

The redox state in the Fizh mantle section, the northern Oman ophiolite as an analog of mantle wedge in subduction zone

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The redox state of the upper mantle is important because it controls phase equilibrium and partitioning of some trace elements. Previous studies of mantle peridotites show mantle xenoliths in arc lavas are more oxidized than abyssal peridotites on the ocean floor because subducting slab is dehydrated to supply 'oxidized fluid' such as water and carbon dioxide to the mantle wedge in hanging wall (e.g., Parkinson and Pearce, 1998).

The mantle section of the Oman ophiolite is a good analog for a mantle wedge because it experienced supra-subduction zone setting during oceanic thrusting prior to the obduction. In this study, we focus on the Fizh mantle section in the north Oman ophiolite as a proxy of mantle wedge in a subduction zone and evaluate the redox state recorded in the peridotites. We calculated delta log f_{O_2} (FMQ) using equation of Ballhaus et al. 1991, chemical composition of olivine and spinel with ferric and ferrous iron ratio assuming stoichiometry. The spatial distribution of delta log f_{O_2} (FMQ) in the Fizh mantle section indicates that the basal part of the mantle section is more reduced whereas the upper part of the mantle section beneath the Moho is more oxidized. This may indicate that the basal part of mantle wedge above the contact to subducting slab is most reduced.

We compared ferric and ferrous iron ratio calculated from spinel composition assuming perfect stoichiometry to those directly obtained by Mössbauer spectrometry. The results show that the difference is minor and does not significantly affect the tendency mentioned above. As independent approach, we used abundance ratio of vanadium against scandium in whole rock peridotites. Vanadium partitioning between peridotite and melt is sensitive to the change in oxygen fugacity whereas scandium doesn't. Thus the ratio of vanadium against scandium is a good proxy for estimating oxygen fugacity. As a result, delta log f_{O_2} (FMQ) shows negative correlation with the ratios of vanadium against scandium for whole rock peridotites. This result confirms that the basal part of the Fizh mantle section is more reduced than the upper part of the mantle section.

One possible factor for the reduced signature in the basal part of Fizh mantle section is a reaction of peridotite with a reduced melt produced by melting of sediment with reduced carbon subducted beneath the Fizh mantle section. This hypothesis is supported by high Th/Ce ratio in whole rock peridotites and clinopyroxenes with low delta log f_{O_2} (FMQ). The high Th/Ce ratio is one of the features which indicate contribution of oceanic sediments and suggests those influence. The Raman peak of methane has also been detected in the fluid inclusions in the peridotite from the basal part. On the other hand, a peak of methane has not been detected from the fluid inclusion in the peridotites beneath the Moho Transition Zone. The presence of methane in the fluid inclusions from the basal part of mantle section also supports reduced condition at the base. We consider that the methane was derived from reduced carbon in the subducted oceanic sediment during oceanic thrusting of the ophiolite.

Keywords: Oman ophiolite, Redox state, mantle peridotite, mantle wedge, oxygen fugacity, subduction zone