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学 位 論 文 要 旨
Dissertation Summary

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論　文　名: Symmetry and elasticity of majoritic garnets and phase relations in the system $MgSiO_3 - Al_2O_3$ at high pressure and high temperature
(Dissertation Title)

Summary:

Investigation of physical and chemical properties of minerals in the system $MgSiO_3 - Al_2O_3$ can provide important information to constrain the chemical composition, structure and mineralogy of the Earth's mantle. In this research thesis, I studied symmetry and elasticity of garnets under pressure and temperature conditions of the mantle transition zone and phase relations in the system $MgSiO_3$–Al_2O_3 under those of the upper part region of the lower mantle

Majoritic garnets in the system the majorite–pyrope were synthesized at high pressure and high temperature. The phase transition from cubic to tetragonal structure was obviously observed at a composition of $Mj_{74}Py_{26}$ in the majorite-pyrope system.

Elastic wave velocities of polycrystalline $Mj_{80}Py_{20}$ garnet along the majorite-pyrope system have been measured at pressures up to 21 GPa and temperatures up to 2000 K using ultrasonic interferometry in conjunction with in-situ X-ray diffraction techniques in a Kawai-type multi-anvil apparatus. Elastic moduli of $Mj_{80}Py_{20}$ garnet and their pressure and temperature derivatives are determined by a two-dimensional linear fitting of the present experimental data, yielding: K_S = 161.5 (7) GPa, $\partial K_S/\partial P$ = 4.42 (4), $\partial K_S/\partial T$ = -0.0154 (2) GPa/K, G = 86.2 (2) GPa, $\partial G/\partial P$ = 1.28 (1), $\partial G/\partial T$ = -0.0096 (5) GPa/K. The present results together with those of early studies on the majorite-pyrope solid solutions suggest the pressure and temperature derivatives of elastic moduli are insensitive to majorite content in the majorite-pyrope system. Velocity gradients of the majorite-pyrope solid solutions are 3~6 times lower than those required to account for the high seismic velocity gradients observed in the mantle transition zone.

Phase relations in the system $MgSiO_3 - Al_2O_3$ were investigated between 15.0 to 51.8 GPa at 2000 K using sintered diamond anvils in a multi-anvil apparatus. A two phase region of garnet and corundum existed between 15.0 to 27.0 GPa, and a wide phase assemblage of aluminous bridgamanite and corundum was stabilized at pressures above 27 GPa. Al_2O_3 solubility in bridgmanite and $MgSiO_3$ solubility in corundum are both dependent on pressure and temperature. The unit-cell volumes of aluminous bridgmanite increased with increasing Al_2O_3 content, and those of corundum also increased with increasing $MgSiO_3$ content. Bridgmanite with pyrope chemical composition is formed at ~ 45 GPa, which is significantly higher than previous result (37 GPa). Al_2O_3 content in bridgmanite and $MgSiO_3$ content in corundum maybe a good pressure reference at pressures greater than 30 GPa.