

Stability of anhydrous phase B, $\text{Mg}_{14}\text{Si}_5\text{O}_{24}$, at the mantle transition zone conditions

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Stability of anhydrous phase B, $\text{Mg}_{14}\text{Si}_5\text{O}_{24}$, has been determined in the pressure range of 14-21 GPa and in the temperature range of 1100-1700°C with both normal and reverse experiments at high pressures and high temperatures. Our results imply that anhydrous phase B is stable at the P - T conditions corresponding to the shallow depth of the mantle transition zone and it decomposes into periclase and wadsleyite at greater depth. The decomposition boundary of anhydrous phase B into wadsleyite and periclase has a positive phase transition slope and can be expressed by the following equation, $P(\text{GPa}) = 7.5 + 6.6 \times 10^{-3}T(^{\circ}\text{C})$. Configuration disorder might account for an increase of entropy for anhydrous phase B at high-temperature conditions. It is suggested that MgO-rich conditions can be available in the deep mantle during hydrous melting of peridotite and the reduction of subduction carbonates by the metal-saturated mantle at depth > 250 km. Anhydrous phase B might become an important phase in the area where SiO_2 activity is low. We propose that the paragenesis of directly touched ferropericlase-olivine inclusions in natural diamonds might be the retrogression products of anhydrous phase B via the decomposition reaction $\text{Anh-B} = \text{Olivine} + \text{Periclase}$ during the transportation of host diamonds from the deep to the surface. Our experimental results put a constraint on the origin of such diamonds at a depth less than 500 km. On the cooling of the magma ocean during the early history of the Earth, a distinctive layer that was concentrated with hydrogen and other elements such as Fe, Ca, Mn substituting Mg might exist with the crystallization and accumulation of anhydrous phase B at depth equivalent to the upper part of the mantle transition zone.

Keywords: Anhydrous phase B, phase relations, Clapeyron slope, diamond inclusions, Raman spectra