

Al substitution mechanism in anhydrous bridgmanite in low Al content

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It is suggested that there are two types of Al substitution mechanisms in anhydrous bridgmanite (Brg), Tschermak and oxygen vacancy substitutions. However, the pure Tschermak substitution Brg has not been reported so far in low Al content, when carefully checked the previous studies. The reason may come from the absorbed water because the previous studies used powder samples as the starting materials. In this study, we investigated whether the pure Tschermak substitution Brg exists or not in extremely anhydrous condition. For the comparison, the stability of oxygen vacancy Brg was also examined in extremely anhydrous condition.

The high pressure synthesis experiments were conducted at 28 GPa and 1600-1700°C for 1 hour 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). These results show that both Tschermak and oxygen-vacancy substitution bridgmanites can exist in low Al content in anhydrous condition. We found the possible compositional area for Al-bearing anhydrous bridgmanite. The maximum Al content for pure oxygen-vacancy substitution bridgmanite is less than 0.025 mol in total cation of 2. Our result shows that hydration in Al-bridgmanite should occur easily if hydrogen exists in the system (lower mantle) in pyrolite (MgO-excess) composition. In MgO excess condition as pyrolite, oxygen-vacancy substitution favors in Al-bridgmanite in low Al content, if no hydrogen. On the other hand in SiO₂ excess condition as MORB and sediment, Tschermak substitution favors in Al-bridgmanite.

Keywords: anhydrous bridgmanite, Al substitution mechanism