Phase transitions in (Ca0.5Mg0.5)SiO3 and MgAl2O4 to 40 GPa and bulk moduli of the high pressure phases

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Phase transitions in (Ca0.5Mg0.5)SiO3 diopside and MgAl2O4 spinel, major constituents of the peridotites from the uppermost mantle, have been studied using a combination of synchrotron radiation and a large multianvil press (SPEED-1500) at SPring-8. Sintered diamond cubes of 14 mm edge length were used for the second-stage anvils of the Kawai-type apparatus, which enabled generation of pressures to ~40 GPa at temperatures to ~1600C.

Diopside decomposed into an assemblage of CaSiO3 cubic and MgSiO3 orthorhombic perovskite at pressures 22 - 35 GPa, at ~1200C, which is consistent with our recent results at about 25 GPa (Irifune et al., 2000). Spinel decomposed into an oxide mixture (i.e. MgO periclase plus Al2O3 corundum) at pressures to 25 GPa, while it further transformed to the CaFe2O4-type phase at higher pressures to ~38 GPa, at around 1500C. No evidence of the existence of the e-MgAl2O4 reported by Liu (1978) was obtained in these P/T conditions, while the formation of the CaTi2O4-type phase (Funamori et al., 1998) was suggested at about 36 GPa, 1600C.

The room-temperature bulk moduli of the high pressure phases encountered in the present study were determined using the unit-cell volume data under pressure after the heating. The obtained K0 for MgSiO3 perovskite was consistent with those of earlier results, while that for CaSiO3 perovskite was substantially smaller than the results of many studies in '80. Still, the present results are in good agreement with those reported recently by Wang et al. (1996) and Shim et al. (2000). The bulk modulus of the CaFe2O4-type MgAl2O4 was also consistent with the result of Funamori et al. (1998), whereas it was significantly lower than that of Yutani et al. (1997).