# THE TIMING OF METASOMATIC ENRICHMENT IN THE SUB-AUSTRALIAN LITHOSPHERIC MANTLE

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## ABSTRACT

Time-integrated depletion of LREE and LIL is a characteristic of the sources of much intraplate alkaline volcanism yet these volcanics have high LREE and LIL contents. Melting models explain moderate and variable degrees of trace element enrichment from trace element depleted sources but in many cases source enrichment must also be advocated. The nature and timing of this enrichment process and the relationship with the associated magmatism remains an unresolved and much debated issue.

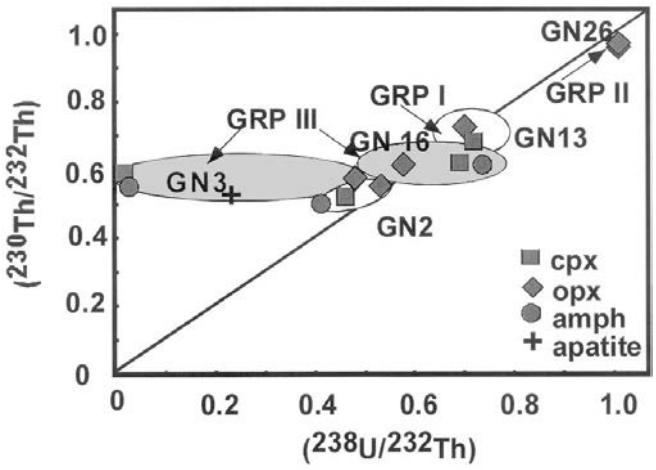


Figure 1 - U/Th equiline diagram.

Here we report a U-Th-Sr-Nd-Pb isotope study of spinel lherzolite xenoliths from the Recent Gnotuk Maar, Victoria, Australia. The young eruption age of the xenoliths will allow unambiguous resolution of the cause of any trace element enrichment; pre- or syn-magmatism. The xenoliths record three styles of petrographic and trace element enrichment. Group II hydrous lherzolites with Ti-rich amphibole ±phlogopite are LIL and LREE enriched $(La/Yb)_N$ ~10 with a similar Sr-Pb-Nd isotope signature to the host Victorian Newer Volcanics ($\varepsilon_{Sr}$ -14 to 0).

Group III hydrous lherzolites contain Ti-poor amphibole ±phlogopite ± apatite and are markedly LIL and LREE enriched $(La/Yb)_n$ up to 75 with Nd and Sr isotope signatures with greater time-integrated enrichment than the host volcanics ($\varepsilon_{Sr}$ -4 to + 15). Group I anhydrous lherzolites have $(La/Yb)_N$ = 10 and time-integrated LIL and LREE enriched sources ($\varepsilon_{Nd}$ -3; $\varepsilon_{Sr}$ +44). Minerals from the anhydrous lherzolites are in U-series equilibrium ($^{230}Th/^{232}Th$ = 0.7) and hence have been unaffected by recent magmatism consistent with a Proterozic enrichment event implied by the Sr-Nd-Pb isotope ratios (figure 1). In contrast Group II and III minerals are in disequilibrium with $^{238}U$ excesses reaching >100% in Group III. In detail the two groups of hydrous xenoliths have distinct isotopic systematics implying interaction with distinct metasomatic agents, one of which is related to the host magmatism. These systematics establish that the lithospheric mantle beneath Victoria has undergone at least three different periods and styles of trace element enrichment, the last of which was related to recent magmatism.