Geophysical Research Abstracts
Vol. 18, EGU2016-3150, 2016
EGU General Assembly 2016
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Origin of the Luobusa diamond-bearing peridotites from the sub-arc mantle

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Ophiolites are the remnants of ancient oceanic lithosphere that were emplaced onto continental margins. 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-Tethys Ocean. The Luobusa ophiolite outcrops at the eastern YTS and mainly consists of harzburgites and dunites that have been intruded by gabbroic/diabase dykes at ca 130 Ma (Zhang et al., 2015). Basaltic lavas are rarely outcropped, and volumetrically minor (< 1% by volume) chromitites are enveloped as lens and layers within dunites (Zhou et al., 1996). The Luobusa peridotites have been interpreted as mantle residues experienced melt extraction at the mid-ocean ridge and subsequently reacted with boninitic magmas in subduction zone, which gave rise to podifiorm chromitites (Zhou et al., 1996). However, such a shallow depth origin fails to explain the occurrence of diamond and other ultra-high pressure (UHP) minerals in both peridotites and chromitites (Yang et al., 2007, 2014). A mantle plume origin has been proposed for the Luobusa ophiolite to explain the UHP minerals. However, this model is not reconciled with the occurrence of low-pressure crustal minerals in both chromitites and peridotites (Robinson et al., 2015). Here we report whole-rock Re-Os isotope data, which suggest that most Luobusa peridotites have subjected to ancient melting events older than 1.9 billion years. High contents of heavy rare earth elements in clinopyroxenes support the occurrence of ancient melting in garnet stability field. Hf-Nd isotopes of clinopyroxenes, which yield young model ages as 110 Ma, with one showing the lowest εNd(T) value of -3, do not preserve the signatures of ancient melting but record metasomatism by subduction-related agents. Consequently, we argue that protoliths of the Luobusa peridotites originated from ancient domains in the transition zone and, together with diamond-bearing chromitites, were accreted through a plume activity (Yang et al., 2014) up to the lithospheric mantle beneath the Lhasa terrane, where they have been metasomatized by Neo-Tethyan subduction processes. This sub-arc lithospheric mantle was exhumed at seafloor during the Early Cretaceous, in response to the fore-arc hyperextension (Maffione et al., 2015), and intruded by mafic dykes resulting from decompression melting of the ascended asthenosphere (Zhang et al., 2015).

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