Timescales of petrogenesis in an active caldera, Rabaul, Papua New Guinea

H.S. Cunningham[1], S.P. Turner[1], A. Dosseto[1], S. Eggins[2]

[1]GEMOC ARC National Key Center, Macquarie University, NSW 2109, Australia (hcunningham@els.mq.edu.au)
[2]Department of Geology, Australian National University, Canberra, ACT 0200, Australia

Understanding shallow crustal processes in caldera systems is essential for volcanic hazards assessment. Rabaul caldera, Papua New Guinea provides a unique place to study caldera-related eruptions. Volcanic activity has increased over the past 500 years with recent eruptions in 1878, 1937–1943 and 1994-present. Intermittent activity over the past 12 years have provided a stratigraphically controlled data set that can be used to monitor short- and long-term changes in magma composition and degassing. Geophysical data show two chambers reside at 3–4 and 9–12 km (Bai and Greenhalgh, 2005).

Petrogenetic modeling has been used to understand Rabaul's magmatic evolution. Andesite and dacite are the most common rocks types. Basaltic blebs are noted in the 1878 and 1937 lavas. Major and trace element compositions of 1878 and 1937 can be modeled by crystal fractionation (Wood et al., 1995). However, the observation of mixed phenocryst populations and reversely zoned phenocrysts (Patia, 2004) along with linear arrays on Sr/Ba vs 1/Ba diagrams indicates magma mixing. Variations of the Ba/Th ratio suggest fluctuations in the relative contribution of fluids with time. Interestingly, the data show that magma mixing and the homogenization of fluid influxes occurs over a period of years. Sr and Nd isotopes are relatively invariant and preclude assimilation of ancient crust. $^{87}Sr/^{86}Sr$ and $^{143}Nd/^{144}Nd$ range from 0.70372 to 0.70446 and 0.51293 to 0.51301, respectively.

Uranium-series isotopes have been analyzed to constrain crustal residence times and rates of degassing. Activity ratios from ($^{238}U/^{230}Th$) range from 1.07 to 1.39 and for ($^{230}Th/^{232}Th$) range from 1.58 to 1.65. ($^{226}Ra/^{230}Th$) range from 1.50 to 1.85. ($^{210}Pb/^{226}Ra$) range from 1.0 to 1.8. Excesses in ^{238}U and ^{226}Ra suggest that rapid fluid influx has occurred within the past 350 kya and 8000 yrs. ^{210}Pb excesses suggest periods of rapid gas accumulation over months to years. Fluctuations in U–Th–Ra–Pb between 1994 and 2001 allow us to monitor shallow crustal processes including crystal fractionation, magma input and degassing.

References

Bai, C., Greenhalgh, S., 2005. *Phys. Earth Planet. Int.* **151**, 259–275.
Wood, C.P., Nairn, I.A., McKee, C.O., Talai, B., 1995. *J. Volcanol. Geotherm. Res.* **69**, 285–302.
Patia, H., 2004. *BSC Thesis.* 111 p.