Li isotopic variations in Eastern Australian granites

C.J. Bryant[1], B.W. Chappell[2], V. C. Bennett[1] and M.T. McCulloch[1]

[1]Research School of Earth Sciences, Australian National University, Canberra, Australia. Colleen.Bryant@anu.edu.au
[2]GEMOC, Macquarie University, North Ryde, Australia.

The large fractionation of Li isotopes during low temperature processes makes this system a potentially powerful tracer of fractionation processes within Earth's crust and mantle. Isotopic compositions of 36 granites from the well-documented and chemically diverse New England Batholith (NEB) of eastern Australia are extremely variable with δ^7Li from –1.3 to +8‰ (relative to L-SVEC). The S-type granites define a narrow isotopic range (δ^7Li = -0.1 to +2.1‰). Lower δ^7Li relative to I-type granites is attributed to the preferential loss of ^{7}Li during weathering of sedimentary precursors. With the exception of the reduced granites from the Uralla supersuite, NEB I-type granites have δ^7Li values (δ^7Li = +1.9 to +8.0‰) equivalent to those of modern arc lavas (typically δ^7Li = +2 to +8‰). The similarity in δ^7Li between I- and S-type granites and arc lavas and shales (δ^7Li = -3 to +3‰; [1]), respectively, indicates minimal fractionation overall during partial melting processes, i.e. Li isotopic compositions of granites closely reflect those of the source components.

Overall, I- and S-type granites from the NEB are heavier than those from the Lachlan Fold Belt and China (δ^7Li = -3 to +3‰; [1]), indicating significant regional-scale variability in δ^7Li within the crust. Higher δ^7Li values in NEB granites relate to the juvenile nature of the crust in this region, which was primarily generated through subduction-related processes. Consequently, Li isotopic studies of granites can potentially provide constraints on the Li isotopic composition of the lower-middle crust, and the dominant mechanisms of crustal growth and differentiation through time, particularly in relation to the extent of sedimentary reprocessing both within the crust and through subduction zones. However, in order to do this we require a greater understanding of the origin of significant heterogeneities evident within arc lavas, i.e. to what extent these reflect variable subducted sediment contributions compared with isotopic fractionations generated within the dehydrating slab (e.g., [2]). The latter may be particularly significant if major crustal growth episodes during the Archean are the product of shallow-level boninitic-style volcanism. The potential for significant isotopic fractionation at shallow mantle depths is currently being investigated in a study of boninites by the author.

References

[1] Teng et al. 2002. *EOS Trans. AGU,* 83, V61D-12.
[2] Zack et al. 2003. *Earth Pl. Sci. Lett.,* 208, 279-290.

The Rooiberg Group: Early Bushveld-related volcanism

P. C. Buchanan[1], C. Koeberl[2] and W. U. Reimold[3]

[1]National Institute of Polar Research, 1-9-10 Kaga, Itabashi-ku, Tokyo 173-8515 JAPAN (buchanan@nipr.ac.jp)
[2]Dept. of Geological Sciences (Geochemistry), University of Vienna, Althanstrasse 14 A-1090, Vienna, Austria
[3]School of Geosciences, University of the Witwatersrand, Private Bag 3, WITS 2050 Johannesburg, South Africa

The Rooiberg Group of South Africa is a voluminous (~6 km thick) series of predominantly volcanic rocks with minor interbedded sediments. These strata represent the earliest phase of Bushveld-related magmatism and, in some areas, comprise the floor and roof rocks of the mafic-ultramafic intrusive phase of the Bushveld Complex.

Rooiberg Group strata are distinguished by a general increase in SiO_2 abundance with increasing stratigraphic height and include, in ascending order, the Dullstroom, Damwal, Kwaggasnek, and Schrikkloof Formations (Schweitzer et al., 1995). Rock types range from predominantly basaltic andesites in the lower Dullstroom Formation to predominantly rhyolites in the overlying formations. The basaltic andesites represent two compositional groups: low Ti (TiO_2<1.0 wt.%) and high Ti (TiO_2>1.0 wt.%). Low Ti and high Ti melts are best explained by partial melting of compositionally distinct source areas (Buchanan et al., 1999). Compositions of overlying units suggest derivation from low Ti melts (Buchanan et al., 1999, 2002).

Among low Ti basaltic andesites and overlying units, increasing SiO_2 contents correlate with increasing abundances of incompatible trace elements and with decreasing abundances of Sc, Co, Sr, CaO, and Al_2O_3 (Buchanan et al., 1999, 2002). Compositions of all of the volcanic rocks of the Rooiberg Group suggest interaction of magmas with continental crust. Compositional and isotopic data are consistent with fractional crystallization and assimilation of crustal material by mantle melts or hybrid melts. Rooiberg Group strata represent magmas that were derived from at least two distinct source areas and experienced fractional crystallization and assimilation of crustal material in two or more shallow magma chambers.

References

Buchanan P.C., Koeberl C. and Reimold W.U., (1999), *Contrib. Mineral. Petrol.* **137**, 133-146.
Buchanan P.C., Reimold W.U., Koeberl C. and Kruger F.J., (2002), *Contrib. Mineral. Petrol.* **144**, 131-143.
Schweitzer J.K., Hatton C.J. and de Waal S.A., (1995), *S. Afr. J. Geol.* **98**, 245-255.