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Nature of the subcontinental lithospheric mantle beneath Tasmania, Southeast Australia: implications for metasomatism

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Anhydrous spinel lherzolite xenoliths from four localities (East Round Lagoon, Sideling, Doctors Rocks and Sandy Creek) in Tasmania (Southeast Australia) have been studied to characterize the subcontinental lithospheric mantle (SCLM) beneath Tasmania. The whole rock compositions of the xenoliths suggest that the SCLM has experienced variable degree of melt extractions. Geothermometry of orthopyroxene and clinopyroxene pairs gives temperature of 910-1180 ºC for the studied xenoliths.

In the majority of the studied xenoliths, the clinopyroxene has a characteristic REE pattern showing a gradual decrease from HREE to MREE (Pr, Nd) with a steep inflection for the LREE ($(La/Yb)N \approx 1$-8; $(Pr/Yb)N < 1$ and $(La/Pr)N \approx 1$-25). These features, together with the strong Zr, Hf, Ti, Nb, Ta depletion and U, Th enrichments are consistent with the trace element composition found in carbonatities and carbonated peridotites.

Moreover, the lack of carbonatite phases and hydrous minerals in the xenoliths, as well as the LREE enrichment, may indicate that carbonatitic fluids played a more important role in forming the observed signature than carbonatitic melt, and caused cryptic metasomatism. Clinopyroxenes have unusual low Zr/Hf ratios, suggesting fractionation of Zr from Hf, which is common for carbonatites.

In Primitive Mantle (PM) normalized whole rock and cpx, REE abundances have patterns that are sub-parallel to each other, indicating that the whole rock REE patterns are controlled by the cpx REE abundances. In some cases, the PM normalized REE patterns are not parallel to each other, suggesting that additional metasomatic agent(s) affected these xenoliths. These decoupled REE patterns appear to be most significant in the samples which contain more evidence for incipient melting (i.e. resorbed pyroxenes, interstitial glass with a second generation of small crystals of olivine and clinopyroxene) that was likely caused by alkali silicate melt/fluid infiltration (host basalt?) accompanied by thermal and decompressional effects. Thus, the intergranular host basalt infiltration could be responsible for the observed discrepancy in REE measured in the clinopyroxene and the whole rock xenoliths.