Carbonatization of oceanic crust during seafloor alteration: Constraints from greenstones from the Japanese accretionary complexes

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The carbonatization of oceanic crust during seafloor alteration and its decarbonation during subduction are among the major processes controlling the global carbon cycle (e.g., Alt and Teagle, 1999; Sleep and Zhanle, 2001). Therefore, knowledge of the carbonatization and decarbonation processes is important to constrain the CO_2 budget at the surface of the Earth. In the present study, for the purpose of elucidating the processes, we conducted major and trace element analyses and carbon determination of greenstones from the Japanese accretionary complexes of the Northern Chichibu, Mineoka and Hayachine Belts, which have been regarded as remnants of accreted oceanic crust.

Geochemical characteristics of the studied greenstones are similar to those of mid-ocean ridge basalts (MORB), although some ocean island basalt (OIB)-like samples are also shown in the Northern Chichibu greenstones. Alteration mineral assemblage of the greenstones are albite, calcite, chlorite, epidote, pumpellyite and quartz in the Northern Chichibu Belt, albite, clay mineral, calcite and zeolite in the Mineoka Belt, and chlorite, albite, epidote, quartz, calcite, sphene, pumpellyite and actinolite in the Hayachine Belt, which correspond to metamorphic grades of prehnite-pumpellyite facies, zeolite facies, and pumpellyite-actinolite facies, respectively.

Average carbon contents of the greenstones from the Northern Chichibu, Mineoka and Hayachine Belts are 2.6, 1.3 and 0.9 wt.%, respectively. The carbon contents of the greenstones are not related to both their ages and metamorphic grades, but are correlated well with the duration times (82 - 128 Myr in the Northern Chichibu Belt, 36 - 41 Myr in the Mineoka Belt, and 13 - 34 Myr in the Hayachine Belt). This carbon uptake trend with time can be comparable well with that of coeval oceanic crust reported from the Pacific Ocean (Alt and Teagle, 1999; Alt, 2004), in turn implying that the carbon contents in the greenstones were not changed during the subduction and accretion. This suggests that accreted ancient oceanic crust, at least in the low-grade metamorphic zones, can be used as a record to infer processes and changes of the carbonatizatino of oceanic crust throughout the Earth's history.