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The upper mantle can be fractured: Cataclasitic peridotite xenolith from Ichinomegata crater, the Northeast Japan arc

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A peculiar peridotite xenolith with cataclastic texture was found from Ichinomegata crater, Megata volcano, the Northeast Japan arc, one of the most famous mantle peridotite xenolith localities (e.g., Kuno, 1967; Takahashi, 1978). The peridotite xenoliths that show strong deformation textures, well-known as "sheared lherzolites", have been reported from kimberlite xenoliths. Mylonitic peridotites have been documented in several localities (e.g., Basu, 1977; Kaeser et al., 2006), and some of them are interpreted to have been derived from ductile shear zones in the upper mantle (e.g., Xu et al., 1993). The texture of the Ichinomegata peridotite discussed here is totally different from these deformed xenoiths.

Coarse mineral grains are angular and rarely kinked, but never elongated. Some of coarse olivine grains are split and displaced. Fragmented grains of pyroxenes and chromian spinel are elongated to form thin streaks. It has the same mineral assemblage as ordinary peridotite xenoliths from Ichinomegata, and is totally free of serpentine and other low-temperature alteration minerals. Coarse minerals are equivalent in mineral chemistry to weakly hydrated lherzolites reported from Ichinomegata (Abe et al., 1992). Fo (100 Mg/(Mg + Fe)) of olivine is around 90, and chromian spinel shows a low Cr/(Cr + Al) ratio, around 0.2. Estimated temperaturesfrom coarse pyroxene grains are in the range of 910-1000°C (Wells, 1977; Witt-Eickschen & Seck, 1991), which are the same as in ordinary Ichinomegata peridotites. On the other hand, some of fine-grained minerals (less than 50 μm) have different chemical characteristics from ordinary xenoliths. Fine-grained olivine show relatively high Fo (91 - 93) and CaO content (0.1 – 0.3 wt%). Pyroxenes show a wide range of the Mg/(Mg + Fe) ratio and Al_2O_3 content. Especially the CaO content of pyroxenes is higher in orthopyroxene, lower in clinopyroxene than in coarse grained pyroxenes, indicating some higher temperatures.

From the textures and chemical compositions, we infer that an ordinary mantle lherzolite protolith was in-situ fractured in the upper mantle to form this cataclasite. This peridotite shows the evidence of brittle fracture in the upper mantle where plastic deformation is dominant.