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$^{87}Sr/^{86}Sr$ in spinel peridotites from Borée, Massif Central, France: melt depletion and metasomatism in the sub-continental lithospheric mantle

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Radiogenic isotopes and elemental concentrations in peridotite xenoliths may be used to model the timing and degree of partial melting in the upper mantle, but this primary melt depletion signature may be overwritten by subsequent episodes of melt or fluid infiltration. Spinel peridotites from the Maar de Borée, Massif Central, France have mainly poikilitic protogranular textures and clear petrographic evidence of a melt phase apparently unrelated to host basalt infiltration. Bulk rock major and compatible trace element concentrations are consistent with varying degrees of partial melting but incompatible trace element concentrations indicate cryptic metasomatism in some samples. Lithophile trace element mass balance cannot always be reconciled by the inclusion of the chemically characterized melt phase and suggest a contribution from a trace abundance grain boundary phase[1].

$^{87}Sr/^{86}Sr$ values for unleached bulk rocks and clinopyroxene mineral separates are higher than those for their leached equivalents, consistent with the removal of a radiogenic grain boundary phase. While unleached bulk rock $^{87}Sr/^{86}Sr$ is sometimes indistinguishable (within error) from its constituent unleached clinopyroxene, in two samples they show distinct patterns, as do the REE trends in these two xenoliths.

BO01-01 bulk-rock is LREE-enriched (La/Yb_N = 3.6)[2], and constituent clinopyroxene shows a similar relative enrichment trend. Bulk-rock $^{87}Sr/^{86}Sr$ is 0.70342$\pm$1 while that of clinopyroxene is lower at 0.70332$\pm$2. Clinopyroxene modal abundance is 11%.

BO01-03 bulk-rock is only slightly LREE-enriched (La/Yb_N = 1.2) and both bulk-rock and clinopyroxene show a generally flatter profile. Bulk-rock $^{87}Sr/^{86}Sr$ is 0.70285$\pm$1 while that of clinopyroxene is in this case higher at 0.70296$\pm$2. Clinopyroxene modal abundance is also higher at 15%, consistent with a greater contribution by clinopyroxene to the bulk-rock Sr-isotope budget.

The results appear to be inconsistent with a simple model of single-stage melt extraction followed by single-stage trace element enrichment and imply a more complex sequence of possibly multiple melt depletion and metasomatic events, similar to those described by previous authors, and likely to include infiltration of C-O-S-H-rich fluids and/or silicate melt.[3,4,5,6,7]

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