Annite: magmatic evolution and subsolidus alteration in nepheline syenites, Mount Saint-Hilaire, Quebec, Canada

AZIN ZANGOOI

Earth & Planetary Sciences, McGill University, 3450 University St., Montreal, Quebec, Canada H3A 2A7 (azinz@eps.mcgill.ca)

Mount Saint-Hilaire (MSH) forms part of the Monteregian alkaline SiO_2-undersaturated intrusions, first grouped and described by Hunt (1859). At MSH, the East Hill suite (Currie *et al.* 1983), is well exposed in the Poudrette quarry, where the samples were collected for this research. Nepheline syenite represents the most highly differentiated product of igneous activity at MSH. It also records a significant subsolidus overprint due to circulation of post-magmatic fluids. Annite forms about 20% of the typical nepheline syenites, and can be a sensitive monitor of magmatic phenomena and of post-magmatic alteration. Annite has been analysed from porphyritic nepheline syenite, poikilitic nepheline syenite, Poudrettre dyke (nepheline syenite pegmatite), sodalite syenite, and completely altered nepheline syenite by means of electron-microprobe to document the evolution of annite in terms of composition and its textural development. Altered nepheline syenites are also characterized by transmission electron microscopy and XRD to elucidate the modification of the layers as well as the existence of micro-inclusions along the cleavage planes of annite. Although crystallization sequence of porphyritic and poikilitic syenites are markedly different, and reflect kinetic effects in addition to compositional factors, annite crystallizes in later stages of solidification of poikilitic nepheline syenites. The most recent map of the Poudrette quarry has been done by the author.

References

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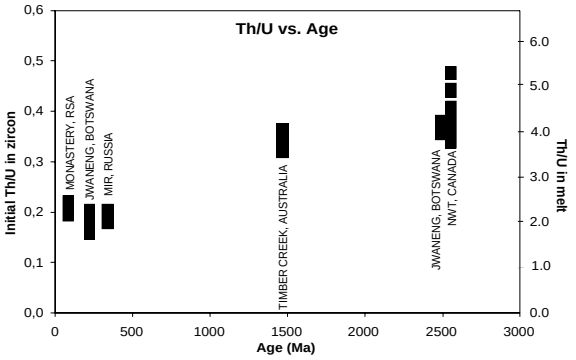
Evidence from kimberlitic zircon for a decreasing mantle Th/U

R. E. ZARTMAN AND S. H. RICHARDSON

Department of Geological Sciences, Univ. of Cape Town, Rondebosch 7700, South Africa (rzart@yahoo.com)

A decoupling in MORB of measured Th/U (κ=2.7) from that calculated by Pb isotopes (κ=3.8) for the depleted asthenosphere is well established, and has been referred to as the second Pb paradox [1] or the kappa conundrum [2]. More controversial has been the cause and timing of this phenomenon, although the recycling of crustal Pb together with a higher return flux of U^{+6} relative to Th^{+4} into the mantle offers a plausible explanation. Such a mechanism operating over the past 2.5 Ga was modelled in Plumbotectonics [3], and found to be quantitatively feasible.

A large TIMS, ICP-MS, and IMP database of Th and U concentrations for kimberlite-hosted zircon, particularly from Cr-poor megacrystic suites, now exists [4-8]. Six suites comprised of 10 or more zircon reveal consistent patterns when plotted on Th/U vs. U diagrams. We interpret these patterns as resulting from fractional crystallization of a kimberlite-related fluid, permitting the extrapolation to an initial Th/U at the time zircon crystallization began. *[Omitted are zircons, especially with high U contents, that appears not related to simple fractionation but may be of metasomatic origin.]* A consistent decrease occurs in the zircon's initial Th/U over the past 2.5 Ga (see figure), suggesting that a similar change has occurred in the coexisting fluid. Estimates of Th and U distribution coefficients between zircon and melt permit calculation of Th/U in the melt, which, for these highly incompatible elements, should be the same as for its mantle source rock. Thus, kimberlitic zircon may indeed record a ~x2 reduction in κ since the Archean for the depleted asthenosphere.



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