1000 years of magmatic volatiles recorded in apatite from Arenal volcano

J.W. BOYCE[1,2]*, R.L. HERVIG[2], G.E. ALVARADO[3], R.C. NEWTON[1] AND C.E. MANNING[1]

[1]Department of Earth and Space Sciences, UCLA, Los Angeles, CA, USA 90095-1567 (*correspondence: jwboyce@alum.mit.edu)
[2]School of Earth and Space Exploration, ASU, Tempe, AZ, USA 85287-1404
[3]Departamento de Geologia, Instituto Costarricense de Electricidad, Apt. 10032, San Jose, Costa Rica

Apatite phenocrysts can record variations in magmatic volatile chemistry by their incorporation of H, Cl, F, C, and S. This makes apatite a useful tool for understanding the open-system magmatic processes that affect volatiles, such as degassing, recharge, mixing, and contamination. Apatite can also provide a temporal framework for melt inclusions, which are often difficult to "date" – even in a relative sense [1].

We report here 151 new SIMS measurements of H, F, and Cl in apatite from Arenal volcano, Costa Rica. Two xenoliths from a ~1020AD block and ash flow both yield large (up to 1mm) euhedral, elongate apatite prisms. Both populations of apatite are OH-rich (with OH/(F+Cl+OH) > 20% by mole), but apatite from xenolith "A" are homogeneous, with low F/Cl (~0.3), while the apatites from "B" are consistently and smoothly zoned in H and Cl, with H- and F-rich cores (F/Cl ~ 2), and rims with lower H and F/Cl of ~1. This zoning is consistent with diffusive reequilibration of these volatile elements over timescales of tens to hundreds of hours [2].

Subhedral to anhedral apatite fragments were also recovered from several other Arenal units erupted in the last thousand years: Analyses of apatites from the ET3 tephra (1080AD) and a 1968AD surge deposit define a compositional field that extends from at/near the two cumulate compositions (OH- and Cl-rich) to very F-rich apatites, consistent with the preferential loss of H and Cl over F from magmas during degassing.

These apatite phenocysts reveal a consistent pattern of volatile evolution in units erupted over a ~1000 year time period, and suggest that Cl+H_2O rich reservoirs (such as that represented by the apatite-rich xenolith lithologies) may influence the bulk volatile chemistry of all of these units. Apatite can also constrain the timescales of incorporation of these xenoliths, pending further experiments to constrain the pressure dependence of F-Cl-OH exchange in apatite [2].

[1] Boyce & Hervig (2009) *Con. Min. Pet.* **157** (2), 135-145.
[2] Brenan (2009) *Chem. Geo.* **110**, 195-210.

A first look at GEOTRACES issues from the IPY BONUS GOODHOPE cruise in the Southern Ocean

M. BOYE[1], E. ACHTERBERG[2], J. BOWN[1], E. BUCCIARELLI[1], D. CARDINAL[3], N. CASSAR[4], A.-J. CAVAGNA[5], F. CHEVER[1], F. DEHAIRS[5], R.A. FINE[6], J. HAPPELL[6], W. JOUBERT[7], F. LE MOIGNE[1], P. MASQUÉ[8], P. MONTEIRO[7], F. PLANCHON[3], G. SARTHOU[1], E. VERDENY[8,9], B. WAKE[1,2] AND H. WALDRON[7]

1LEMAR-IUEM, Brest, France (marie.boye@univ-brest.fr)
[2]NOCS, Southampton, United-Kingdom.
[3]Royal Museum for Central Africa, Tervuren, Belgium.
[4]Princeton University, USA
[5]Vrije Universiteit Brussel, Brussel, Belgium
[6]RSMAS, Miami, USA
[7]CSIR-UCT, Capetown, South Africa
[8]Institut de Ciència i Tecnologia Ambientals, Universitat Autonoma de Barcelona, Spain
[9]University of South Carolina, Columbia, USA

Trace metals play a key role in marine ecosystems. Several ocean processes can be inferred by trace elements and isotopes such as production and export to deep waters, water-masses ventilation and pathways, sedimentary and atmospheric sources. The multi-tracers approach is key issue of the international GEOTRACES program which had its flying start in IPY 2007-2008. The Bonus-Goodhope expedition took place in the Atlantic sector of the Southern Ocean from Capetown southward to 57°S along the zero meridian in late summer 2008, onboard Marion Dufresne. Surface enrichment of Fe in the subtropical sector was likely due to atmospheric source and South-African margin inputs through eddies transportation, while deep-sea plumes of high Fe over the ocean ridge crests and in AABW were probably due to sedimentary resuspension. Dissolved Al, Mn, Cd, Co, Zn in combination with their speciation, the ocean and atmospheric biogeochemistry and dynamics in the section will further highlight the internal cycle of these elements. Inferences from the abundance of oxygen isotopes versus Ar, and by ^{15}N uptake rates indicate high regenerated production in the oligotrophic subtropical domain, and beyond as well as at the SACCF. New production accounts for up to 40-60% of the production in the subantarctic region toward the southern side of the Polar Front, the later consisting of a late summer diatom post-bloom. Export fluxes and mineralization processes assessed by $^{234}Th/^{238}U$ and $^{210}Po/^{210}Pb$ disequilibria and Ba_{part}, suggest relatively higher export carbon fluxes from the mixed layer in the PFZ, at PF, at SACCF and in the Antarctic Zone, while remineralization rates could be more significant in the mesopelagic zone in the PFZ. The lowest export flux of the section is observed in the Weddel Gyre, and the lowest remineralization rates in the SAZ and STZ. The CFC's, Si* signatures and macro-nutrients were powerful tracers for tracking water-masses and the mesoscale structures that crossed the section. Finally Bonus-Goodhope and Zero&Drake aboard Polarstern achieved intercalibration stations for TEI's providing crucial statements to accurately interpret the whole transect of several TEI's from Capetown to the Antarctic Peninsula along the zero meridian during IPY.