Melt generation process in the mantle wedge under island arc recorded in the Hayachine-Miyamori ophiolitic complex

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Peridotites provide direct information on chemical fractionation processes such as melt separation and migration in the upper mantle. Recently, precise trace element analyses of peridotites have proposed a common occurrence of an open system melting induced by melt influx in the upper mantle (e.g. Kelemen et al., 1992; Johnson and Dick, 1992; Ozawa and Shimizu, 1995). Sr and Nd isotopic compositions for peridotites have been believed to provide important clue to confirm origins of mantle and influxed melt. However, the reliable precise isotopic data have not accumulate yet because of analytical difficulty.

The Hayachine-Miyamori ophiolitic complex is located in the Hayachine Tectonic belt that forms the northeast boundary of the South Kitakami Belt of the northeast Japan, that is one of the oldest geological terrains in Japan (Ehiro, 2000). The open system melting of hydrous mantle under island arc has been proposed in this complex (e.g. Ozawa, 1988). According to Ozawa(1984, 1988), the peridotites and pyroxenites are divided into two types on the bases of a clear gap in spinel Cr# (Cr/(Cr+Al)): i.e. an aluminous spinel (Cr# less than 0.4) bearing ultramafic suite (ASUS) and a chromite (Cr# larger than 0.4) bearing ultramafic suite (CSUS). The ASUS occurs as kilometric sized patches in the CSUS in the Miyamori complex (Ozawa, 1984).

Bulk rock compositions and forsterite value of olivine display a systematic change in this complex, which can be explained by deference of degree of melting as pointed out by Ozawa (e.g. 1988). Chondrite normalized trace element patterns tend to show more enrichment in incompatible elements as peridotites become refractory. On the basis of such reverse correlation between incompatible and major elements and occurrence of ASUS in the Miyamori complex, it is inferred that CSUS was formed by open system melting with significant melt influx and refractory ASUS had minor involvement of the same influxed melt in melting during entrainment to CSUS diapir (e.g. Ozawa and Shimizu, 1995). However, calculated trace element concentrations by applying the open system melting model (Ozawa and Shimizu, 1995) to our new data with previously reported data indicate that 1) the trace element patterns of this complex can not be explained by partial melting with a single melt influx, 2) modeled influxed melt to ASUS shows moderate enrichment in incompatible elements and slight Sr negative anomaly, and estimated influxing melt of CSUS shown an extensive enrichment of incompatible elements with Sr positive anomaly, and 3) two stage open system melting needs to explain a trace element pattern of the refractory ASUS.

The variation of Nd isotopic compositions of the peridotites is larger (eNd = +4 to +20) than those of gabbroic intrusive rocks (eNd = +5 to +8)(Shibata and Ozawa, 1992; Ozawa et al., unpublished data). The more refractory peridotites show more enriched isotopic signature. The Nd model age of the most primitive ASUS sample, which is considered as the sample without any melt influx, is about 430 Ma. This age is consistent with K-Ar ages (421 - 480 Ma) of amphiboles in intruded rocks which have been interpreted as emplacement age of this complex (Ozawa et al., 1988; Shibata and Ozawa, 1992). Thus, the partial melting event was likely to happen just before the emplacement. Time corrected Nd isotopic compositions of the refractory ASUS are lower than those of the most primordial ASUS. It is suggested that the influxed melt had enriched isotopic composition compared to a source peridotite. Although the time corrected Nd isotopic ratios of most of CSUS overlap the range of the refractory ASUS, some of CSUS show more enriched characteristics. Thus, the formation of CSUS could be induced by more enriched melt influx. These observations may indicate that path of influxing melt was gradually shifted and composition of isotopic and trace elements for the influxed melt was more enriched with time.