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Comparison of Different-sized Chromite Mineralizations in the Yarlung-Zangbo Ophiolite Belt, Southern Tibet

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1 Abstract

Podiform chromitites are characteristically occurred in ophiolites (e.g., Thayer, 1964; Dickey, 1975). However, the metallogenic processes for podiform chromitites are still unclear. Early models involved fractional crystallization and crystal settling from picritic or basaltic melts in magma chambers (Dickey, 1975; Boudier and Coleman, 1981), but it was also proposed that podiform chromitites formed from partial melting and melt extraction in host mantle peridotites (Dick, 1977; Dick and Bullen, 1984). Recent studies by the majority of authors have suggested that melt-rock interaction at the Moho transition zone may have played a key role in the formation of podiform chromitites (Zhou and Robinson, 1994; Zhou et al., 1996, 2005, 2014; Robinson, 2008; Page and Barnes, 2009; Uysal et al., 2009, 2012; González-Jiménez et al., 2011, 2015). Based on the occurrence of some ultrahigh pressure minerals (e.g. diamond and coesite) in chromitites, it has been proposed recently that the formation of podiform chromitite is likely related to multiple processes inclusing mantle recycling (Yang et al., 2007; Yamamoto et al., 2013). Although geat progresses have been made towards understanding the genesis of podiform chromitites, some fundamental issues in remain unanswered. For examples, what are the major controls on the size of chromitites? And why some ophiolites contain large podiform chromitite bodies, whereas most ophiolitic massifs are essentially chromitite-barren?

The Yarlung-Zangbo Ophiolite belt is one of the most famous ophiolite zone in the world. It contains fresh peridotites as well as different-sided podiform chromitites. The Luobusha ophiolite in the eastern segment of the belt hosts the largest chromite deposit in China. In the central and western segments of belt the Dazhuqu and Dongbo ophiolitic massifs contain some small-scale chromitite bodies. Such characteristics make the Yarlung-Zangbo Ophiolites an ideal subject to investigate the major controls on the metallogenesis of podiform chromitites.

The Luobusha chromitites are large lens and enclosed in dunite. In contrast, the Dazhuqu and Dongbo chromitites display generally as narrow dykes or irregular seams with dunite envelopes. The closely spatial association of the chromitites and dunite envelopes, together with their textural features, support a petrogenetic model that the chromitites from the Luobusha, Dazhuqu and Dongbo massifs form from reaction of melt with host peridotite. In terms of chemical composition of chromite, there are distinctive differences between those from the Luobusha and the Dazhuqu or the Dongbo. Chromite from the Luobusha chromitites has high $Cr^{\#}$ (71-82), whereas Chromite in the Dazhuqu chromitites show relatively low $Cr^{\#}$ (16-63), and chromite in the Dongbo chromitites includes low $Cr^{\#}$ (11-47) and high $Cr^{\#}$ (70-81) types. For the Dongbo and Dazhuqu massifs, linear trends of $Cr^{\#}$ with MgO, FeOt, Ni, Ga, V and Sc in chromite from the chromitites and dunites of are similar to those of the host peridotites, suggesting that the melt-rock reaction may provide major budget of Cr for the chromitites. The similar compositions at a given $Cr^{\#}$ in chromite from these rocks also demonstrate that the chromitites may have been formed by in-situ crystallization of chromite under low melt/rock ratio. In contrast, the Luobusha chromitites have different trends of compositions in chromite from that of the host peridotites, implying that the formation of the chromitite bodies requires a continual replenishment of Cr-rich melts from deeper mantle. Fractionation and accumulation of chromite from a large volume of Cr-rich melt may play an important role on the formation of the Luobusha chromitites. MORB-normalized trace element patterns of chromite from the Luobusha chromitites

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suggest that it has been formed from Cr-rich boninitic melt at surpra-subduction zone (SSZ) setting. However, the Dongbo and Dazhuqu chromitites have formed originally from a MORB-affinity melt at a mid-ocean ridge (MOR) environment.

In summary, the Luobusha chromitites crystallized from a Cr-rich melt in a dynamic conduit, where fractional crystallization and crystal settling play a key role in formation of the large chromitites. In contrast, the small-scale mineralizations of the Dongbo and Dazhuqu chromitite pods are formed from in situ produced melts. Podiform chromitites can be formed in MOR environment, whereas the higher Cr content in boninitic melt and assimilation of subducted slab materials at SSZ setting may benefit the formation of large chromite deposit.