Observations of three-dimensional microstructures of the symplectite minerals in the Horoman Peridotite Complex using a high-resolution X-ray CT method

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Symplectites in the Horoman peridotites, which are intergrowth of irregular fine-grained orthopyroxene, clinopyroxene and spinel, have been basically interpreted to be of pyropic garnet origin (e.g., Kushiro & Yoder, 1966; Tazaki et al., 1972; Takahashi & Arai, 1989; Ozawa & Takahashi, 1995; Obata et al., 1997; Morishita & Arai, 1997; Takahashi, 2001). Ozawa & Takahashi (1995) and Takahashi (1997) suggested that there were thermal gradients in the Horoman complex. Textural and chemical variations of symplectite minerals in the complex will provide opportunity to investigate the phase transition from garnet to spinel lherzolite stability fields as a function of thermal history during exhumation.

X-ray computerized tomography is a completely nondestructive means of examining the interiors of an object (e.g., Nakano et al., 2000). We imaged symplectites obtained from the Upper Zone (northern part), which followed a higher temperature decompression path than the Lower Zone (southern part), using a high-resolution X-ray CT system at SPring-8 (Uesugi et al., 2000) with a monochromatic X-ray beam (15 keV). Three-dimensional structures of the symplectites were obtained from the CT images of 1000 x 1000 x 1018 voxels with the voxel size of 0.5 x 0.5 x 0.5 μm, which gave spatial resolution of about 1 μm. Clusters of orthopyroxene, clinopyroxene and spinel in the symplectites were clearly identified using the contrast of the CT images which represented the linear attenuation coefficients in the samples.

In the 3-D microstructures, planar shapes of symplectite spinels are commonly observed with some rod-shapes and some of them are branched. These spinel plates and rods in each sample are elongated to one direction, which is not consistent with the foliation plane of peridotite. The predominant elongation axis of the spinel might be related to distribution of clinopyroxene. These textural characteristics support a model for the textural evolution of symplectite proposed by Obata et al. (1997). They suggested that Al-Cr spinels finally nucleated preferentially on the grain boundaries of orthopyroxene and clinopyroxene, due to a reaction between excess Al- and Cr-rich components in the pyroxenes and forsterite component being supplied through diffusion from the surrounding mineral phases, after the formation of pyroxene domains. Furthermore, there is no essential difference in 3-D microstructures of symplectites between the Upper Zone and middle part of the Lower Zone (Morishita, 2000) in spite of variation in size of symplectite minerals. This indicates a possibility that there had been already thermal gradients in the whole complex as symplectites were formed.

Keywords: X-ray CT method, SPring-8, 3-D microstructure, the Horoman Complex, symplectite