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Mineralogy, Petrology and Geochemistry of Peridotites from the Northern Ophiolititc Sub-belt, Western Yarlung Zangbo Suture Zone, Tibet

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1 Introduction

Ophiolites, mostly found in orogenic belts, represent fragments of palaeo–oceanic lithosphere emplaced on the continent through tectonic processes (Bizimis et al., 2000; Dilek and Furnes, 2011, 2014; Pearce, 2014). These remnants of ancient oceanic lithosphere have recorded important information for the magmatic, tectonic and metamorphic processes associated with the evolution of ancient oceanic basins (Bezard et al., 2011; Dilek and Furnes, 2014; Liu et al., 2014; Saka et al., 2014; Tang et al., 2014). Peridotites are usually considered to be the solid residues of oceanic upper mantle left behind after varied degree of mantle meting and crust–mantle segregation (Aldanmaz et al., 2009). Thus, geochemical data on the peridotites and their constituent minerals record important information on mantle melting, melt extraction and melt/fluid–rock interaction in the upper mantle and contribute to our understanding of the origin and tectonic setting of ophiolitic rocks (Kelemen et al., 1992; Niu, 2004; Parkinson and Pearce, 1998; Xu et al., 2011). LREE-enriched (U-shaped or spoon-shaped) chondrite-normalized REE patterns are widespread in worldwide ophiolitic mantle peridotites. The enriched LREE contents are generally considered to be caused by the reaction between the mantle residues and suprasubduction zone melts. However, according to the abyssal peridotite data compiled by Niu et al. (2004), abyssal peridotites can also have enriched LREE contents, suggesting that the enriched LREE can also be generated by the reaction between the mantle residues and melts in a mid-ocean ridge setting. Thus, the LREE-enriched geochemical characteristic of the ophiolitic mantle peridotite is not an indicator of suprasubduction zone setting. Ophiolitic mantle peridotites from suprasubduction zone and mid-ocean ridge settings can both have U-shaped or spoon-shaped chondrite-normalized REE patterns.

Cretaceous ophiolitic massifs crop out discontinuously along the Yarlung Zangbo Suture Zone (YZSZ) (Allegre et al., 1984; Dubois-Cote et al., 2005; Guilmette et al., 2009; Liu et al., 2014; McDermid et al., 2002). Ophiolitic belts along the Yarlung Zangbo suture zone are typically divided into eastern (e.g., Luobusa ophiolite), central (e.g., Xigaze ophiolite) and western (e.g., Dongbo and Purang ophiolites) segments (Dubois-Cote et al., 2005; Dubois-Cote et al., 2005). In the central and eastern segments, the ophiolites lie along a single lineament, whereas, in the western part, the suture is divided into the northern and southern branches. As the ophiolites provide important constraints for reconstruction of the geodynamic evolution of the Neo–Tethyan Ocean, and record significant events during the period of India–Asia collision, large numbers of studies have been carried out on the Yarlung Zangbo suture zone. However, previous studies of this ophiolitic belt mainly focused on the eastern and central segments (Malpas et al., 2003; Xu et al., 2011; Yamamoto et al., 2013; Yang et al., 2007), and the southern ophiolitic sub-belt of the western segment (Miller et al., 2003; Liu et al., 2013). Because of the absence of data on the ophiolitic rocks of the northern sub-belt, the tectonic setting of the northern sub-belt ophiolite and the relationship between the northern and southern sub-belt remain ambiguous.

In this study, we present new whole-rock major oxide, trace, REE and PGE data on the mantle peridotites from

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the northern ophiolitic sub-belt. These data are used to constrain the partial melting and subsequent metasomatism in the mantle rocks from the northern sub-belt ophiolites in the western segments of the Yarlung Zangbo suture. This paper mainly focuses on the petrological processes that dominated in the formation of the peridotites in order to provide new constraints on the evolution of the western segment of the Yarlung Zangbo ophiolitic belt.

2 Conclusions

The Yarlung Zangbo Suture Zone marks the zone where the Tethyan Ocean was consumed as the India plate approached and ultimately collided with Eurasian plate. Ophiolites are distributed discontinuously along this suture zone. Based on the spatial distributions of the ophiolitic massifs, the YZSZ ophiolitic belts can be divided into the eastern, central and western segments. In the central and eastern segments, the ophiolites lie along a single lineament, whereas from the Saga ophiolite to the west (western segment), the ophiolitic belt is divided into the northern and southern branches. The northern ophiolitic sub-belt mainly includes the Dajiweng, Kazhan, Baer, Cuobuzha, Jianabeng and Zhalai ophiolitic massifs. Ophiolitic massifs from the northern sub-belt are usually 1–2 km in width and 10–20 km in length and dominated by peridotites with minor volcanic rocks and siliceous rocks. No cumulates have been observed in the northern ophiolitic sub-belts. The Mineral chemistry and bulk rock geochemistry of the peridotites from the northern ophiolitic sub-belt have relatively wide ranges, indicating a varied degree of depletion. The Dajiweng and Zhalai harzburgites both have prominent LREE-enriched (U-shaped or spoon-shaped) chondrite-normalized REE patterns. The LREE-enriched chondrite-normalized REE patterns used to be widely accepted as a symbol of a suprasubduction zone fingerprint. However, the large numbers of peridotite samples collected from mid-ocean ridges with LREE-enriched REE patterns suggest that this LREE-enriched characteristic is not unique to suprasubduction zone peridotites. U-shaped REE patterns combined with low HREE contents and the mineral chemistry indicate that Dajiweng harzburgites have been modified by melts (e.g. boninitic melts) from a forearc setting. Although Zhalai harzburgites also have U-shaped REE patterns, the high HREE contents, high Al_2O_3/SiO_2 ratios, low MgO/SiO_2 ratios and the relatively fertile mineral chemistry suggest that the Zhalai harzburgites formed in the mid-ocean ridge setting. Kazhan, Baer and Cuobuzha peridotites are similar to abyssal and back-arc peridotites in mineral chemistry and whole rock geochemistry. Combined with the previously published data from the southern ophiolitic sub-belt and the mafic rock data from the Jianabeng and Cuobuzha massifs, we propose the ophiolites from the western segments of the Yarlung Zangbo ophiolitic belt first formed in a mid-ocean ridgesetting. Some ophiolitic massifs such as the Cuobuzha and Xiugugabu were trapped in a back-arc setting generating back-arc basalt, while some ophiolitic massifs such as Dajiweng, Dongbo and Purang were trapped in a forearc setting where they were modified by the melts from the subduction zone. After the collision of the Indian and Eurasian plate, the Dongbo, Purang and Xiugugabu massifs of the southern ophiolitic sub-belt were displaced and transported over the Paleozoic – Mesozoic sedimentary sequence of the Tethyan Himalaya to the south.

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