Evolution of redox state inferred from trivalent cations in antigorite from Higashi-akaishi peridotite body, SW Japan

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Antigorite is stable in a relativity wide range of temperature (200-600 ˚C) (Evans, 1977) and, therefore, it can be a witness of tectonic and geochemical histories in depths of subduction zones. Antigorite includes minor but various amounts of Al and Cr. Importance of these trivalent cations for antigorite formation in discussed from several points of view: stabilized condition (Bromiley and Pawley, 2003; Padron-Navarta et al, 2013) and reaction speed (Andreani et al., 2013). However, there are a few petrological works on natural antigorite to ensure these ideas. We focus on the trivalent cations in antigorite from Higashi-akaishi peridotite body, SW Japan, and interpret the compositional change in terms of hydration reactions and redox states in the system consisting of olivine, Cr-spinel and Fe-Ni sulfides.
Occurrence of antigorite is divided into two types: the discrete antigorite in weakly serpentinized dunite and the bundle antigorite in antigorite schist. The discrete antigorite shows conspicuous chemical zoning of Al and Cr, regardless of distance from chromite. The Al and Cr contents of discrete antigorite are evenly high implying these elements released from chromite were available for antigorite formation throughout the rock. The bundle antigorite has homogenous and relativity pure composition (poor in Al and Cr). Altered chromite shows wide range of chemical composition from Cr rich to Fe^{3+} rich, reflecting miscibility gap in Cr-spinel compositions and redox state of reaction. Pentlandite, Fe-Ni sulfide, occurs as inclusions in olivine and altered Cr rich chromite. In the matrix, the sulfide mineral assemblage coexisting with antigorite is mainly heazlewoodite + godlevskite + magnetite. Break down of pentlandite indicates that the redox state has changed from a reducing state to a relatively oxidizing state. This is consistent with the alteration trend in chromite compositions. Fe content of olivine (fayalite content) increases with increasing degrees of antigorite serpentinization. Magnetite formation, indicating oxidation of Fe in olivine, is inactive in the initial stage of antigorite serpentinization. At the later stage, its occurrence is dominant in antigorite schists although the cause of the oxidizing conditions is unclear.
This study correlates the compositional changes of antigorite with alteration of chromite. The difference in compositional trends is due to different oxidation states for two stages of antigorite serpentinization. Coexisting sulfide minerals give constrains on the redox states for these serpentinization stages consistently. The change of redox state took place during exhumation of the ultramafic unit implying more oxidizing conditions at the shallower depth along the subduction boundary.

Andreani, M. et al., 2013, Am. Min. 98, 1738-1744.
Bromiley, G.D. and Pawley, A.R., 2003. Am. Min. 88, 99–108.
Evans, B. W., 1977, Ann. Rev. Earth Planet. SCi. 5, 397-447.
Evans, B. W., 2010, Geology 38, 879-882.
Padron-Navarta, J. A. et al., 2013, Lithos 178, 186-196.

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