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Evolution History of Mantle Peridotites in the Xigaze Ophiolite: Constraints from Whole-rock and Mineral Geochemistry

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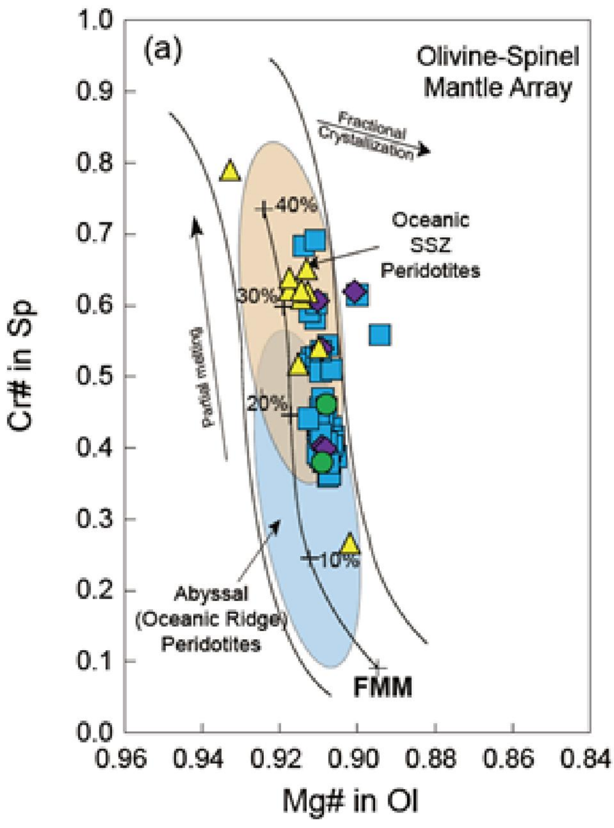

Fig.1 Diagram of Olivine-Spinel Mantle Array (OSMA)

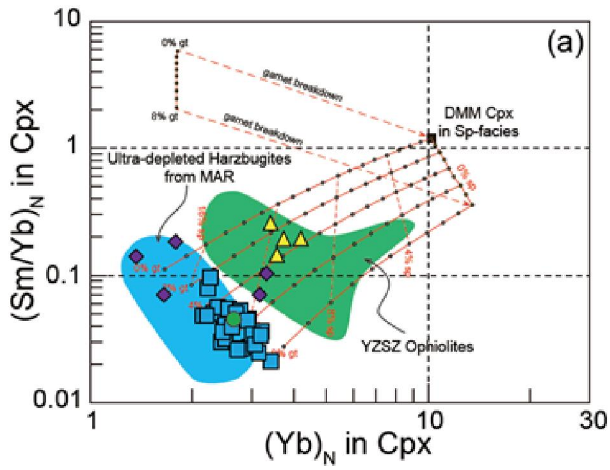

Fig.2 $(Sm/Yb)_N$ in Cpx vs $(Yb)_N$ in Cpx, illustrating that the peridotites in Luqu ophiolite have undergone partial melting in garnet stability field, followed by melting in spinel stability field.

Ophiolites along the E-W trending Yarlung-Tsangpo Suture (YTS), which separates the Indian plate from the Eurasian plate, have been regarded as relics of the Neo-Tethyan Ocean. The Xigaze ophiolite in the central YTS has been extensively studied. One of the most intact crust-mantle sequences is preserved in the Luqu (or Beimarang) ophiolite. Mantle peridotites of the Luqu ophiolite are dominated by harzburgites, with 55%–65% olivine, 30%–40% orthopyroxene, 1%–5% clinopyroxene and 1%–3% spinel. Minor lherzolites and dunites are also outcropped, and the mode contents of clinopyroxene in lherzolite can be locally up to 10%.

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This contribution presented whole-rock major element and mineral chemistry including EMPA (Electronic MicroProbe Analysis) and clinopyroxene in situ trace elements. Whole rock Al_2O_3 (0.23%–2.05%) and CaO (0.41%–1.7%) contents are very low but show obviously inverse correlation with MgO (39.7%–47.0%), indicating that the Luqu peridotites are residues of variable degrees of partial melting. This is supported by the $Cr^{\#}$[=molar Cr/(Cr+Al)] values of spinels which vary from 0.36 to 0.69. Meanwhile, the high $Cr^{\#}$ values of spinels and homogenously high $Mg^{\#}$ [= molar $Mg/(Mg+Fe^{2+})$] values of olivines, clustering at 0.91, indicate high degrees of partial melting (Fig. 1). The low REE (rare earth elements) concentrations and chondrite-normalized distribution partterns of clinopyroxenes reflect ultra-depleted natures, with most showing LREE (light REEs) and MREE

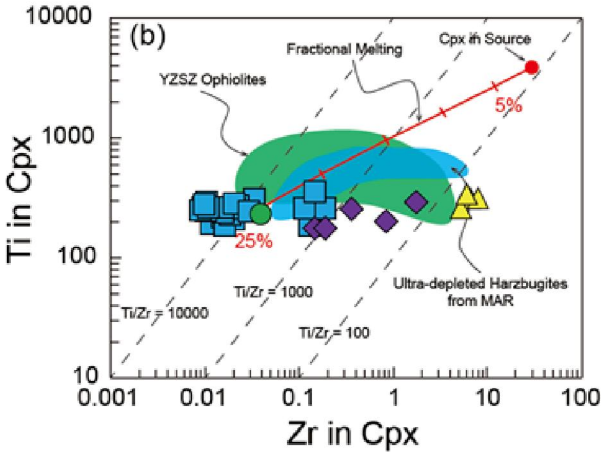

Fig.3 Zr in cpx vs Ti in cpx, showing Zr and Ti contents are very fractionationed by the fractional melting process (Ti/Zr ratios can reach to 10000 and more) and also indicating the affection of melt-rock reactions are very strong, especially for the Zr contents (Ti/Zr ratios may be elevated by melt-rock reaction)

(medium REEs) depleted patterns and strong fractionations between MREEs and HREE (heavy REEs) ($(Sm/Yb)_N$: 0.021–0.184). Based on the observations and analyses, a model of two-stage melting process was proposed that the primitive mantle underwent 2%–8% melting in garnet stability field which was followed by 10%–15% melting in spinel stability field (Fig. 2).

The clinopyroxenes in some peridotites exhibit obvious enrichment of somestrongly incompatible elements (such as sodium and LREE) that reveal later refertilization process for the residues after partial melting. It is attributed to melt-rock reaction between exotic melt from deeper sources and the peridotites in Luqu ophiolite which possibly occurred after uplift of the peridotites. The irregular contacts between dunites and harzburgites and the increases of some incompatible elements (such as the Ce_N elevated to 0.18, whereas the majority clustering at 0.02) also demonstrate the existence of later enrichment reactions. Furthermore, this strong melt-rock reaction process also can be evidenced by the Ti/Zr ratios (Fig. 3). The ratios of harzburgites (>10000) are fractionated by highly degrees of fractional melting; however, the ratios of the reactive harzburgites and dunites are elevated by Zr increasing with Ti being constant as a result of the differently fractional behavior of Ti and Zr in reactiong process.