

Phase diagram of MgSiO₃ in the upper mantle

*Shigeaki Ono¹

1. Japan Agency for Marine-Earth Science and Technology

As olivine, pyroxene and garnet are major minerals in the upper mantle, understanding the dynamics and evolution of the mantle requires knowledge of MgSiO₃, which is an end-member of pyroxene. Therefore, phase relations in MgSiO₃ have been repeatedly investigated by a number of author. We investigated the disputed issue of two phase boundaries (high-pressure clinoenstatite and wadsleyite + stishovite, ringwoodite + stishovite and akimotoite) in MgSiO₃, and suggest a revised phase diagram for MgSiO₃ based on the obtained data.

We performed the high-pressure experiments using a multi-anvil high-pressure system combined with a synchrotron radiation source made it possible to acquire precise data from samples under high-pressure and high-temperature conditions. Experimental details have been described elsewhere [1,2]. A synthetic gel was used to produce a reactive and homogeneous starting material. The chemical composition of the synthesized gel was MgSiO₃.

The reaction boundaries in MgSiO₃ were determined over the range of 1150–1450 K. The stability of each phase was determined by observing the powdered X-ray diffraction data and analyzing the recovered samples. The reaction boundary between high-pressure clinoenstatite and wadsleyite + stishovite was found to occur at $P \text{ (GPa)} = 16.1 + 0.0064 \times (T - 1250) \text{ (K)}$. According to our new data, the stability field of wadsleyite and stishovite expands to a low temperature region. The reaction boundary between ringwoodite + stishovite and akimotoite was found to occur at $P \text{ (GPa)} = 22.0 - 0.0012 \times T \text{ (K)}$ [3]. This indicated that the triple point of ringwoodite+stishovite-wadsleyite+stishovite-akimotoite estimated in our study was at ~20 GPa and ~1700 K. The revised phase boundaries reconcile inconsistencies recorded between previous studies regarding the phase relation in MgSiO₃.

[1] S. Ono et al. (2011) *Phys. Chem. Minerals*, 38, 735-740.

[2] S. Ono et al. (2013) *Phys. Chem. Minerals*, 40, 811-816.

[3] S. Ono et al. (2017) *Phys. Chem. Minerals*, 44, 425-430.

Keywords: Pyroxene, Upper mantle, Phase diagram