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Redox state of mantle wedge above subduction zone as inferred from the Oman mantle section

Eiichi TAKAZAWA[1*], Nami KANKE[2]

[1]Dept Geol, Facul Sci, Niigata University, [2]Grad School Sci and Tech, Niigata Univ

This research aims to understand the redox status of a mantle wedge as a case study of the mantle section of the Oman ophiolite. The Fizh mantle section of the northern part of the Oman ophiolite exposes about 14-km-stratigraphic height of the uppermost mantle from the Moho to the basal thrust. In accordance with the method of Ballhause et al. (1991), oxygen fugacity was calculated from the mineral compositions of olivine and a spinel using the peridotites collected from the mantle section. When the deviation from the FMQ buffer of Log fO2 was plotted on the topographic map of the Fizh mantle section, it became clear that the basal part of the ophiolite has quite low oxygen fugacity and is reduced than the peridotites near the Moho. In particular, near the basal thrust, there is also a place where deltalog fO2 reaches to FMQ-3. In general, island arc basalts and mantle xenolithes have oxygen fugacity higher than both MORB and abyssal peridotites, so that the mantle wedge is more oxidized than a MORB source mantle. Our results show that the mantle wedge just above the subducting slab is more reduced than those previously expected.

The mantle section of the Oman ophiolite records an incipient stage of subduction zone that formed by the intra-oceanic thrusting of an oceanic lithosphere. This is supported by the presence of highly refractory peridotites with high-Cr# ($>$ 0.7) spinels. A H2O-rich fluid was liberated from the metamorphic sole during thermal metamorphism by obducting oceanic lithosphere (Ishikawa et al., 2005). The infiltration of the fluid from the basal thrust triggered a flux melting of residual harzburgites forming highly refractory peridotites in the mantle section (Arai etal., 2006; Takazawa, 2012; Kanke and Takazawa, 2013). This configuration indicates that the upper surface (metamorphic sole) of the sinking slab is directly in contact with the lowermost part of the mantle wedge (ophiolite) in the Oman ophiolite. Our results indicate that the mantle wedge on the upper surface of subducting slab is the most reductive and it becomes more oxidative toward the mantle-crust boundary. The degree of contribution of a slab component is examined using the indices (Th/Ce ratio etc.) of a sediment-derived melt and the proxy of oxygen fugacity (the V/Sc ratio and the Zn/Fe ratio). It verifies either possibility that the mantle wedge was reduced by a reductive melt which originates in the sediment on the sinking slab, or that the reductive oceanic mantle was oxidized from the upper part by a hydrothermal circulation.

Keywords: Oman ophiolite, peridotite, oxigen fugacity, mantle wedge, subduction zone, redox state