadoon Intrusive Complex lies to the south of the Highland Boundary Fault, and comprises a dominantly quartz-feldspar-phyric rhyolite sill and the composite intrusions of Drumadoon Point and An Cumhann. The dykes of Cleiteadh nan Sgarbh and An Cumhann generally comprise a central rhyolitic member flanked by xenocryst-bearing basalt/dolerite, often associated with zones of dacite with quartz and feldspar phenocrysts. The main Drumadoon sill predominantly comprises an enclave-bearing rhyolite with associated rhyolite, dacite and xenocryst-bearing dolerite. Rare earth element data indicate the mafic and felsic magmas may have had a similar source at depth, while a Zr vs Nb plot shows the magmas are not related through a sim-

ple parent-daughter fractionation lineage. Least-squares mixing analysis of major and trace elements suggests ∼60:40 mixing of rhyolite and basalt to form the dacite, with the An Cumhann rhyolite and the Drumadoon dolerite as end-members. The magmas also show variation in Sr-isotope ratios, with ranges of 0.70620-0.70797(7), 0.70963-0.71048(1) and 0.71006-0.71202(1) for basalt/dolerite, dacite and rhyolite, respectively. Combined with Nd isotope ratios, these data provide evidence of crustal contamination; with the dolerite preserving some evidence of contamination within the lower crust, while the rhyolite mainly records interaction with upper crustal lithologies. Importantly, the isotope data point towards major involvement of the Grampian terrane, despite the Drumadoon Igneous Complex being located within the Midland Valley crustal block. Therefore, while the magmas originated at depth on the northern side of the Highland Boundary Fault, they have crossed this boundary at some point during their evolution and ascent, most likely during shallow-level emplacement, as all data excepting those from a K-feldspar separate (the latest major mineral phase to crystallise), suggest the Grampian Terrane as the sole crustal influence. Gravimetric studies on the Highland Boundary Fault (e.g. Dentith et al, 1992, Geol. Mag.) suggest a sub-vertical orientation, dipping very steeply to the northwest. Given this geometry, the magma is unlikely to have taken a direct vertical traverse through the crust, but rather experienced an element of horizontal movement, not least during final shallow-level emplacement.