P-V-T relations of MgSiO3 perovskite determined by in situ X-ray diffraction using a large-volume high-pressure apparatus

Tomoo Katsura[1]; Sho Yokoshi[2]; kazuyuki Kawabe[3]; Anton Shatskiy[4]; M. A. Geeth M. Manthilake[1]; Hiroshi Fukui[5]; Takashi Yoshino[6]; Daisuke Yamazaki[1]; Takuya Matsuzaki[1]; Akira Yoneda[1]; Eiji Ito[7]; Kenji Hagiya[8]; Ken-ichi Funakoshi[9]

[1] ISEI, Okayama Univ.; [2] Dept of Earth Sci, Okayama Univ; [3] ISEI,Okayama Univ; [4] Tohoku University; [5] SPring-8, RIKEN; [6] ISEI, Okayama Univ; [7] ISEI; [8] Life Sci., U. of Hyogo; [9] JASRI

The volume of $MgSiO_3$ perovskite has been precisely measured at pressures of 19 to 53 GPa and temperatures of 300 to 2300 K by means of in situ X-ray diffraction in a multi-anvil apparatus. The present results indicate the isothermal bulk modulus K_{T0} = 256(2) GPa and its pressure derivative K_{T0}' = 3.8(2). The fixed Debye temperature $theta_0$ = 1030 K gives a Grueneisen parameter at ambient pressure $gamma_0$ = 2.6(1) and its logarithmic volume dependence q = 1.7(1). The pressure derivative of the isothermal bulk modulus, Anderson-Grueneisen parameter and thermal expansion coefficient at ambient pressure are found to be (dK_T/dT) = -0.035(2) GPa/K, $delta_T$ = 6.5(3), $alpha_0$ = 2.6(1)x10^{-5} + 1.0(1)x10^{-8} (T-300) /K. Thus the thermal expansion coefficient largely becomes smaller with increasing pressure. The adiabatic geotherm would be fairly large, such as 0.41 K/km at a 660 km depth, and becoming smaller with increasing depth. The temperature and adiabatic geothermal gradient at the bottom of the D' layer would be 2400 K and 0.14 K/km. The buoyancy-driven mantle convection could be very small in the lower part of the lower mantle.