Systematic tapping of independent magma chambers during the 1 Ma Kidnappers supereruption

G.F. COOPER*, C.J.N. WILSON AND J.A. BAKER

SGEES, Victoria University, PO Box 600, Wellington, NZ (*correspondence: george.cooper@vuw.ac.nz)

The 1.0 Ma Kidnappers eruption (~1200 km^3 bulk volume) from Mangakino volcanic centre produced the largest phreatomagmatic fall deposit in New Zealand, followed by the most widespread ignimbrite on Earth [1]. Samples collected through a proximal 4.0 m section of the Kidnappers fall deposit, representing the first 60-70 % of erupted material, reveal multiple, independent magma chambers of comparable size were tapped during the eruption. Evidence for this includes the following: (i) Major and trace element chemistries of individual matrix glass shards define three glass populations (types A, B and C), which display a systematic change through the fall deposit. (ii) Plagioclase, hornblende and Fe-Ti oxide compositions show bimodal distributions, corresponding to type A and B glass compositions, with a minor tail corresponding to C. (iii) Type B glass shards and biotite first appear at the same level in the fall deposit suggesting the later tapping of a biotite-bearing magma. (iv) Compositional gaps between glass types A and B imply that no mixing between these magmas occurred.

Parallel covariant trends in glass trace element chemistry indicate at least two independent magmas (A, B) underwent a parallel evolution with respect to crystallizing plagioclase and zircon. Temperature and pressure estimates from hornblende and Fe-Ti oxide equilibria from each magma type show that the two magma chambers were similar and therefore adjacent, not vertically stacked, in the crust. Hornblende temperature and pressure estimates from magmas A and B range from 770 to 860°C and 90 to 220 MPa corresponding to magma chamber depths of *ca*. 4 to 8 km. Hornblende pressure estimates coupled with *in situ* trace element fingerprinting imply that a horizontal stratification was also present in both of the A and B magma chambers. Pumice glass analyses from the subsequent ignimbrite display a broader compositional range than the fall deposits indicating the discharge of magma(s) that are not represented earlier in the eruption. This work has implications for understanding the dynamics of large (‘super‘) volcanic events and how such large volumes of silicic magmas are generated, stored and erupted.

[1] Wilson *et al*. (1995), *Nature* **378**, 605-607.

Distinguishing between open and closed system magma differentiation at arc volcanoes by combining U-series and elemental systematics

L.B. COOPER[12]*, O. REUBI[1], M. DUNGAN[2], B. BOURDON[3] AND C.H. LANGMUIR[4]

[1]Inst. of Geochemistry and Petrology., ETH Zurich, Switzerland (correspondence: lauren.cooper@erdw.ethz.ch)
[2]Sect. of Earth Sciences, Univ. of Geneva, Switzerland
[3]Ecole Normale Supérieure de Lyon and CNRS, France
[4]Dept. of Earth and Planetary Sciences, Harvard Univ., USA

Constraining crustal assimilation in volcanic arcs is important because crustal components can be added during both mantle melting and magma ascent. Reubi *et al*. [1] present evidence for up to 10-15% assimilation of crust at Volcán Llaima (38.7°S), Chilean Southern Volcanic Zone, resulting in a diminution of U-series excesses from mantle signatures towards U-rich plutonic endmembers on the equiline. These trends strongly correlate with trace element indices of contamination over 51-57 wt% SiO_2. Llaima is now a very well-characterized volcano with respect to U-series activity ratios (U-Th-Ra-Pa), with 28 historic samples selected from >180 on the basis of major and trace elements. These data will be used to model differences in magma evolution in seven historic eruptive episodes (1640-2009).

In order to evaluate along-arc variations in crustal contributions, we have analyzed five selected samples from nearby Volcán Lonquimay (30 km NE of Llaima, 38.4°). Major and trace element variations over 52-63 wt% SiO_2 provide much less evidence for open-system processes than that recorded by the more contaminated Llaima samples (Rb/Zr=0.12-0.31 at Llaima versus 0.14-0.17 at Lonq.). U-series activity ratios for Lonquimay are constant and overlap with the least contaminated Llaima samples. And, simple equilibrium phenocryst assemblages in the Lonquimay lavas suggest that magma evolution is controlled almost exclusively by closed-system crystal fractionation. The cause of the Llaima/Lonquimay contrast remains unclear. Llaima is larger and more active than Lonquimay, perhaps leading to a higher efficiency of assimilation.

With the further constraints provided by U-series, greater quantitiative understanding of the extent and causes of crustal contamination will become possible. Much of the earlier data from southern Chile may need to be re-evaluated. More U-series studies are currently underway at Nevados de Chillán (36.8°), Antuco (37.3°), Villarrica (39.5°), and Osorno (41°).

[1] O. Reubi *et al*. (2011) *Earth Planet Sci Lett* **303**, 37-47.