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REE AND SR-PB-ND ISOTOPE GEOCHEMISTRY OF TIBETAN PERIDOTITES: IMPLICATIONS FOR MELTING PROCESSES

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ABSTRACT

It is ubiquitously accepted that mantle peridotite are residue after melting and are formed after extraction of variable amount of MORB type melt (Prinzhofer and Allègre, 1985; Jonhson et al., 1990; Snow et al., 1994). For this reason, they are a key in understanding melting in the mantle and melt extraction processes. They also provide information about mantle source heterogeneity and constraints on temporal evolution of the mantle. Nevertheless petrogenetic studies of ophiolite complexes generally concentrate on the magmatic oceanic crust. Trace elements and isotopic studies of highly depleted peridotite are rare partly due to their extensive alteration and weathering. Moreover Radiogenic and REE are found in very low concentration in mantle peridotites meaning that it is difficult to obtain high quality data.

The Tibetan ophiolites provide a unique opportunity to study mantle processes because they are fresh (<10% serpentinisation) and well exposed. We have used ID ICP-MS and NdO techniques to measure REE and Nd isotopes in these highly depleted peridotites.

We present major, trace element and Nd isotope data of 15 harzburgites from Luobusa ophiolite massif, Tibet. The aim of this study is to obtain a better understanding of the mantle processes that lead to the geochemical characteristics of these residues and to the formation of the oceanic crust.

The Luobusa peridotite massif is situated in the Yarlung Zangbo Suture Zone and is assumed to have the same formation and emplacement ages as the Xigaze ophiolite (respectively 110 and 50 Ma). The massif is 43 km by 3-5 km. It has a mantle sequence mainly composed of diopside-bearing harzburgites with abundant dunite lenses and podiform chromitites that are residual after extraction of tholeitic (MORB type) magmas (Zhou et al., 1996). Remains of the oceanic crust (cumulates rocks, pillow lava, marine sediments) are present in a melange zone tectonically overlying the mantle peridotites (Zhou et al., 1996).

The major element compositions of Luobusa peridotites show a large range of variation: CaO and MgO contents vary between 0.6 and 2 wt% and 42.1 and 45.1 wt% respectively. There is an excellent correlation between major element contents (e.g., Al_2O_3 or CaO) and HREE. Similar relationships have been reported elsewhere and are consistent with HREE depletion being associated with the loss of Al- and Ca-rich phases during melting.

Luobusa peridotites have REE patterns with subparallel HREE and constant MREE depletion. LREE are significantly more variable. Some samples are highly depleted in LREE, with minimum values of La at 0.004 x chondrite. Other have a "spoon-shaped" REE patterns, with a marked inflection at Sm. Their $(Ce/Sm)_N$ ratios varies between 0.2 and 0.9 and reflected different degree of LREE enrichment. The $(^{143}Nd/^{144}Nd)_i$ ratios vary between 0.5120 and 0.5130 and Sm/Nd from 1.1 to 3. $(^{143}Nd/^{144}Nd)_i$ also correlates positively with $(Ce/Sm)_N$. The degree of LREE depletion in the peridotites is controlled by stratigraphic position: shallow peridotites being characterised by the highest $(Ce/Sm)_N$ and the highest depletion in HREE . Together with the "spoon-shaped" REE patterns, these data imply that either melt was trapped in the residua during the extraction process or that the residua have been subsequently LREE enriched by melt addition.

Similar observations have been made for other peridotites massif (Voykar and Trinity) and several possible mechanisms have been put forward to explain the geochemical data. The high degree of depletion of the Tibetan peridotites implies that they have recorded a multistage melting event. The samples with LREE depleted and high Nd ratios probably represent the residue after MORB type melt extraction from a previous depleted source. The LREE enrichment can be explained by 2 alternatives models: 1)- Melt/Residue interaction in a chromatographic column (Navon and Stolper, 1987; Bodinier et al., 1990 and others) or 2)- Crustal contamination either in a supra-subduction environment or during emplacement of the ophiolite (Sharma and Wasserburg, 1996; Gruau et al., 1998). The large range in Nd isotopic composition and the presence of samples showing less radiogenic Nd ratios associated with the highest degree of LREE enrichment tend towards the second alternative: a second melting event in a supra-subduction zone. This idea is also supported by the composition of the chromite pods present in the Luobusa massif that show boninite affinity (Zhou et al., 1996). This preliminary study show that the LREE enrichment is not as extensive as reported for other massif and tend to suggest that the geochemical characteristics are mantle melting related feature and not due to secondary alteration by infiltrating groundwater.

The detailed REE and Sr/Pb/Nd isotope analysis of minerals are underway and will constrain the nature and the provenance of the melt involved and the succession of processes that occurred in the melting column and the geodynamic environment in which the massif was formed.

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