Stable isotope study of carbonate associated with antigorite serpentinite: O–C isotope characterization of a textually zoned calcite rock from the Itoigawa–Omi area, Japan

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In order to understand carbon behavior in forearc serpentinite, we investigated a textually zoned metasomatic calcite rock associated with antigorite serpentinite of the Non-eclogitic Unit of the Omi area, Japan (Tsujimori, 2004 [doi:10.5575/geosoc.110.591]; Yamada et al., 2019 [doi:10.2465/jmps.190726]). The investigated calcite rock (~ 10 cm in size) occurs in 'blackwall'-like outcrop of chlorite-tremolite rock containing decimeters-size blocks of amphibolite and partially-carbonated antigorite serpentinites. The presence of antigorite and feritchromite in serpentinites and the lack of glaucophanitic amphibole rim in the hornblende of amphibolite suggest that the calcite rock had formed at the amphibolite-facies condition. The calcite-rich rock shows a concentric zoning that subdivided into three layers based on mineral assemblages. In the core part, a pseudomorph consisting of microcrystalline calcites with polycrystalline fine-grained talc aggregates suggest the presence of precursor dolomite. The transition of the mineral assemblage calcite + talc + quartz at the core to the assemblage calcite + talc + tremolite + quartz in the middle layer can be explained by decreasing X_{CO2} and/or increasing temperature.

Despite the zoned texture and the different mineral assemblage, systematic stable carbon and oxygen isotope analyses using by micro-sampling technique found no clear core-to rim change. $\delta^{13}C$ (‰ VPDB) and $\delta^{18}O$ (‰ VSMOW) values are from −5.0 to −4.1‰ (average −4.4‰ [n = 34]) and +15.6 to +16.4‰ (average 16.1‰ [n = 34]), respectively. It is noteworthy that $\delta^{13}C$ of zoned calcite rock is significantly higher than the $\delta^{13}C$ values of graphite (−8.6 to −7.9‰) in jadeitite in the Omi area (Ogawara and Akai, 2014 [doi:10.2465/jmps.131125a]) and also dolomite nodule (−13.4 to −13.6‰; this study) associated with lizardite serpentinite in the Franciscan Complex. Although there are a few possible carbon sources for the calcite rock, the $\delta^{13}C$ close to −5‰ might have reflected a mantle-derived carbon. On the other hand, relatively high $\delta^{18}O$ values suggest that the calcite-rock-forming aqueous fluids were in equilibrium with metasedimentary rocks.

Keywords: antigorite serpentinite, metasomatic rock, carbon isotope, oxygen isotope, amphibolite-facies

