Diamond in Oceanic Peridotites and Chromitites: Evidence for Deep Recycled Mantle in the Global Ophiolite Record

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Diamonds have been discovered in mantle peridotites and chromitites of six ophiolitic massifs along the 1300 km-long Yarlung-Zangbo suture (Fig. 1) (Bai et al., 1993; Yang et al., 2014; Xu et al., 2015), and in the Dongqiao and Dingqing mantle peridotites of the Bangong-Nujiang suture in the eastern Tethyan zone (Robinson et al., 2004; Xiong et al., 2018). Recently, in-situ diamond, coesite and other UHP mineral have also been reported in the Nidar ophiolite of the western Yarlung-Zangbo suture (Das et al., 2015, 2017). The above-mentioned diamond-bearing ophiolites represent remnants of the eastern Mesozoic Tethyan oceanic lithosphere. New publications show that diamonds also occur in chromitites in the Pozanti-Karsanti ophiolite of Turkey, and in the Mirdita ophiolite of Albania in the western Tethyan zone (Lian et al., 2017; Xiong et al., 2017; Wu et al., 2018). Similar diamonds and associated minerals have also reported from Paleozoic ophiolitic chromitites of Central Asian Orogenic Belt of China and the Ray-Iz ophiolite in the Polar Urals, Russia (Yang et al., 2015a, b; Tian et al., 2015; Huang et al, 2015). Importantly, in-situ diamonds have been recovered in chromitites of both the Luobusa ophiolite in Tbet and the Ray-Iz ophiolite in Russia (Yang et al., 2014, 2015a). The extensive occurrences of such ultra-high pressure (UHP) minerals in many ophiolites suggest formation by similar geological events in different oceans and orogenic belts of different ages. Compared to diamonds from kimberlites and UHP metamorphic belts, micro-diamonds from ophiolites present a new occurrence of diamond that requires significantly different physical and chemical conditions of formation in Earth's mantle.

The discovery of many pressure-sensitive minerals such as coesite pseudomorph after stishovite, high-pressure forms of chromite and qingsongites (BN) indicate that ophiolitic chromitite may form at depths of >150-380 km or even deeper in the mantle (Yang et al., 2007; Dobrthinetskaya et al., 2009). The very light C isotope composition ($\delta^{13}C$ -18 to -28‰) of these ophiolitic diamonds and their Mn-bearing mineral inclusions, as well as coesite and clinopyroxene lamallae in chromite grains all indicate recycling of ancient continental or oceanic crustal materials into the deep mantle (>300 km) or down to the mantle transition zone via subduction (Yang et al., 2014, 2015a; Robinson et al., 2015; Moe et al., 2018). These new observations and new data strongly suggest that micro-diamonds and their host podiform chromitite may have formed near the transition zone in the deep mantle, and that they were then transported upward into shallow mantle depths by convection processes. The in-situ occurrence of micro-diamonds has been well-demonstrated by different groups of international researchers, along with other UHP minerals in podiform chromitites and ophiolitic peridotites clearly indicate their deep mantle origin and effectively address questions of possible contamination during sample processing and analytical work.

The widespread occurrence of ophiolite-hosted diamonds and associated UHP mineral groups suggests that they may be a common feature of in-situ oceanic mantle. The fundamental scientific question to address here is how and where these micro-diamonds and UHP minerals first crystallized, how they were incorporated into ophiolitic chromitites and peridotites and how they were preserved during transport to the surface. Thus, diamonds and UHP minerals in ophiolites have raised new scientific problems and opened a new window for geologists to study recycling from crust to deep mantle and back to the surface.

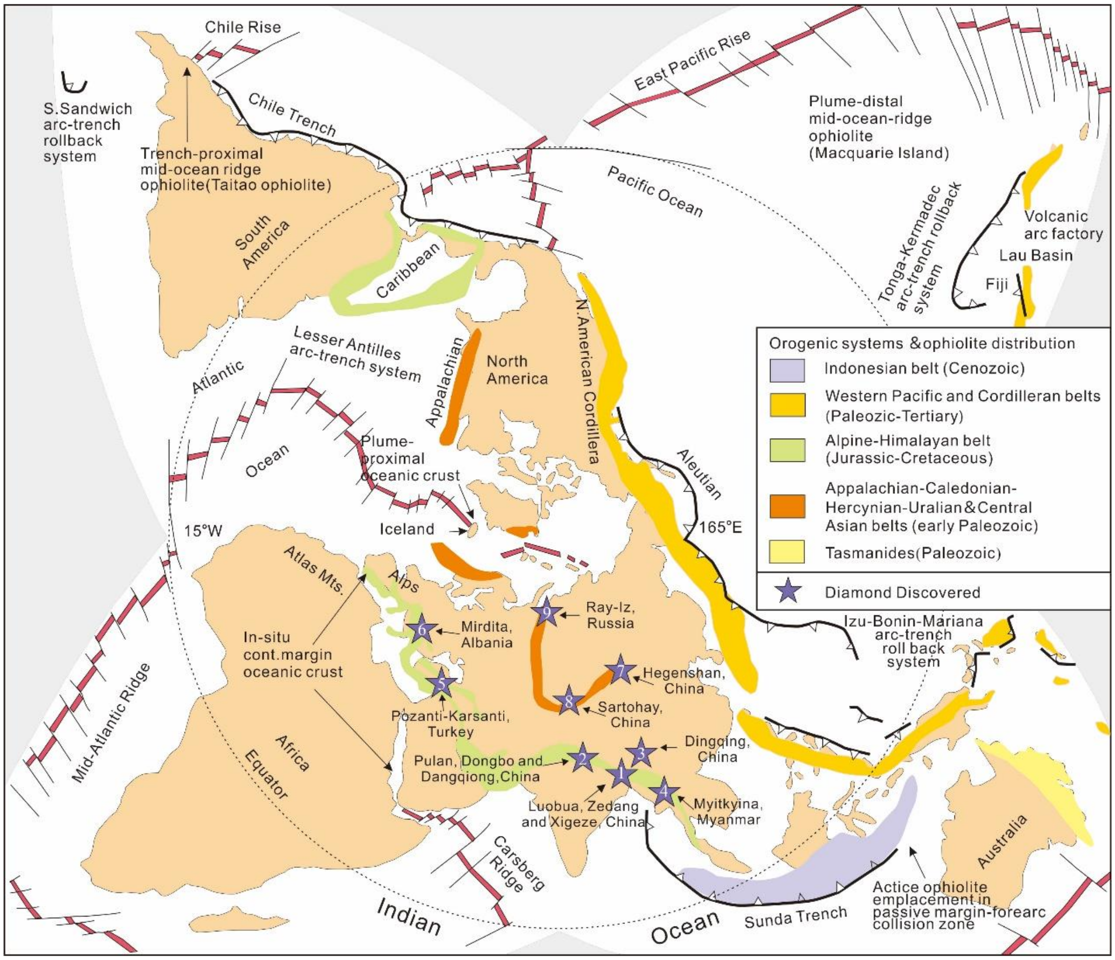

Figure 1. Distribution of diamond-bearing ophiolite (modified after Dilek and Furnes, 2011).

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