

Effects of pressure and oxygen fugacity for the production of metallic Fe from (Mg, Fe)O

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It is well established that the mantle transition can contain a substantial amount of water. Moreover, the transport of water-rich materials from the MTZ down to the lower mantle (LM) would induce partial melting. It has been reported that the presence of metallic Fe under the shallow lower mantle conditions. If metallic iron formed, it can influence partial melting by absorbing water from those water-rich minerals. However, there are no quantitative studies on metallic Fe as a function of pressure and some other thermochemical conditions such as oxygen fugacity.

Tsujino et al. conducted an experimental study on metallic Fe formation in bridgmanite (Tsujino et al. 2018); Here, we focus on its creation in (Mg, Fe)O. A combination of these two studies may provide a better understanding of metallic Fe formation in the lower mantle. We first investigated metallic Fe formation at room pressure. Metallic Fe was formed when oxygen fugacity was below a certain level, and, as a result of its formation, FeO content in (Mg, Fe)O was reduced. We then extended to high pressures to examine the influence of confining pressure on metallic Fe formation. We performed high-pressure experiments (up to ~23 GPa) with controlling oxygen fugacity by two different buffers. To understand the formation processes of metallic Fe in these experiments, we measured the left FeO content by EPMA in both the sample region and buffer region. We also calculated the metallic iron content by image analysis to compare with that derived from mass balance.

According to the results, the pressure has a negative effect on metallic iron formation in our experiment condition. Besides, the lower oxygen fugacity can reduce more FeO into metallic iron. Which means that it may be hard to form metallic iron in depth with high pressure but not low enough oxygen fugacity. In another word, it may explain why we have partial melting in the 730km not 660km as well.