Metasomatic records of lithosphere prior to subduction inferred from petit-spot

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The lithospheric mantle below oceanic regions is directly known only about largely restricted portions (mid-ocean ridges, back-arc spreading centers, and hotspots) where the ultramafic rocks are generally sampled from fracture zones and oceanic core complexes, or as xenolith entrained by magmas. The geochemical mantle has ever been previously recognized only by MORB and OIB as well. Monogenetic petit-spot volcano was first identified as magma squeezed upward at the flexed plate off the Japan Trench due to subduction. The magmas originate from the asthenosphere immediately under the plate, and erupt over a large eruption area (over 800 km of plate motion) but with low volumes of magma production each (Hirano et al., 2006). Such volcanoes have been reported from subduction zones worldwide (e.g., the Japan, Chile, Java, and Tonga trenches) (Hirano et al., 2008; 2013; 2016; Taneja et al., 2016). Xenoliths and xenocrysts entrained in petit-spot lavas provide direct information on lithosphere of subducting plate because the magma ascends along the concavely flexed lithosphere prior to the outer-rise along the trench. Here, we discuss the geochemical interactions between lithosphere and asthenosphere during ascending petit-spot melt using geochemistry of lava and xenoliths/xenocrysts from mantle.

Melt fractionations are required at the mid- or lower depth of lithosphere, given that bulk compositions clearly show fractionation trends of olivine in the absence of phenocrysts, in spite of raising lherzolitic xenoliths and xenocrystic olivines from deepest approximately 45 km (Yamamoto et al., 2015). Depth of the fractionation could be correspond to the σ_3 rotation from extensionally lower to upper compressional lithosphere due to the concave flexure prior to outer rise (Valentine & Hirano, 2010). The high levels of carbon dioxide derived by petit-spot magma recently explains the low seismic velocity and high electrical conductivity of oceanic asthenosphere as the source mantle. Experimentally equilibrated petit-spot melt, adopted 10 wt % CO_2 before emission (Okumura & Hirano, 2013), with harzburgite at the lower lithosphere implies the stagnation of ascending melt at the depth (Machida et al., 2017). Subducting lithosphere is likely metasomatized by the carbon-rich melt just prior to its subduction. The conventional theory about subducting lithosphere requires revision in light of recently obtained petit-spot data.