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Petrological characteristics of cataclasitic peridotite xenolith from NE Japan

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A deformed peridotite xenolith from Ichinomegata crater, the Northeast Japan arc, one of the most famous mantle peridotite xenolith localities (e.g., Kuno, 1967; Takahashi, 1978), is studied in detail. Deformed peridotite xenoliths with mylonitic textures have been documented from several localities (e.g., Basu, 1977; Yang et al., 2010), and possibly have been derived from ductile shear zones in the upper mantle (e.g., Xu et al., 1993). The Ichinomegata peridotite discussed here has a peculiar cataclastic texture totally different from those mylonitic peridotite xenoliths.

The peridotite is a mixture of coarse grains (up to 1.3 mm across) and fine grains (more than 1 um across) of olivine, orthopyroxene, clinopyroxene, chromian spinel, and amphibole. All grains possibly formed by fragmentation of mantle minerals, including the pyroxene-spinel symplectite, which is a reaction product between olivine and plagioclase (Takahashi, 1986). Coarse mineral grains are angular and rarely kinked, but never elongated. It has the same mineral assemblage as ordinary lherzolite xenoliths from Ichinomegata, and is totally free of serpentine and other low-temperature alteration minerals. Grain sizes of the peridotite satisfy the power law distribution, which indicates fragmentation (e.g. Turcotte, 1986).

Coarse minerals are equivalent in mineral chemistry to ordinary lherzolites reported from Ichinomegata (Abe et al., 1992). The Fo of olivine is around 90, and chromian spinel shows a low Cr#, around 0.2. Clinopyroxenes show LREE-depleted chondrite-normalized patterns. The textural and chemical characterristics suggest that an ordinary mantle lherzolite protolith was in-situ fractured in the upper mantle to form this cataclasite. This peridotite provides us with the evidence for brittle fracture in the upper mantle where plastic deformation is dominant.

Some of fine-grained minerals have different chemical characteristics from ordinary xenoliths. The fine-grained olivine show relatively high Fo (91-93) and CaO content (0.1-0.3 wt%) at the rim, the core showing the same composition as the coarse one. The CaO content of pyroxenes is higher in orthopyroxene but lower in clinopyroxene than in coarse grained equivalents, indicating some higher temperatures indicate that of equilibration. These features indicate that the fine grains were formed simultaneously with or subsequently to fracturing. The zoned fine olivine is probably a residue after melting generated by frictional heating, and fine pyroxenes are precipitates from the frictional melt.

Keywords: peridotite, cataclasite, xenolith, mantle