The 481th Geodynamics Seminar

Relationship between Al substitution mechanism and the physico-chemical properties of Al-bearing anhydrous bridgmanites

Masamichi Noda (Msc. student, Ehime University)

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Abstract

It is considered that two substitution mechanisms, Tschermak substitution and oxygen vacancy substitution, exist in $MgSiO_3$ bridgmanite for the incorporation of Al in anhydrous condition. Kubo and Akaogi (2000) has conducted the phase equilibrium experiment in the system $MgSiO_3$-Al_2O_3, and established the phase diagram up to 28 GPa. However the careful observation in the bridgmanite shows that the chemical compositions are slightly deviated from Tschermak substitution join. The same tendency can be also observed in the run products by Irifune et al. (1996). This result indicates that pure Tschermak substitution bridgmanite cannot be stable even in the $MgSiO_3$-Al_2O_3 join experiment. However, the previous studies used powder samples as the starting materials, so the absorbed water may affect the results. Therefore, we tried to conduct the experiment in the join $MgSiO_3$-Al_2O_3 in extremely anhydrous condition to clarify whether the pure Tschermak substitution bridgmanite can be stable or not. In addition, we also examined the stability of oxygen vacancy bridgmanite in the extremely anhydrous condition for the comparison.

The high pressure synthesis experiments were conducted at 28 GPa and 1600-1700℃ for 1hour using a Kawai-type multi-anvil apparatus. Four different Al content samples were prepared as the starting materials along the ideal substitution line of Tschermak (Al=0.025, 0.05, 0.1, 0.15 mol) and oxygen-vacancy (Al=0.025, 0.05, 0.075, 0.1 mol) substitutions, respectively (when total cation of 2). The glass rods were used as the starting materials to eliminate the absorbed water on the sample surface. The chemical compositions of the synthesized bridgmanite could not be measured by EPMA because of small grain size less than submicron. Therefore the chemical compositions were estimated from the result of the XRD pattern by subtracting the amount of the other phases. The estimated chemical compositions of Tschermak substitution bridgmanites were consistent with the ideal compositions. On the other hand, oxygen-vacancy substitution bridgmanite was possible to be existed less than Al=0.25 mol on the basis of total cation of 2. These results show that both Tschermak and oxygen-vacancy substitution bridgmanites can exist in low Al content in anhydrous condition.

Contact : Dr. Nishi (e-mail: nishi@sci.ehime-u.ac.jp)