Influence of high oxygen fugacity on melting temperature of wadsleyite

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About 60% of the upper part of the Earth's mantle transition zone is composed of wadsleyite, which is the high-pressure phase of olivine. It is known that water and ferric iron are supplied to the mantle transition zone by subduction of the oceanic plates. A recent study revealed that ferric iron lowers melting temperature of bridgmanite, the major mineral in the lower mantle, in the MgO-FeO-Fe_2O_3-SiO_2 system (Sinmyo et al., 2019). However, the effect of high oxygen fugacity on melting temperature of wadsleyite has not been studied so far. Therefore, in this study, we conducted experiments to clarify the effect of high oxygen fugacity on the melting temperature of $(Mg_{0.9},Fe_{0.1})_2SiO_4$ wadsleyite using a Kawai-type multi-anvil press. The experiments were performed 11 times in the range of 13.7-16.6 GPa and 1300-1500 ℃ with controlled oxygen fugacity by Re-ReO_2 or Mo-MoO_2 buffer. As a result, quenched crystals were observed in the range of 1500-~1900 ℃ at high oxygen fugacity with controlled oxygen fugacity by Re-ReO_2 buffer while no quenched crystals were observed at low oxygen fugacity with controlled oxygen fugacity by Mo-MoO_2 buffer. Wadsleyite with the $(Mg_{0.9},Fe_{0.1})_2SiO_4$ composition melts at about 2300 ℃ at low oxygen fugacity (Ohtani et al., 1998). Therefore, this result shows that the melting temperature of wadsleyite is lowered by at least about 800 ℃ due to the influence of high oxygen fugacity.

Keywords: Wadsleyite, Mantle transition zone, Oxygen fugacity buffer, Melting temperature, Quenched crystals

