Growth of olivine crystals from totally-molten San Carlos olivine

Hideki Kanazawa[1], Kazuhiko Ito[2], Hiroki Sato[3]

[1] Human and Environmental Studies, Kyoto Univ, [2] Faculty of Business Administration, Southern Osaka Univ., [3] Earth and Space Sci., Osaka Univ.

Olivine is the major constituent of the Earth's upper mantle. For various physical property measurements related to the upper mantle, it is important to synthesize a large olivine single crystal. In this study, we investigate growth of olivine crystals from totally-molten natural olivine.

The starting material was San Carlos olivine (Fo91). Before heating, olivine was thoroughly washed in the acetone. Up to about 1.0 kg of olivine was mounted in an iridium (Ir) crucible of 90 mm diameter and 90 mm height, and heated up to about 2000C under N2 atmosphere in the radio-frequency induction furnace. After olivine was completely melted, the temperature of the crucible was gradually decreased to room temperature in 30h. The size of the obtained product was 86 mm diameter and 50 mm height. The boring core of 54 mm diameter and 50 mm height was drilled from the product inside the crucible.

The quality of the product was examined using EPMA (EDS) and XRD. The upper area (depth 3 - 25 mm) formed nearly homogeneous olivine crystals, and their Fo contents were 96-97%. The lower area (depth 25 - 50 mm) was composed of olivine, pyroxene and magnetite. The magnetite in the lower area was separated by magnet, and identified using XRD analysis. The pyroxene contained Fe, Mg and minor amount of Ca and Mn, while the magnetite contained minor amount of Mg and Cr. In the lower area (depth 25 - 50 mm), Fo contents of olivine were 90-95%. And at the boundary where olivine was in contact with magnetite, Fo contents were lower than 90%. Microscopic observations indicate that the product is not a single crystal but poly crystals. Nevertheless, all olivine poly crystals become extinct simultaneously under the cross-polarized light so that their orientations are almost uniform.

The magnetite at 25 - 50 mm depth was oxidized. A part of ferrous iron has changed to ferric iron. It is likely that the crystallization of olivine causes an increase of ferric iron in the melt, since M sites in M2SiO4 are generally occupied by divalent cations. The enrichment of ferric iron may lead to the crystallization of magnetite. Then the melt becomes more felsic, crystallizing pyroxene.

The product contained magnetite and pyroxene as inclusions. However, at the upper region of the product (depth 3 - 25 mm), olivine poly crystals were homogeneous, and their orientations were almost uniform. Large homogeneous olivine single crystals may be grown by simply cooling the totally-molten natural olivine.

The authors thank the Material Design and Characterization Laboratory of the Institute for Solid State Physics of the University of Tokyo. This work was supported by grants from JSPS (C12640467), and from the Earthquake Research Institute of the University of Tokyo (2001-A-18 and 2002-A-18).