Antecryst trace element mapping: Solving magma history puzzles

T. UBIDE[1]*, C. A. MCKENNA[1], D. M. CHEW[1] AND B. S. KAMBER[1]

[1]Department of Geology, Trinity College Dublin, Dublin 2, Ireland (*correspondence: teresaubide@gmail.com)

Growth zoning in magmatic crystals is an interesting but cryptic record of magma history [1]. Recent analytical advances have revealed that many large crystals in volcanic deposits, rather than being phenocrysts, are antecrysts whose growth occurred largely prior to eruption. The complex crystal zoning reflects processes in the magma plumbing system, including contamination, recharge and magma mixing [2]. Because events of recharge and magma mixing can trigger volcanic eruptions [3] [4], *in situ* analytical efforts continue into decoding the information locked in antecrysts.

Here we show that laser ablation ICP-MS can be used to obtain high resolution quantitative maps of trace element distribution in antecrysts, unveiling magma histories at greater detail than traditional analytical methods. Maps can be obtained in as little time as 1 hour, can resolve complexities smaller than the laser beam diameter (< 10 μm) and remove less than 1 µm of thin section material. Therefore, it is feasible to ablate the identical map area many times with varying instrument parameters or analyte menus to get different levels of detail and chemical information.

In the current study, LA-ICP-MS maps of clinopyroxene and amphibole antecrysts from Mount Etna basalts will be presented. These crystals define very sharp compositional zoning, highlighting events of mafic recharge as zones enriched in compatible metals such as Cr, Ni or Sc. A consistent feature of the antecrysts is oscillatory zoning in compatible elements, suggesting multiple mafic recharge events. This observation opens the question of why some recharge events were effective triggers of volcanic eruptions whereas others were not or were unable to drag crystals towards the surface. We propose that maps of glomerocrysts or crystals from mushes disaggregated prior to eruption, may hold important information.

When coupled with diffusion modelling, LA-ICP-MS trace element maps may eventually help to improve our understanding of processes in the magmatic environment and beyond.

[1] Streck (2008) *Rev. Mineral Geochem* **69**, 595-622. [2] Davidson *et al.* (2007) *Ann. Rev. Earth Planet Sci* **35**, 271-311. [3] Reuby & Blundy (2007) *Nature* **461**, 1269-1273. [4] Kent *et al.* (2010) *Nature Geoscience* **3**, 631-636.