Scales of chemical heterogeneity in felsic magmas: The Fasnia Member, Tenerife, Canary Islands

P.H. OLIN[1], J.A. WOLFF[1] AND C.J. EDGAR[2]

[1]Washington State Univeristy, Pullman, WA 99164, USA (polin@mail.wsu.edu, jawolff@mail.wsu.edu)
[2]Department of Earth Sciences, Monash University, Clayton, Vic 3168, Australia (ST-edgar@mail.earth.monash.edu.au)

The Fasnia Member (~310 ka, 13 km^3) of the Diego Hernandez Formation, Tenerife, is a complex phonolitic eruptive sequence that exhibits geochemical heterogeneity on multiple volume scales. The phonolite composition is close to the minimum at 1 kb water pressure and hence major elements exhibit little variation, but Zr is highly incompatible in this system and is used as an indicator of magmatic evolution. The main fallout units of the deposit (1 - 10 km^3 scale) define non-monotonic zoning between 2,000 and 600 ppm Zr, with, in vertical section, several compositional reversals. The endmember phonolites cannot be related by *in situ* fractionation mechanisms such as sidewall differentiation. Small amounts of mafic and intermediate magmatic components are also present, but are not responsible for significant compositional variations within the phonolite. Within individual depositional layers (0.01 - 0.1 km^3 scale), pumices vary typically by ± 200 and up to ± 400 ppm Zr. LA-ICP-MS analysis of trace elements in pumice glass shows that these heterogeneities in fact exist within single pumice clasts (mm^3 scale). In a few clasts, glass compositions span most of the compositional range of the deposit (750 - 1,800 ppm Zr). The Fasnia phonolite is therefore largely a mixture of two phonolitic liquids with contrasting petrogenesis, preserved on a length scale of tens of microns. The small scale heterogeneities imply very short timescales between mingling of magmatic endmembers and eruption.

Mineral assemblages in the Fasnia Member are complex. Assemblages representing mafic, intermediate and evolved compositions may be present within a single sample. LA-ICPMS analyses of REE in sodic clinopyroxenes have been used to identify the phonolitic liquid(s) from which they grew. We are able to show that one population of pyroxenes probably crystallized from the low-Zr phonolite endmember, whereas the host liquid for the most evolved clinopyroxene compositions, which we infer to be the true high-Zr phonolite endmember, is not preserved among the glass populations.

Petrogenesis of voluminous mixed rhyodacite-basalt ash-flows of the Tertiary Rum Igneous Centre, NW-Scotland

V.R. TROLL[1], C.H. DONALDSON[2] AND C.H. EMELEUS[3]

[1]Dept. of Geology, Trinity College, Dublin 2, Ireland (trollv@tcd.ie)
[2]School of Geosciences, University of St Andrews, St Andrews KY 16 9AL, Scotland (chd@st-andrews. ac.uk)
[3]Dept. of Earth Sciences, University of Durham, Durham DH1 3LE (c.h.emeleus@durham.ac.uk)

The Northern Marginal Zone of the Rum Igneous Centre is a remnant of an early caldera. Intra-caldera breccias and various small-volume pyroclastic deposits are overlain by prominent rhyodacite ash-flow sheets of up to 100m thickness. The ash-flows were erupted from a feeder system near the caldera ring-fault, and intrusive rhyodacite is locally seen to grade into extrusive deposits. A variety of features suggest that the ash-flows were erupted from a chamber that contemporaneously hosted felsic and mafic magmas: **i)** chilled basaltic enclaves in rhyodacite; **ii)** formerly glassy basaltic to andesitic enclaves with fluid-fluid relationships; **iii)** feldspars with thick reaction rims enclosed in mafic enclaves, yet with cores resembling those of the rhyodacite; **iv)** trace element compositions of the rhyodacite and the mafic enclaves fall on mixing lines between the basaltic and the rhyodacite end-members. In addition, Sr and Pb isotopic analysis of the end-member compositions indicate the basaltic magma to be virtually uncontaminated, whereas the rhyodacite seems to contain a substantial crustal component (>50%) derived from local Precambrian amphibolite-facies gneiss.

The combined evidence points to eruption of the rhyodacite ash-flows from an established high-level felsic magma chamber that was periodically replenished by injection of fresh basaltic magma. Mixing between the two magmas was permitted by temperature and compositional differences but was slow due to the contrast in viscosities and densities. The exchange between the two end-member magmas produced hybrid andesite enclaves enriched in trace elements beyond that caused by simple mixing, implying trace element diffusion in addition to bulk mixing. Eruption was caused by replenishment with, and degassing of, the basic magma and the chamber partially evacuated while the process of hybridisation was underway. The basaltic magma is, however, not related to the rhyodacite in a direct parent-daughter lineage. Instead, the two magmas are derived from distinct sources, being thus co-eruptive but not co-genetic.