Rehydration metamorphism of the Iratsu eclogite mass in the Sambagawa metamorphic belt

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Fluid plays major roles in various dynamic processes in plate-boundary zones, including mountain buildings, seismicity, volcanic activities and hydration of the wedge mantle (e.g. Peacock and Wang 1999; Kerrick and Connolly 2001; 2003; Hacker et al. 2003; Seno and Yamasaki 2003). In subduction zones, fluid behavior, such as generation, migration and consumption of fluids, is mainly controlled by prograde dehydration metamorphism and retrograde hydration (rehydration) metamorphism. On the other hand, recent precise reconstructions of P-T paths and detailed analyses of metamorphic textures (Ota et al. 2004; Okamoto and Toriumi 2005; etc.) show that regional metamorphic belts underwent pervasive retrogressive hydration metamorphism, and that metamorphic P-T structures were frequently modified at the retrograde stages during exhumation (Maruyama et al. 2004). Therefore, rehydration metamorphism may be a key process to understand fluid behaviors and various geodynamics, such as exhumation processes of a metamorphic belt, in subduction zones, because rehydration may have major influences on the fluid flux and the rock's physical properties in the plate boundaries (e.g. Jamveit et al. 2000).

However, the detailed processes of rehydration metamorphism, including physical mechanism of rehydration reactions, the relationship to the fluid flow, have not been clarified. Moreover, the nature of spatial and temporal variations of the progress of rehydration reactions in natural system is sill little understood, because hydration proceeds very heterogeneously on various scales (from a sub-grain scale to a metamorphic-belt scale), depending on various environmental factors (e.g. geological settings, lithologies, deformation structures) (e.g. Brodie and Rutter 1985).

The Iratsu eclogite mass is the largest eclogitic mass that locates in the highest-grade zones in the Sambagawa metamorphic belt, central Shikoku, Japan. It is originated from gabbro and basalt, and is interpreted as a relic of a fossil subducted slab (e.g. Miyagi and Takasu 2005; Terabayashi et al. 2005). The Iratsu mass underwent pervasive rehydration metamorphism, so that most of all retrogressed to amphibolite. Gradual stages of rehydration retrogression from eclogite to low-grade greenschist are preserved by disequilibrium textures of incomplete reactions. Hence, the Iratsu eclogite mass provide an exceptional opportunity to study the process of rehydration reactions and exhumation of a subducted oceanic crust.

The first aim of this study is to understand the elementary processes, the physical mechanism of rehydration and the role of intergranular fluid from small-scale observations. The second aim is to clarify the spatial variations of the progress of rehydration reactions in the Iratsu eclogite mass, in order to understand the nature of rehydration metamorphism and the process of fluid infiltration.

Firstly, we have conducted geological and petrological researches on the Iratsu hydrated eclogite. Secondly, the characteristics and physical processes of rehydration reactions were investigated from the observations and compositional analyses of the replacement textures. Then, a new methodology was developed according to Gresens (1967) and Godard and Mabit (1998), which enable us to specify the reaction, and to estimate the reaction progress and the amounts of material transfer from pseudomorphic structures. Detailed mapping by this method was performed from the central part to the rim part in the Iratsu eclogite mass. From these results, the roles of fluid on rehydration reactions, deformation process and exhumation of the Iratsu eclogite mass were discussed.